

## **SECTION 02 41 16**

### **DEMOLITION**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

A. Section Includes:

1. Demolition and removal of site improvements.
2. Abandoning in-place and/or removing below-grade construction.
3. Disconnecting, capping or sealing, and abandoning in-place and/or removing site utilities.
4. Salvaging items for reuse by Owner.

##### **1.2 MATERIALS OWNERSHIP**

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

##### **1.3 PREINSTALLATION MEETINGS**

- A. Predemolition Conference: Conduct conference at Project site.

##### **1.4 INFORMATIONAL SUBMITTALS**

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, including dust control. Indicate proposed locations and construction of barriers.
1. Adjacent Structures: Detail special measures proposed to protect adjacent structures to remain.
- B. Schedule of demolition activities with starting and ending dates for each activity.
- C. Predemolition photographs or video.

##### **1.5 CLOSEOUT SUBMITTALS**

- A. Inventory of items that have been removed and salvaged.

## **1.6 FIELD CONDITIONS**

- A. Facilities immediately adjacent to demolition area will be occupied. Conduct demolition so operations of occupied facilities will not be disrupted.
  - 1. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied facilities.
  - 2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent facilities.
    - a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent facilities without written permission from the Engineer.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
  - 1. Before demolition, Owner will remove the following items:
    - a. Porta-potties.
- C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. .
- D. On-site storage or sale of removed items or materials is not permitted.
- E. Arrange demolition schedule so as not to interfere with operations of adjacent occupied facilities.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

### **2.2 SOIL MATERIALS**

- A. Satisfactory Soils: Comply with requirements in Section 312000 "Earth Moving."

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Inventory and record the condition of items to be removed and salvaged.

### **3.2 PREPARATION**

- A. Salvaged Items: Comply with the following:
1. Clean salvaged items of dirt and demolition debris.
  2. Pack or crate items after cleaning. Identify contents of containers.
  3. Store items in a secure area until delivery to Owner.
  4. Transport items to storage area designated by Owner.
  5. Protect items from damage during transport and storage.

### **3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS**

- A. Existing Utilities to be Disconnected: Locate, identify, disconnect, and seal or cap off utilities serving buildings and structures to be demolished.
1. Owner will arrange to shut off site-owned utilities when requested by Contractor.
  2. Arrange to shut off utilities with utility companies if required.
  3. If removal, relocation, or abandonment of utility services will affect adjacent occupied facilities, then provide temporary utilities that bypass facilities and structures to be demolished and that maintain continuity of service to other facilities and structures.
  4. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
  5. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

### **3.4 PROTECTION**

- A. Existing Facilities: Protect adjacent walkways, fences, retaining walls, facility entries, and other existing improvements to remain during demolition operations. Maintain exits from existing facilities.
- B. Existing Utilities to Remain: Maintain utility services to remain and protect from damage during demolition operations. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and/or authorities having jurisdiction.
- C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, etc., where required by Engineer and as indicated. Comply with requirements in Section 015200 "Temporary Facilities."
1. Protect adjacent facilities from damage due to demolition activities.
  2. Protect existing site improvements, appurtenances, and landscaping to remain.
  3. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent facilities to remain.
  4. Provide protection to ensure safe passage of people around demolition area and to and from occupied portions of adjacent facilities and structures.
- D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

### **3.5 DEMOLITION**

- A. General: Demolish indicated site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
  - 2. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
  - 3. Maintain adequate ventilation when using cutting torches.
- B. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
  - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.
- C. Explosives: Use of explosives is not permitted.
- D. Salvage: Items to be removed and salvaged are indicated on Drawings.
- E. Existing Utilities: Demolish or abandon existing utilities and below-grade utility structures.
- F. Below-Grade Areas: Completely fill below-grade areas and voids resulting from demolition operations with satisfactory soil materials according to backfill requirements in Section 312000 "Earth Moving."
- G. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.
- H. Promptly repair damage to adjacent facilities caused by demolition operations.

### **3.6 CLEANING**

- A. Remove demolition waste materials from Project site and recycle or dispose of them according to Section 017419 "Construction Waste Management."
- B. Do not burn demolished materials.
- C. Clean adjacent facilities and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before building operations began.

## **PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit prices paid per SQUARE FOOT for REMOVE ASPHALT CONCRETE PAVEMENT and REMOVE CONCRETE SIDEWALK shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with removing asphalt and Portland cement concrete pavement including saw cutting and

disposal, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.

- B. The Contract unit prices paid per LINEAR FOOT for REMOVE ASPHALT CONCRETE DIKE, REMOVE CONCRETE CURB AND GUTTER, and REMOVE CONCRETE CURB shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with removing asphalt concrete dikes and concrete curb and gutter, including saw cutting and disposal, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- C. The Contract unit price paid per LINEAR FOOT for REMOVE CHAIN LINK FENCE AND GATES shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with removing chain link fencing, including removing footings and gates, and disposal, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- D. The Contract lump sum price paid for REMOVE DRAIN INLET shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with removing the storm drain inlet, including disposal, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- E. The Contract unit prices paid per EACH for REMOVE AND SALVAGE EXISTING LIGHT POLE, for REMOVE AND DISPOSE OF EXISTING LIGHT POLE, and for REMOVE AND SALVAGE TRASH CAN shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with removing and salvaging or disposing of existing light poles, including foundations, and removing and salvaging trash cans, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- F. The Contract unit price paid per EACH for REMOVE ELECTRICAL HANDHOLE shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with removing and disposing of electrical handholes, including backfill, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- G. The Contract unit price paid per EACH for REMOVE ROADSIDE SIGNS (SALVAGE PANEL) shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with removing signs, including removing post and footing, and salvaging sign panel, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- H. The Contract unit prices paid per EACH for REMOVE WOOD POLE and REMOVE BOLLARD AND OPEN GATE POST shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with removing wood pole barriers and bollards, including foundation, if existing, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.

**END OF SECTION 02 41 16**

**SECTION 03 20 00**  
**CONCRETE REINFORCING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Steel reinforcement bars.
- B. Related Requirements:
  - 1. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For the following:
  - 1. Each type of steel reinforcement.
  - 2. Mechanical splice couplers.
- B. Shop Drawings: Comply with ACI SP-066:
  - 1. Include placing drawings that detail fabrication, bending, and placement.
  - 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
  - 1. Location of construction joints is subject to approval of the Architect.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Statements: For testing and inspection agency.
- B. Welding certificates.
  - 1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M

- C. Material Test Reports: For the following, from a qualified testing agency:
  - 1. Steel Reinforcement:
    - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
  - 2. Mechanical splice couplers.
- D. Field quality-control reports.
- E. Minutes of preinstallation conference.

## 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
  - 1. Store reinforcement to avoid contact with earth.

## PART 2 - PRODUCTS

### 2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.
- C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.
- D. Galvanized Reinforcing Bars:
  - 1. Steel Bars: ASTM A615/A615M, Grade 60, deformed bars.
  - 2. Zinc Coating: ASTM A767/A767M, Class I zinc coated after fabrication and bending.
- E. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60, deformed bars, assembled with clips.
- F. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- G. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

- H. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.

## 2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
  - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
    - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
    - b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
    - c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
    - d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
    - e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Mechanical Splice Couplers: ACI 318 Type 1, same material of reinforcing bar being spliced; mechanical-lap type.
- D. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.
  - 1. Finish: Plain.
- E. Zinc Repair Material: ASTM A780/A780M.

## 2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection of In-Place Conditions:
  - 1. Do not cut or puncture vapor retarder.
  - 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

### **3.2 INSTALLATION OF STEEL REINFORCEMENT**

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
  - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
  - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
  - 1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than bar diameters at splices, or 24 inches, whichever is greater.
  - 2. Stagger splices in accordance with ACI 318.
  - 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
  - 4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install welded-wire reinforcement in longest practicable lengths.
  - 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
    - a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches.
  - 2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
  - 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
  - 4. Lace overlaps with wire.

### **3.3 JOINTS**

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 1. Place joints perpendicular to main reinforcement.
  - 2. Continue reinforcement across construction joints unless otherwise indicated.
  - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

### **3.4 INSTALLATION TOLERANCES**

- A. Comply with ACI 117.

**3.5 FIELD QUALITY CONTROL**

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
  - 1. Steel-reinforcement placement.
  - 2. Steel-reinforcement mechanical splice couplers.
  - 3. Steel-reinforcement welding.
- D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Full compensation for CONCRETE REINFORCING shall be considered as included in the various cast-in-place concrete related items of work and no separate payment will be made therefor.

**END OF SECTION 03 20 00**

**SECTION 03 30 00**

**CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
  - 1. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
  - 2. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
  - 3. Section 321313 "Concrete Paving" for concrete pavement and walks.

**1.3 DEFINITIONS**

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

**1.4 PREINSTALLATION MEETINGS**

- 1. Review the following:
  - a. Special inspection and testing and inspecting agency procedures for field quality control.
  - b. Construction joints, control joints, isolation joints, and joint-filler strips.
  - c. Anchor rod and anchorage device installation tolerances.
  - d. Cold and hot weather concreting procedures.
  - e. Curing procedures.
  - f. Concrete repair procedures.
  - g. Concrete protection.
  - h. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
  - i. Protection of field cured field test cylinders.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each of the following.
1. Portland cement.
  2. Aggregates.
  3. Admixtures:
    - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
  4. Curing materials.
  5. Joint fillers.
  6. Repair materials.
- B. Design Mixtures: For each concrete mixture, include the following:
1. Mixture identification.
  2. Minimum 28-day compressive strength.
  3. Durability exposure class.
  4. Maximum w/cm.
  5. Slump limit.
  6. Air content.
  7. Nominal maximum aggregate size.
  8. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
  9. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
  10. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
  11. Intended placement method.
- C. Shop Drawings:
1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
    - a. Location of construction joints is subject to approval of the Engineer.
- D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:
1. Location within Project.
  2. Curing process.
  3. Floor treatment if any.
- E. Concrete Stamps for Enhanced Concrete Paving – see plans.
- F. Field Sample of Enhanced Concrete paving – see plans.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For the following:
  - 1. Installer: Include copies of applicable ACI certificates.
  - 2. Ready-mixed concrete manufacturer.
  - 3. Testing agency: Include copies of applicable ACI certificates.
- B. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Curing compounds.
  - 4. Floor and slab treatments.
  - 5. Adhesives.
  - 6. Vapor retarders.
  - 7. Repair materials.
- C. Material Test Reports: For the following, from a qualified testing agency:
  - 1. Portland cement.
  - 2. Aggregates.
  - 3. Admixtures:
    - a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.
- D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.
- E. Research Reports:
  - 1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
  - 2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.
- F. Preconstruction Test Reports: For each mix design.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.
  - 1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.
- B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
  1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
  1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

## **1.8 PRECONSTRUCTION TESTING**

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
  1. Include the following information in each test report:
    - a. Admixture dosage rates.
    - b. Slump.
    - c. Air content.
    - d. Seven-day compressive strength.
    - e. 28-day compressive strength.
    - f. Permeability.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with ASTM C94/C94M and ACI 301.

## **1.10 FIELD CONDITIONS**

- A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.
  1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  3. Do not use frozen materials or materials containing ice or snow.
  4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
  5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## **PART 2 - PRODUCTS**

### **2.1 CONCRETE, GENERAL**

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

### **2.2 CONCRETE MATERIALS**

- A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

- B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I/II.
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Silica Fume: ASTM C1240 amorphous silica.

- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 1N coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:
  - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
  - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
  - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.
2. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm) nominal.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

- D. Air-Entraining Admixture: ASTM C260/C260M.

- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.
  - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  - 2. Retarding Admixture: ASTM C494/C494M, Type B.
  - 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  - 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
  - 7. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).
    - a. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRD C48 at a hydraulic pressure of 200 psi for 14 days.
- F. Water and Water Used to Make Ice: ASTM C94/C94M, potable or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4.

### 2.3 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
  - 1. Color:
    - a. Ambient Temperature Below 50 deg F: Black.
    - b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
    - c. Ambient Temperature Above 85 deg F: White.
- D. Curing Paper: Eight-feet- wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
- E. Water: Potable or complying with ASTM C1602/C1602M.

### 2.4 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

## 2.5 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
  4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

## 2.6 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash or Other Pozzolans: 25 percent by mass.
  2. Slag Cement: 50 percent by mass.
  3. Silica Fume: 10 percent by mass.
  4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
  5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.

2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use permeability-reducing admixture in concrete mixtures where indicated.

## 2.7 CONCRETE MIXTURES

- A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.
1. Exposure Class: ACI 318 S3.
  2. Minimum Compressive Strength: 4000 psi at 28 days.
  3. Maximum w/cm: 0.40.
  4. Slump Limit: 4 inches, plus or minus 1 inch 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
- B. Class B: Normal-weight concrete used for foundation walls.
1. Exposure Class: ACI 318 S3.
  2. Minimum Compressive Strength: 4000 psi at 28 days.
  3. Maximum w/cm: 0.40.
  4. Slump Limit: 4 inches, plus or minus 1 inch 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
- C. Class C: Normal-weight concrete used for interior slabs-on-ground.
1. Exposure Class: ACI 318 S3.
  2. Minimum Compressive Strength: 4000 psi at 28 days.
  3. Maximum w/cm: 0.40.
  4. Minimum Cementitious Materials Content: 520 lb/cu. yd..
  5. Slump Limit: 4 inches, plus or minus 1 inch 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
  6. Air Content:
    - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

## 2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
  2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
  3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verification of Conditions:
  - 1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
  - 2. Do not proceed until unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
  - 1. Daily access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
  - 4. Security and protection for test samples and for testing and inspection equipment at Project site.

#### **3.3 INSTALLATION OF EMBEDDED ITEMS**

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
  - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
  - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

#### **3.4 INSTALLATION OF VAPOR RETARDER**

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
  - 1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
  - 2. Face laps away from exposed direction of concrete pour.
  - 3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
  - 4. Lap joints 6 inches and seal with manufacturer's recommended tape.
  - 5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
  - 6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
  - 7. Protect vapor retarder during placement of reinforcement and concrete.

- a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

### 3.5 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
  1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Engineer.
  2. Place joints perpendicular to main reinforcement.
    - a. Continue reinforcement across construction joints unless otherwise indicated.
    - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
  3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
  4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
  1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
  2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
  3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

- E. Doweled Joints:
  - 1. Install dowel bars and support assemblies at joints where indicated on Drawings.
  - 2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
  - 1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
  - 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Engineer and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer in writing, but not to exceed the amount indicated on the concrete delivery ticket.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
  - 1. If a section cannot be placed continuously, provide construction joints as indicated.
  - 2. Deposit concrete to avoid segregation.
  - 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
    - a. Do not use vibrators to transport concrete inside forms.
    - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
    - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - 1. Do not place concrete floors and slabs in a checkerboard sequence.
  - 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 3. Maintain reinforcement in position on chairs during concrete placement.
  - 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 5. Level concrete, cut high areas, and fill low areas.
  - 6. Slope surfaces uniformly to drains where required.
  - 7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleed water appears on the surface.
  - 8. Do not further disturb slab surfaces before starting finishing operations.

### 3.7 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish:
  - 1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
  - 2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
- C. Float Finish:
  - 1. When bleed water sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
  - 2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
- D. Trowel Finish:
  - 1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
  - 2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
  - 3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 4. Do not add water to concrete surface.
  - 5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
  - 6. Apply a trowel finish to surfaces exposed to view.
  - 7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
    - a. Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.

### **3.8 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS**

- A. Filling In:
  - 1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
  - 2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
  - 3. Provide other miscellaneous concrete filling indicated or required to complete the Work.
  
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
  
- C. Equipment Bases and Foundations:
  - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  - 2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
  - 3. Minimum Compressive Strength: 4000 psi at 28 days.
  - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
  - 6. Prior to pouring concrete, place and secure anchorage devices.
    - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - b. Cast anchor-bolt insert into bases.
    - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

### **3.9 CONCRETE CURING**

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
  - 1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
  - 2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
  
- B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
  - 1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
  - 2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
  - 3. If forms remain during curing period, moist cure after loosening forms.
  - 4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
    - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    - b. Continuous Sprinkling: Maintain concrete surface continuously wet.

- c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
- d. Water-Retention Sheetting Materials: Cover exposed concrete surfaces with sheetting material, taping, or lapping seams.
- e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
  - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
  - 2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

- 1. Begin curing immediately after finishing concrete.

### **3.10 TOLERANCES**

A. Conform to ACI 117.

### **3.11 CONCRETE SURFACE REPAIRS**

A. Defective Concrete:

- 1. Repair and patch defective areas when approved by Engineer.
- 2. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

- 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
  - a. Limit cut depth to 3/4 inch.
  - b. Make edges of cuts perpendicular to concrete surface.
  - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
  - d. Fill and compact with patching mortar before bonding agent has dried.
  - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
- 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
  - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
  - b. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
  - a. Correct low and high areas.
  - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
  - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
  - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
  - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
  - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
  - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
  - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
  - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
  - d. Place, compact, and finish to blend with adjacent finished concrete.
  - e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
  - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
  - b. Dampen cleaned concrete surfaces and apply bonding agent.
  - c. Place patching mortar before bonding agent has dried.

- d. Compact patching mortar and finish to match adjacent concrete.
  - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

### 3.12 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- 1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
  - 2. Testing agency shall immediately report to Engineer, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
  - 3. Testing agency shall report results of tests and inspections, in writing, to Owner, Engineer, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
      - 1) Project name.
      - 2) Name of testing agency.
      - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
      - 4) Name of concrete manufacturer.
      - 5) Date and time of inspection, sampling, and field testing.
      - 6) Date and time of concrete placement.
      - 7) Location in Work of concrete represented by samples.
      - 8) Date and time sample was obtained.
      - 9) Truck and batch ticket numbers.
      - 10) Design compressive strength at 28 days.
      - 11) Concrete mixture designation, proportions, and materials.
      - 12) Field test results.
      - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
      - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Engineer.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
  - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
  - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - b. Perform additional tests when concrete consistency appears to change.
3. Slump Flow: ASTM C1611/C1611M:
  - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - b. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete
  - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
  - a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Compression Test Specimens: ASTM C31/C31M:
  - a. Cast and laboratory cure two sets of three 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
  - b. Cast, initial cure, and field cure twosets of two standard cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M.
  - a. Test one set of three laboratory-cured specimens at seven days and one set of two specimens at 28 days.

- b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
  9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
  10. Additional Tests:
    - a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
    - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Engineer.
      - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 section 1.6.6.3.
  11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within **24** hours of completion of floor finishing and promptly report test results to Engineer.

### **3.13 PROTECTION**

- A. Protect concrete surfaces as follows:
1. Protect from petroleum stains.
  2. Diaper hydraulic equipment used over concrete surfaces.
  3. Prohibit vehicles from interior concrete slabs.
  4. Prohibit use of pipe-cutting machinery over concrete surfaces.
  5. Prohibit placement of steel items on concrete surfaces.
  6. Prohibit use of acids or acidic detergents over concrete surfaces.
  7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
  8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

### **PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit price paid per CUBIC YARD for CONCRETE BIOFILTRATION BASIN WALLS shall include full compensation for furnishing all labor, material, tools, equipment and

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incidentals, and for doing all Work involved with forming and pouring the structure elements, including excavation and disposal, reinforcement, curing, and block outs for penetrations, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.

**END OF SECTION 03 30 00**

## **SECTION 10 14 26**

### **ROADSIDE SIGNS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Nonilluminated post-and-panel signs.

##### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For signage.
  - 1. Include fabrication and installation details and attachments to other work.
  - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
  - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.

#### **PART 2 - PRODUCTS**

##### **2.1 POST-AND-PANEL SIGNS**

- A. Post-and-Panel Sign: Sign of single-panel configuration; with smooth, uniform surfaces and support assembly; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
  - 1. Sign Panels: Aluminum and conforming to Caltrans Standard Specifications Section 82-2, "Sign Panels." Use removed and salvaged sign panels that are in good condition and
  - 2. Posts: Perforated square steel tubing and conforming to Caltrans Standard Specifications Section 82-3, "Roadside Signs," and as indicated.
- B. Fasteners and Anchors: Conform to Caltrans Standard Specifications Section 82-3, "Roadside Signs."

#### **PART 3 - EXECUTION**

##### **3.1 INSTALLATION**

- A. General: Install signs using installation methods indicated, in conformance with Caltrans Standard Specifications Section 82-2, "Sign Panels", Section 82-3, "Roadside Signs," and according to manufacturer's written instructions.

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1. Install signs level, plumb, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign components are clean and free of materials or debris that would impair installation.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract prices paid per EACH for RESET ROADSIDE SIGN ON NEW POST and for NEW ROADSIDE SIGN ON NEW POST shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals, and for doing all Work involved in furnishing and installing post and footing materials and fastening salvage signs, complete in place, as specified in these Technical Specifications, as shown on the Plans, and as directed by the Engineer.

**END OF SECTION 10 14 26**

**SECTION 12 93 00**  
**SITE FURNISHINGS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This work is to be completed by City forces. Contractor shall work closely with City to ensure that the site and planting work are properly coordinated,
- B. This Section includes the following:
  - 1. Benches
  - 2. Trash and Recycling Receptacle
- C. Products furnished, but not installed under this Section, include anchor bolts.

**1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
  - 1. 03 30 00 Cast-in-Place Concrete for general building applications of concrete and concrete footings.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Submit catalog cuts, samples and manufacturers literature of all manufactured items in this section to the City for approval before installation.
  - 1. Provide color samples, brushouts, or charts for all items.
- C. Product Schedule: For site furnishings. Use same designations indicated on Drawings.
- D. Material Certificates: For site furnishings, signed by manufacturers.
- E. Maintenance Data: For site furnishings to include in maintenance manuals.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURED ITEMS**

- A. Benches: See Details

- B. Trash & Recycling Receptacles: See Details

## **2.2 FABRICATION (NOT USED)**

## **2.3 FINISHES, GENERAL**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION, GENERAL**

- A. Benches, Bike Racks, Trash Receptacles: Install products per manufacturer's recommendations, provide embedded installation where specified in plans and details, materials shall be square, plumb, level, accurately aligned, and securely anchored at locations as indicated on Drawings. Use extensions where required.
- B. Coordinate placement of anchor screws in concrete with site furnishing manufacturers.
- C. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

### **3.3 CLEANING**

- A. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

### **3.4 GUARANTEE:**

- A. At completion of project, Contractor shall provide City with written guarantee from each manufacturer identifying the nature of warranty for each product component.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. All work associated with Site Furnishings is not included in this contract. As such, no additional compensation will be made therefor.

**END OF SECTION 12 93 00**

**SECTION 22 13 13**  
**FACILITY SANITARY SEWERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Hubless cast-iron soil pipe and fittings.
  - 2. HDPE pipe and fittings.
  - 3. Nonpressure-type transition couplings.
  - 4. Cleanouts.
  - 5. Manholes.
  - 6. Concrete.

**1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of pipe and fitting.
- B. Field quality-control reports.

**PART 2 - PRODUCTS**

**2.1 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings: ASTM A888 or CISPI 301.
- B. CISPI-Trademark, Shielded Couplings:
  - 1. Description: ASTM C1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Shielded Couplings:
  - 1. Description: ASTM C1277 and ASTM C1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

## **2.2 PE PIPE AND FITTINGS**

- A. PE, AWWA Pipe: AWWA C906, DR No. 17; with PE compound number required to give pressure rating not less than 125 psig.
  - 1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 125 psig.

## **2.3 NONPRESSURE-TYPE TRANSITION COUPLINGS**

- A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
  - 1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
  - 2. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
  - 3. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded, Flexible Couplings:
  - 1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Nonpressure-Type, Rigid Couplings:
  - 1. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

## **2.4 CLEANOUTS**

- A. Cast-Iron Cleanouts:
  - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
  - 2. Top-Loading Classification(s): Medium Duty.
  - 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

## **2.5 MANHOLES**

- A. Standard Precast Concrete Manholes:
  - 1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  - 2. Diameter: 48 inches minimum unless otherwise indicated.

3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch- minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile or ASTM A48/A48M, Class 35 gray iron unless otherwise indicated.

## 2.6 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II or V.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
  - a. Invert Slope: 1 minimum percent through manhole.

2. Benches: Concrete, sloped to drain into channel.
  - a. Slope: 8 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
  1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
  2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

### **PART 3 - EXECUTION**

#### **3.1 EARTHWORK**

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

#### **3.2 PIPING INSTALLATION**

- A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
  1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
  2. Install piping with 48-inch minimum cover.
  3. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  4. Install PE pipe according to ASTM D2774 and ASTM F645.
- F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

#### **3.3 PIPE JOINT CONSTRUCTION**

- A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
  2. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
  3. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.
- B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - a. Shielded flexible couplings for pipes of same or slightly different OD.

### **3.4 MANHOLE INSTALLATION**

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

### **3.5 CONCRETE PLACEMENT**

- A. Place cast-in-place concrete according to ACI 318.

### **3.6 CLEANOUT INSTALLATION**

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
  1. Use Medium-Duty, top-loading classification cleanouts.
  2. Use Heavy-Duty, top-loading classification cleanouts if moved to paved areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade if in landscaped areas.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

### **3.7 CONNECTIONS**

- A. Make connections to existing piping and underground manholes.
  1. Make branch connections from side into underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform

to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

- a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
  - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

### **3.8 IDENTIFICATION**

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
  1. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

### **3.9 FIELD QUALITY CONTROL**

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
  1. Submit separate report for each system inspection.
  2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  1. Do not enclose, cover, or put into service before inspection and approval.
  2. Test completed piping systems according to requirements of authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  4. Submit separate report for each test.
  5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

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- a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
  - b. Close openings in system and fill with water.
  - c. Purge air and refill with water.
  - d. Disconnect water supply.
  - e. Test and inspect joints for leaks.
6. Manholes: Perform hydraulic test according to ASTM C969.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit price paid per LINEAR FOOT for 6" HDPE SANITARY SEWER PIPE shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with installing sewer pipe, including excavating a trench, bedding, backfill, and compaction, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- B. The Contract unit prices paid per EACH for SANITARY SEWER MANHOLE and SANITARY SEWER CLEANOUT shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with installing sanitary sewer manholes and cleanouts, including excavation, backfill, compaction, and surface improvements, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.

**END OF SECTION 22 13 13**

**SECTION 26 05 00**

**COMMON WORK RESULTS FOR ELECTRICAL**

**PART 1 – GENERAL**

**1.1 SCOPE OF WORK**

- A. Provide labor, materials, equipment, transportation and perform operations necessary or incidental to the proper execution and completion of the electrical work, whether specifically mentioned or not, and as directly indicated or reasonably implied by the Drawings and Specifications.

**1.2 WORK NOT INCLUDED**

- A. Refer to the specific electrical specification sections for a detailed listing of work that is not included in this Contract.
- B. In any case, cooperate with the other trades who may or may not be party to this Contract for the purpose of coordinating the electrical requirements and installation of equipment, materials, and furnishings provided by those other trades, including the Owner.

**1.3 CODES AND STANDARDS**

- A. Provide equipment and materials which conform to, and perform the installation thereof in accordance with the following codes and industry standards. The applicable version of each shall be that in effect as of the date of the Contract:
  - 1. California Electrical Code (CEC).
  - 2. Titles 8, 19 and 24 of the California Code of Regulations (CCR).
  - 3. American National Standards Institute (ANSI).
  - 4. California State Fire Marshal (CSFM).
  - 5. Underwriters' Laboratories (UL).
  - 6. National Electrical Manufacturers' Association (NEMA).
    - a. Institute of Electrical and Electronics Engineers (IEEE).
      - 1) National Electrical Safety Code (NESC).
        - a) Electrical Safety Orders.
        - b) Other applicable local codes and ordinances.
- B. Where the authority-having-jurisdiction makes an interpretation or decision, as is their prerogative in accordance with the Code, such direction shall be considered a part of these Contract Documents as if contained herein. With respect to completing the intent of the Contract Documents, comply with any and all requirements of the authority-having-jurisdiction and utility company field inspectors, at no additional cost.
- C. The above referenced codes and standards are considered to be absolute minimum requirements. The Drawings and Specifications shall take precedence over the above

referenced codes and standards where materials or workmanship of higher quality or larger size is indicated. Nothing in these Drawings or Specifications shall be construed to allow work not conforming to the applicable codes and standards.

**1.4 REVIEW OF CONTRACT DOCUMENTS**

- A. Examine all relevant Contract Documents including Drawings, Specifications, and Shop Drawings in order to become acquainted with the Work of other installers whose activities will adjoin or be affected by the Electrical Work.

**1.5 PERMITS, LICENSES, AND FEES**

- A. Procure and pay for all permits, licenses and fees that are required to carry out and complete the Electrical Work.
- B. Pay for building department or utility company imposed inspection fees.
- C. Pay utility company charges for normal or after hours shutdowns, service calls, repairs, and cable locating that are directly related to the installation of the Electrical Work.

**1.6 SITE VERIFICATION OF INFORMATION**

- A. Visit the project site prior to submitting a bid and verify the condition, location and dimensions of buildings, equipment, and facilities. Become acquainted with conditions under which the Work is to be performed and which may affect the cost thereof.
- B. Verify at the project site, the accuracy of information shown on the Drawings regarding existing equipment, materials, and facilities. This includes but is not limited to: size, type, rating, quality, age, and serviceability. No allowance will be made on behalf of the Contractor for extra expenses resulting from the failure to discover conditions affecting the Work.

**1.7 WORKING SPACE**

- A. Maintain adequate work space around, and access to, electrical and mechanical equipment in strict accordance with the applicable Codes. Verify during the course of construction that sufficient space will be available for the installation equipment, fixtures, etc.

**1.8 MATERIALS AND SUBSTITUTIONS**

- A. Materials shall be new, high quality, free from defects, of standard make, and of the brand or grade as shown on the Drawings or specified herein. Specific trade names are used in the Drawings and Specifications in order to establish the standard grade and characteristics of said items. This does not imply the right upon the part of the Contractor to use other materials or methods without the approval of the Architect.
- B. Electrical materials and equipment shall bear the label of, or be listed by, the Underwriters' Laboratories (UL) wherever standards have been established and label service is regularly furnished by that agency. Comply with the installation and application requirements of UL as documented in their published directories.
- C. Unless specifically noted, equipment and systems shall be the product of a manufacturer who has been in the manufacture of, and has nationally distributed catalogs covering the ratings and specifications of, said equipment or systems, for a period of not less than five (5) years.

- D. Maintain uniformity throughout the Project by making use of only one make or brand of material for each material used.
- E. Substitutions of materials or methods will only be allowed if such items are approved in writing by the Engineer as equal in quality and utility to the specified items. Submit a list of proposed substitutions within ten (10) days of the award of the Contract. Include on the list the original manufacturer's name and model number, the proposed manufacturer's name and model number, catalog cut sheets, ratings, sizes, performance curves, shop drawings, and other data as may be required to demonstrate equality to the specified item.
- F. The approval of a substitution does not authorize any deviation from the utility, size, function, or durability of the specified item unless specifically pointed out and requested in the proposed substitution list, and said deviation is approved in writing by the Engineer. Responsibility of the Contractor for dimensional considerations or space conflicts is not relieved by the approval of a substitution.
- G. If requested by the Engineer, submit samples of materials and equipment for approval prior to installation.

#### **1.9 SUBMITTALS**

- A. See the General Conditions for conditions of submittal approval and general requirements for submission of shop drawings.
- B. Submit a minimum of five copies (or more as required by the General Conditions) of electrical shop drawings and manufacturer's cut sheets for equipment and materials as noted in each electrical specification section. Bind the submittals as complete volumes according to classification of equipment such as power, lighting, fire alarm, etc. When possible, make all electrical submittals at the same time.
- C. Submit shop drawings and supporting data as instruments of the Contractor. Stamp each item in the submittal documents with the Contractor's stamp, thereby stating that the equipment meets all requirements and conditions of the Drawings and Specifications. In particular, certify that the items shown on the shop drawings conform to the dimensional, environmental, and space restrictions as pertains to all work under this Contract and the work of other parties in conjunction with this Project.
- D. Provide a blank space on the title page of each submittal classification for the Engineer's or Engineers approval stamp and comment field. The minimum size of such space shall be eight inches wide by five inches high.
- E. Arrange panelboard submittals to show bussing, circuit numbering, and branch circuit protective devices similar the schedules on the Drawings. Show elevations of switchboards, motor control centers, and distribution centers indicating the layout of devices, meters, handles, etc. Provide device ratings, circuit numbers, and nameplate descriptions in table form. Include terminal strip mounting arrangements on elevations for terminal cabinets.

#### **1.10 DRAWINGS AND SPECIFICATIONS**

- A. The data and information contained on the Drawings is as accurate as was reasonably possible at the time they were produced, but absolute accuracy is not guaranteed. Exact locations, distances, elevations, etc., will be dictated by the actual building and the conditions at the site.

- B. The layout of electrical equipment, wiring, and accessories is shown in a diagrammatic fashion (not pictorially) in order to achieve clarity and legibility. Although the size and location of electrical equipment is drawn to scale wherever possible, refer to all data in the Contract Documents and field verify this information as the project progresses. Examine architectural, structural, mechanical, and other drawings to determine the exact location of conduits, outlets, fixtures, and equipment and to note any conditions which may affect the electrical work.
- C. The Drawings and Specifications may be superseded by later detail drawings and specifications prepared by the Engineer. Conform to such detail drawings, specifications, addenda, change orders, other reasonable changes as if they are contained herein. See the General Conditions for change order cost considerations.
- D. Because the Electrical Drawings may be distorted for clarity of representation, it may be necessary to field verify the exact location of electrical outlets, lights, switches, etc. in order to conform to the architectural elements. The Engineer reserves the right to make minor changes to the locations of equipment, devices, and wiring shown on the Drawings, at no additional cost, providing the changes are ordered before the rough-in of conduit, boxes, or related items is completed, and no extra material are required.
- E. For dimensional and locational purposes, the Architectural Drawings take precedence over the Electrical Drawings. Determine the appropriate location of lighting fixtures, outlets, wall-mounted devices, etc. by studying the reflected ceiling plans, building sections, and interior elevations. Report conflicting conditions to the Engineer before rough-in for adjustments to the locations.
- F. Conduit quantities, sizes, termination points, and wiring are depicted on the Electrical Drawings. However, not all conduit bends or routing details are necessarily shown. Route conduit so as to conform to the structural conditions, avoid obstructing other trades, maintain space restrictions and keep circulation areas and access openings clear.
- G. Thoroughly examine the Contract Documents prior to submitting a bid in order to determine electrical requirements which are not necessarily indicated on the Electrical Drawings. Include sufficient allowance in the bid sum to cover the costs of these other requirements.
- H. Should the Contractor perceive that the Drawings and Specifications do not sufficiently define the intent of electrical work, contact the Engineer for clarification or additional information. The absence of such contact will be considered as evidence of understanding, on the part of the Contractor, of the intended Electrical Work and the required installation thereof.

#### **1.11 WORKMANSHIP**

- A. Constantly supervise the work personally or through an authorized and competent representative. Keep the same foreman or supervisor on the project from commencement through completion.
- B. Perform the Electrical work using the highest caliber craftsman available. Workmanship shall be first class and of the best quality available to insure a long and trouble free service life. Allow only experienced and competent workmen on the job.

#### **1.12 COOPERATION AND COORDINATION**

- A. Consult with the other installers and trades in coordinating the Work so as to avoid conflicts, omissions and delays. Cooperate with other contractors, third parties, and the Owner in order to expedite the project and provide for the proper execution of the building as a whole. Work

performed without regard to other trades or the overall project scheme, may necessarily be required to be moved at the Contractor's expense.

**1.13 MANUFACTURER'S DIRECTIONS**

- A. Adhere to the manufacturer's directions regarding the proper installation and configuration of electrical equipment where those directions cover points not included in these Drawings and Specifications.

**1.14 PROTECTION AND STORAGE**

- A. Deliver electrical materials to the site new, and in unbroken packages. Provide for the temporary storage of such materials, equipment, and construction tools in accordance with the General Conditions. Protect electrical equipment and materials during transit, storage and handling to prevent damage, soiling and deterioration.
- B. During shipping storage and handling protect electrical materials from damage of any type including dust, water, over-spray, and temperature. Avoid damage during construction to the work and materials of other trades as well as the electrical work and material. Repair or replace, at the Contractor's expense, defective or damaged items such that the entire Work is completed in a condition satisfactory to the Engineer.

**1.15 EXCAVATION, CUTTING, PATCHING, AND REPAIR**

- A. Cut, core-drill, and demolish existing walls, floors, ceilings and other building surfaces as required for the installation of Electrical Work. Obtain the approval of the Engineer prior to performing any operation which may affect any structural elements of the building.
- B. Patch and repair wood, plaster, tile, or concrete surfaces which have been damaged by the installation of the Electrical Work so that the finished surface matches the surrounding conditions.

**1.16 FLASHING, WATERPROOFING, SEALING, AND FIREPROOFING**

- A. In general, install in an approved watertight manner, Electrical Work which pierces exterior walls or waterproofing membranes. Flash and counter-flash roof and wall penetrations in a manner described in other applicable sections of this Specification and as approved by the Engineer.
- B. Fit conduits passing through finished walls with steel escutcheon plates of brass, chrome, or painted finish as directed by the Engineer. Grout penetrations of floor slabs, concrete or masonry walls with an approved grout or silicone elastomeric caulk.
- C. Fire-Rated Surface:
  - 1. Where conduit penetrates fire rated surface, install fire-stopping product in accordance with manufacturer's published instructions.
  - 2. All openings through fire rated wall, floor, ceiling or roof must be sealed.
  - 3. Install galvanized sheet metal sleeves (minimum 12-gage) through opening and extending beyond minimum of one (1) inch on each side of building element.
  - 4. Pack void between sleeve and building element with backing material.

5. Seal ends of sleeve with UL listed fire-resistive silicone compound to meet fire rating of structure penetrated.

D. Non-Rated Surfaces:

1. Opening through a non-fire rated wall, floor, ceiling or roof must be sealed using an approved type of material.
2. Use galvanized sheet metal sleeves in hollow wall penetrations to provide a backing for the sealant. Grout area around sleeve in masonry construction.
3. Install escutcheons or floor/ceiling plates where raceway, penetrates non-fire rated surfaces in occupied spaces.
4. Install rubber links of mechanical seal tightened in place and sized for the pipe, in exterior wall openings below grade, in accordance with the manufacturer's instructions.
5. All pipe penetrations at interior partitions and/or walls, laboratory spaces, telephone, data and communication rooms and similar spaces where the room pressure or odor transmission must be controlled, shall be sealed. Sealant shall be applied to both sides of the penetration in such a manner that the annular space between the pipe sleeve and the pipe is completely filled.

**1.17 CLEANING, ADJUSTING, AND TOUCH-UP**

- A. Remove on a daily basis electrical debris, scraps, packaging material and other rubbish. Dispose of such items off-site in an approved manner and debris. Maintain the site free from physical hazards at all times in accordance with OSHA regulations. See the General Conditions for additional requirements.
- B. After installation, completely clean electrical equipment, fixtures, and materials of excess paint, over-spray, plaster, cement, insulating products, and other foreign matter. Leave the Electrical Work in a clean, finished, dry, level, like new condition.
- C. Touch-up paint scratches and scuffs on electrical equipment and lighting fixtures with paint recommended by the manufacturer and matching the original item finish.
- D. Make setting, adjustments, and programming in accordance with the manufactures' operating and installation instructions. Settings and program variables will be issued by the Engineer prior to commissioning of the electrical system.

**1.18 AS-BUILT DRAWINGS**

- A. Throughout the project, maintain accurate and current record documents. Show on the record drawings deviations from the Electrical Drawings, locations of underground conduits and pull-boxes, and concealed equipment which is not readily apparent. Dimension the record drawings using permanent, readily identified benchmarks such as column or wall lines.
- B. At the completion of the project, present one clearly legible set of the record drawings to the Engineer.

**1.19 INSPECTIONS AND TESTING**

- A. Arrange for the inspection of the Work at various stages of completion by the Authority Having Jurisdiction, utility company representatives, and the Engineer. Comply with all directions and remedial measures issued thereby. Any objections to these orders on the part of the Contractor

must be presented to the Engineer in writing within forty eight (48) hours of the inspection report.

- B. Coordinate the installation of the Work so that observation of all rough-in, concealed, or underground Work can take place by the Engineer. Provide a minimum of seventy two (72) hours notice to the Engineer prior to covering up the work. Uncover Work that has not been properly observed and make repairs to restore the Work and adjoining surfaces to their proper condition at no additional cost.
- C. Perform tests of the electrical system during the course of the project and at project completion to ensure safe and proper function in accordance with the Contract Documents, manufacturers' recommendations, and applicable codes. Provide complete documentation of all test results to the Engineer prior to project completion. Testing shall include, but not necessarily be limited to, the following:
  - 1. Test for short circuits, open circuits, neutral leakage, and improper grounds on feeders and branch circuits. Perform this test with mains in disconnect from feeders, branch circuits closed, fixtures and devices permanently connected, lamps removed from sockets and wall switches closed.
  - 2. Provide insulation resistance tests of all phase and neutral circuit conductors using a 500 Volt Megger for circuits of 240 Volt rating and below, and a 1000 Volt Megger for circuits of 277 volts and above. Minimum acceptable insulation resistance is one (1) megohm.
  - 3. Perform a ground resistance test of each main grounding electrode system, ground rod, and supplemental grounding electrode. Utilize a calibrated, direct reading, earth ground test set and make the tests using the "Three-terminal, Fall-of-Potential" method. The maximum allowable earth ground resistance is 25 ohms.
  - 4. Test for proper phase-to-phase and phase-to-neutral operating voltage on the main service and on each separately derived system. Perform this test at full load and at no load. With all circuits at full operating conditions, test the phase and neutral load currents using a clamp-on ammeter.
  - 5. Tests as required by other sections of these Specifications.
  - 6. Tests as prescribed by individual equipment manufacturers whether or not described in these Specifications.
- D. At project completion, demonstrate to the Engineer that the entire installation is complete, in proper operation condition and that the Contract has been properly and fully executed. Activate all circuits, lights, devices, and controls under full load and normal operating conditions. Identify faulty items and immediately replace or repair defective equipment, workmanship, and materials to like new condition and retest in the presence of the Engineer.
- E. At the completion of the Project, demonstrate to the Engineer that the entire electrical system is free from short circuits and improper grounds, or upon request of the Engineer anytime, make necessary tests under the observation of the Engineer which will ensure that electrical equipment, materials and installation methods are as specified.

**1.20 GUARANTEE**

- A. In accordance with Division 1 requirements.

**1.21 WARRANTIES, CERTIFICATES, AND OPERATING MANUALS**

- A. Properly fill out and deliver to the Engineer, all warranties, guarantees, certificates, etc. for equipment and materials that are furnished and installed under this Section of the Work. The effective date on each item shall be the date of acceptance of the work by the Owner.

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- B. Deliver to the Engineer, a minimum of two (2) copies of the manufacturers' operating and maintenance manuals for major items of equipment.

**PART 2 - PRODUCTS**

Not used.

**PART 3 – EXECUTION**

Not used.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Full compensation for common work results for electrical shall be considered as included in the various items of related work and no separate payment will be made therefor.

**END OF SECTION 26 05 00**

## **SECTION 26 05 19**

### **600-VOLT POWER CONDUCTORS AND CABLES**

#### **PART 1 - GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Labor, material, tools, equipment and services required to install building wire and cable, service entrance cable, control cables, wiring connectors and connections.
  - 1. All circuits shall be installed in conduit unless specifically noted otherwise on the drawings. Type MC or AC cable shall not be used on this project.

##### **1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

- A. ASTM B 3 Soft or Annealed Copper Wire
- B. ASTM B 496 Compact Round Concentric-Lay-Stranded Copper Conductors
- C. ASTM B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- D. ANSI C 2 National Electrical Safety Code – latest edition
- E. IEEE 242 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
- F. IEEE 399 Recommend Practice for Industrial and Commercial Power System Analysis.
- G. NECA (National Electrical Contractors Association) - Standard of Installation.
- H. NEMA WC-26 Wire and Cable Packaging
- I. NETA ATS National Electrical Testing Association Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- J. NFPA 70 National Electrical Code – latest edition.
- K. UL 83 Thermoplastic-Insulated Wires and Cables.
- L. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- M. UL 510 Polyvinyl Chloride, Polyethylene and Rubber Insulating Tapes.

##### **1.3 SYSTEM DESCRIPTION**

- A. The applications for cable, wire and connectors required, but not limited to, are as follows:
  - 1. Power distribution circuitry.
  - 2. Lighting circuitry.

3. Appliance and equipment circuitry.
4. Wiring for motors of mechanical equipment
5. Wiring from the motor(s) of mechanical equipment to the disconnect switches or junction boxes, including wiring for pushbuttons, pilot lights, interlocks and similar devices as directed, shown, or specified.
6. Wiring from the motors of mechanical equipment to motor starters, including other auxiliary wiring as may be required, directed, or shown.
7. Line voltage wiring as required by other Divisions 2 thru 15, and interlocking to motor starters.
8. Control wiring for motors, mechanical equipment, relays and switches, and similar mechanical-electrical devices.
9. Line voltage wiring to thermostats, alarm systems and other miscellaneous equipment.

#### **1.4 PROJECT CONDITIONS**

- A. All wire and cables shall be minimum No. 12 AWG copper conductor unless otherwise shown on drawings.
- B. All conductor sizes are based on copper.
- C. Wire and cable routing shown on Drawings is diagrammatic unless dimensioned.
- D. Route wire and cable as required to accommodate project conditions.
- E. The contractor shall be responsible for any and all raceways and raceway/cable supports in accordance with all other sections of these specifications.

#### **1.5 REGULATORY REQUIREMENTS**

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, acceptable testing and listing agencies as suitable for the purpose specified and shown.

#### **1.6 SUBMITTALS**

- A. Product Data:
  1. Submit manufacturer's catalog cuts and technical data for building wire and cables.
- B. Field Test Report:
  1. Measure overall insulation resistance to ground. Provide certified test report for Engineer's Review.

#### **1.7 CLOSEOUT SUBMITTALS**

- A. Provide project record documents showing actual locations of components and circuits.
- B. Submit final certified test reports of all insulation resistance tests.

## 1.8 QUALIFICATIONS

- A. Manufacturer shall be a Company specializing in manufacturing products specified in this section with a minimum of five (5) years' experience.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products on site in accordance with Division 1 requirements.
- B. Accept cable and accessories on site in manufacturer's packaging. Inspect for damage.
- C. Store and protect cable and accessories from the environment in accordance with manufacturer's published instructions. Provide adequate heating and ventilation to prevent condensation.
- D. Damaged items shall be replaced at no additional cost to Owner.

## 1.10 COORDINATION

- A. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
- B. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths within 10 feet of length shown.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

- A. Domestic manufacturer regularly engaged in the manufacture of Building Wire and Cable products for at least five (5) years as follows:
  - 1. American Wire and Cable.
  - 2. Cerro Wire and Cable Co.
  - 3. General Cable Corp.
  - 4. Okonite Co.
  - 5. Or Approved Equal.

### 2.2 BUILDING WIRE AND CABLE

- A. Building wire and cable shall be UL83 compliant, insulated, single conductor, copper, solid or stranded, rated for 600-volts AC. The insulation shall be thermoplastic material rated for 90 degrees Celsius dry locations, 75 or 90 degrees Celsius wet locations, THW, THHN/THWN, RHW or XHHW, per ANSI/NFPA 70.
- B. For Interior Dry Location: Use only building wire, THHN/THWN insulation rated 90 degree Celsius, in raceway.
- C. For Exterior Wet or Dry Locations: Use THHN/THWN-2 or XHHW insulation rated for 90 degree Celsius, in raceway.

- D. For Underground Dry or Wet Locations: Use THHN/THWN-2 or XHHW insulation rated 90 degree Celsius, in raceway.
- E. For connections to electrical equipment, coordinate wire type with equipment manufacturer.

### **2.3 SERVICE ENTRANCE CABLES**

- A. Service entrance cables shall be insulated, single conductor, copper, stranded, rated for 600-volts AC, type XHHW insulation.
- B. Overhead Service entrance cables shall be insulated, single conductor, copper, stranded, rated for 600-volts AC, type SE insulation.

### **2.4 WIRING CONNECTORS**

- A. Split Bolt Connectors:
  - 1. FCI Burndy Corp.
  - 2. Cooper Crouse Hinds.
  - 3. O.Z./Gedney Co.
  - 4. Thomas & Betts Co.
  - 5. 3-M Co.
- B. Solderless Pressure Connectors:
  - 1. FCI Burndy Corp.
  - 2. Ideal Industries Co.
  - 3. Thomas & Betts Co.
  - 4. 3-M Co.
- C. Spring Wire Connectors:
  - 1. Ideal Industries Co.
  - 2. 3-M Co.
- D. Compression Connectors:
  - 1. FCI Burndy Corp.
  - 2. Thomas & Betts Co.
  - 3. 3-M Co.

### **2.5 WIRE COLOR CODE**

- A. Color-code all conductors:
  - 1. Wire sizes No. 10 AWG and smaller shall have integral color-coded insulation.
  - 2. Wire sizes No. 8 AWG and larger may have black insulation but shall be identified by color-coded electrical tape at all junction, splice, pull, or termination points.
  - 3. Color tape shall be applied to at least 3 inches of the conductor at the termination ends and in junction or pull boxes or where readily accessible.
  - 4. Conductors for all systems shall not change color at splice points.

5. Where there are two or more neutrals in one conduit, each shall be individually identified with the proper circuit.
6. For No. 4 AWG and larger ground conductors, identify with green tape at both ends and all visible points, included in all junction boxes.

B. Each phase wire shall be uniquely color-coded as indicated below:

1. 120/240-Volts
  - a. Phase A – Black
  - b. Phase B – Red
  - c. Neutral - White
  - d. Ground - Green
2. 120/208-Volts
  - a. Phase A – Black
  - b. Phase B – Red
  - c. Phase C – Blue
  - d. Neutral – White
  - e. Ground – Green
3. 277/480-Volts
  - a. Phase A - Brown
  - b. Phase B - Orange
  - c. Phase C – Yellow
  - d. Neutral - White or Natural Gray
  - e. Ground – Green
4. Isolated Grounds: Green with Yellow Stripes

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.
- C. Verify that raceway installation is complete and supported as required by the specifications.

#### **3.2 PREPARATION**

- A. Test raceway with a mandrel and thoroughly swab out to remove foreign material before pulling cables.
- B. For conduits sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel.

- C. For conduits sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. Then draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel.

### 3.3 EXISTING WORK

- A. Disconnect and remove exposed and/or abandoned wire and cable. Patch surfaces where removed cable pass through building finishes.
- B. Disconnect abandoned circuits and remove wire and cable. Remove abandoned boxes if wire and cable servicing them is abandoned and/or removed. Provide blank cover for abandoned boxes that are not removed.
- C. Ensure access to existing wiring connections which remain active and which require access. Modify installation or provide access panel as appropriate.
- D. Extend existing circuits using materials and methods and compatible with existing electrical installations, or as otherwise specified.
- E. Tag and repair existing wire and cable that remain or are being reused.

### 3.4 INSTALLATION

- A. General:
  - 1. Install wire and cable in accordance with manufacturer's instructions and NECA "Standard of Installation".
  - 2. Route wire and cable as required to meet project conditions.
  - 3. Identify and color code wire and cable. Identify each conductor with its circuit number or other designation indicated.
  - 4. Protect exposed cable from damage.
  - 5. Pull all conductors into raceway at same time.
  - 6. Use suitable wire pulling lubricant for building wire No. 4 AWG and larger. Lubricant shall not be deleterious to the cable sheath, jacket or outer covering.
  - 7. Do not exceed cable manufacturer's recommended pulling tension limits when installing wire or cable.
  - 8. Support cables above accessible ceiling using standard support methods to support cables from structure. Do not rest cable on ceiling panels.
  - 9. Neatly train and lace wiring inside boxes, equipment, and panelboards
- B. Cable and Wire Size:
  - 1. Conductor sizes are based on copper unless specifically indicated as aluminum or "AL".
  - 2. Use conductor no smaller than No. 12 AWG for power and lighting circuits.
  - 3. Use conductor no smaller than No. 14 AWG for control circuits.
  - 4. Use No. 10 AWG conductors for 20 ampere, 120-volt branch circuits longer than 75 feet.
  - 5. Use No. 10 AWG conductors for 20 ampere, 277-volt branch circuits longer than 200 feet.
  - 6. Use stranded conductor for all feeders, branch and control circuits.
- C. Cable Identification
  - 1. Identify all wires and cables as specified in other Sections of these Specifications.

D. Special Techniques - Wiring Connections:

1. Clean conductor surfaces before installing lugs and connectors. Where an anti-oxidation lubricant is used, apply liberally, coating all exposed conductor surfaces.
2. Use suitable cable fittings and connectors.
3. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
4. Use split bolt connectors for copper conductor splices and taps, No. 8 AWG and larger.
5. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, No. 8 AWG and smaller.
6. Tape un-insulated conductors and connector with two layers of half-lapped rubber insulating compound tape and two layers of half-lapped, 7-mil electrical tape, Scotch 33+, or equal.
7. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, No. 10 AWG and smaller.
8. Stranded conductors for control circuits shall have fork or ring terminals crimped on for all device terminations. Bare stranded conductors shall not be placed directly under the screws.

**3.5 FIELD QUALITY CONTROL**

A. Field inspection and test shall be performed under provisions of NETA ATS section 7.3 (2) - Low Voltage Cables, 600-Volt Maximum as follows.

1. Visual and Mechanical Inspection:

- a. Compare cable data with drawings and specifications.
- b. Inspect exposed sections of cable for physical damage and correct connection in accordance with single-line diagram.
- c. Inspect all bolted electrical connections for high resistance using one of the following methods:
  - 1) Use of low-resistance ohm-meter in accordance with NETA section 7.3.2.2 (Electrical Tests).
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data from NETA ATS Table 10.12.
- d. Inspect compression-applied connectors for correct cable match and indentation.
- e. Verify cable color coding with applicable specifications and National Electrical Code.

2. Electrical Tests

- a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.
- b. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable, in accordance with Section 7.3.2.1 (Visual and Mechanical Inspection).
- c. Perform continuity test to insure correct cable connection.
- d. Correct malfunctions and/or deficiencies immediately as detected at no additional cost to the District, including additional verification testing.

- e. Subsequent to final wire and cable terminations, energize all circuitry and demonstrate functional adequacy in accordance with system requirements.
3. Test Values
- a. Compare bolted connection resistance to values of similar connections.
  - b. Bolt-torque levels should be in accordance with NETA ATS Table 10.12 unless otherwise specified by the manufacturer.
  - c. Micro-ohm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
  - d. Minimum insulation-resistance values should not be less than 50 meg-ohms.
  - e. Investigate deviations between adjacent phases.

#### **PART 4 - MEASUREMENT AND PAYMENT**

- A. Power circuits will be paid at the contract unit price per linear foot (LF) which price shall include full compensation for furnishing all labor, materials, tools, equipment and other incidentals necessary for the installation of conductors as noted on plans, including, splices, fuses and fittings as required by California Electrical Code, and all incidental work involved, as designated by the Engineer and all other related work.

**END OF SECTION 26 05 19**

## SECTION 26 05 26

### GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 SECTION INCLUDES

- A. Furnishing of grounding electrodes and conductors; equipment grounding conductors; bonding methods and materials; conduit and equipment supports; anchors and fasteners; sealing and fireproofing of sleeves and openings between conduits and wall.
- B. Inspection and testing of the Grounding and Bonding System; and Ground-Fault Protection Systems.

##### 1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. The standards referenced herein, except as modified in the Contract Documents, shall have full force and effect as though included in these Specifications. These standards are not furnished to the Contactor since manufacturers and trades involved are assumed to be familiar with these requirements. The Contractor shall obtain copies of reference standards direct from publication sources as needed for proper performance and completion of the work.
  - 1. ASTM B 187 Specifications for Copper Bus, Rod, and Shapes.
  - 2. ASTM A 653 Standard Specifications for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by Hot Dip Process
  - 3. IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
  - 4. IEEE 1100 Recommended Practice for Powering and Grounding Electronic Equipment.
  - 5. NECA (National Electrical Contractors Association) – Standard of Installation.
  - 6. NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
  - 7. NFPA 70 National Electrical Code (NEC). Latest edition adopted by the State of California (CEC).
  - 8. UL 467 Electrical Grounding and Bonding Equipment.

##### 1.3 SYSTEM DESCRIPTION

- A. Grounding electrode system consist of the following elements:
  - 1. Metal frame of the building, where effectively grounded
  - 2. Metal underground water piping
  - 3. Concrete encased (Ufer) grounding electrodes
  - 4. Other made electrodes
- B. Anchor and fasten electrical products to building elements and finishes as follows:
  - 1. Concrete Structural Elements: Provide preset inserts.
  - 2. Concrete Surfaces: Provide epoxy or expansion anchors.

3. Interior Structural Steel: Provide appropriate size beam clamps.
4. Solid Masonry Walls: Use expansion anchors and preset inserts.
5. Sheet Metal: Provide sheet metal screws.

#### **1.4 DESIGN REQUIREMENTS**

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, acceptable testing and listing agencies as suitable for purpose specified and shown.
- B. Grounding shall be in accordance with the National Electrical Code (NEC). Where size, type, rating and quantities indicated or specified are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
- C. Select materials, sizes, and types of anchors, fasteners, and supports to carry at least twice the loads of equipment and raceway, including weight of wire and cable in raceway.

#### **1.5 SUBMITTALS**

- A. Product Data:
  1. Submit product data for grounding electrodes and connections for fastening components; fire stopping material; and fireproofing sealants.
- B. Test Report:
  1. Grounding & Bonding: Provide certified test report for Engineer's Review.
  2. Ground-Fault Protection System: Provide certified test report for Engineers Review.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Record actual locations of components and grounding electrodes.
- B. Submit final one (1) electronic copy on CD-ROM and certified, five (5) bound copies of the Power System Study report.
- C. Submit final certified five (5) copies of the test reports of all grounding tests and ground-fault protection systems.

#### **1.7 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five (5) years' experience.
- B. Installer: A firm with at least five (5) years of installation experience on projects with electrical grounding work similar to that required for this project.

#### **1.8 FIELD MEASUREMENTS**

- A. Verify field measurements prior to fabrication.

- B. Field testing shall be performed by a third party testing firm with certification from a recognized testing agency, with a minimum of five (5) years of testing experience.

## **PART 2 - PRODUCTS**

### **2.1 GROUNDING SYSTEM**

- A. Except as indicated elsewhere, provide materials for electrical grounding system, including, but not limited to, cables, wires, connectors, terminals (solderless lugs) and exothermic welds, grounding rods and electrodes, bonding jumper and braided straps, and other items and accessories required for a complete installation. Where more than one type of material or equipment meets indicated requirements, selection shall be at Installer's option. Where materials or components are not otherwise indicated, provide products as recommended by the accessories manufacturers and in compliance with the NEC and established industry standards.
- B. All grounding materials required shall be furnished new and undamaged in accordance with the requirements of these specifications:

### **2.2 WIRE**

- A. Service Equipment Grounding Electrode Conductor: Bare, soft-drawn copper, Class AA stranding, ASTM B 8. Size per NEC Table 250-66, unless otherwise noted.
- B. Electrical Equipment Grounding Conductor: Insulated, soft-drawn copper, Class B stranding or solid, with green colored polyvinyl chloride insulation per Section 26 05 19. Size per NEC Article 250-122, unless otherwise noted.

### **2.3 BUS AND BARS**

- A. Silver plated, soft copper with cross section not less than 1 square inch per 1,000 ampere rating, but in no case less than 1/4-inch thick by 1-inch wide, ASTM B 187. Rating shall be per the NEC, unless otherwise noted.

### **2.4 EXOTHERMIC WELD CONNECTIONS**

- A. Exothermic materials, accessories and tools for preparing and making permanent field connections between grounding system components. Molds, cartridges, materials, and accessories as recommended by the manufacturer of the molds for the items to be welded.
- B. Manufacturer:
  - 1. Cadweld (Erico Products) "Exolon" Low Emission. Molds and powder shall be furnished by the same manufacturer.
  - 2. Acceptable equal.

### **2.5 MECHANICAL CONNECTORS**

- A. Mechanical connectors shall be permitted only when exothermic weld connections are not suitable or recommended by the manufacturer.

- B. Bolt-on bronze connectors, suitable for grounding and bonding applications in configurations required for the particular installation.
- C. Manufacturer
  - 1. Burndy Corp.
  - 2. Anderson
  - 3. Thomas & Betts
  - 4. 3-M Co.

## **2.6 FLUSH GROUND PLATES**

- A. Cadweld B-162 series, B-164 series, or acceptable equal.

## **2.7 FLEXIBLE JUMPER STRAP**

- A. Flexible flat conductor, 480 strands of 30-gauge, bare copper wire; 3/4-inch width, 9-1/2-inch-long; 48.25 kCMil, minimum. Protect braid with copper bolt-hole ends with holes sized for 3/8-inch diameter bolts.

## **2.8 BONDING PLATES, CONNECTIONS, TERMINALS AND CLAMPS**

- A. Provide electrical bonding plates, connectors, terminals and clamps, and accessories as recommended by the manufacturer for the specific applications. Components shall be high-strength, high-conductivity copper alloy.

## **2.9 GROUNDING WELL COMPONENTS**

- A. Well Pipe: 8 inches NPS (DN200) by maximum 12 inches (300-mm) long, precast concrete or fiberglass pipe with belled end.
- B. Well Cover: Cast iron, high impact traffic rated cover with legend "GROUND" embossed on outer face.

## **2.10 ANCHORS AND FASTENERS**

- A. Indoor Locations: Epoxy type anchors and heavy-duty, galvanized steel screws and bolts.
- B. Outdoor Locations: Epoxy type or Red Head anchor bolts and stainless steel screws and bolts.

## **2.11 SUPPORT CHANNEL**

- A. All conduit and electrical equipment support channels for interior, exterior, wet and corrosive areas shall be galvanized steel.
- B. Support channels for free standing electrical equipment such as switchgear, switchboard and motor control centers, shall be:

1. Indoors: galvanized steel channel and hardware, minimum 12 gauge, ASTM A653 Grade 33 sheet steel, zinc coated by hot dip process.
2. Outdoors: 316 Stainless steel

## **2.12 SEALING AND FIREPROOFING**

- A. Furnish UL listed products or products tested by a nationally recognized independent testing laboratory. Select products with rating not less than the rating of the wall, ceiling or floor being penetrated.
- B. Manufacturers:
  1. 3M CP 25WB + Caulk
  2. 3M FS 195 wrap or strip with restricting collar
  3. 3M CS 195 composite sheets
  4. Proset Systems fire rated floor and wall penetrations
  5. Dow Corning Fire Stop System
  6. Substitutions not permitted.
- C. Use stamped steel, chrome plated, hinged, split ring escutcheons or floor/ceiling plates for covering openings in occupied areas where conduit is exposed.
- D. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and the cored opening or a water-stop type wall sleeve.
- E. At non-rated interior wall or floor openings use Tremco Fyre-Sil, Sika Corp. Sikaflex Ia, Sonneborn Sonolastic NPT, or Mameco Vulkem 116 urethane caulk or approved equal.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.

### **3.2 EXISTING WORK**

- A. Modify existing grounding system to maintain continuity to accommodate renovations.
- B. Extend existing grounding system using materials and methods as specified.
- C. Install temporary wiring and connections to maintain existing grounding systems in service during construction.
- D. Perform work on energized equipment or circuits with experienced and trained personnel following all safety rules and procedures.
- E. Remove, relocate, and extend existing installations to accommodate new construction.
- F. Repair adjacent construction and finishes that are damaged during demolition and extension work.

- G. Remove exposed and/or abandoned grounding and bonding components, fasteners, supports and electrical identification labels. Cut embedded support elements below surface of walls and floors. Patch surfaces damaged by removal of existing components to match surrounding finishes.

### **3.3 GROUNDING AND BONDING INSTALLATION:**

- A. Verify that final backfill and compaction has been completed before driving rod electrodes.
- B. Install grounding well with cover at rod locations as indicated on Drawings. Install well top flush with finished grade.
- C. Installation:
  - 1. Remove paint, rust, mill-oils, and surface contaminants at connection points.
  - 2. Install grounding electrode conductor and connect to reinforcing steel in slab or foundation.
  - 3. Bond together metal siding not attached to grounded structure; bond to ground.
  - 4. Bond together reinforcing steel and metal accessories.
  - 5. Connect to site grounding system.
  - 6. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, provide an artificial station ground by means of driven rods or buried electrodes.
  - 7. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panel boards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
  - 8. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel in accordance with IEEE 1100.
  - 9. Accomplish grounding of electrical system by installing insulated grounding conductor with each feeder and branch circuit conductor in conduit. Install separate insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Size grounding conductor in accordance with the NEC.
  - 10. Install grounding conductor from ground bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes, and metal enclosures of service equipment.
  - 11. Bond all metallic conduits to grounding bus at service panel by means of grounding bushings using minimum No. 12 AWG conductor.
  - 12. Ground electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC. Bond together each metallic raceway, pipe, duct and other metal object entering enclosures and exiting slabs.
  - 13. Permanently bond all equipment, grounding conductors, lightning protection system and grounding system prior to energizing equipment.

### **3.4 GROUND CONDUCTORS**

- A. Grounding conductors shall be located and connected as indicated on drawings or as required by Code.
- B. Ground conductors under buildings or structures shall be buried with at least 6 inches of earth cover. Buried grounding conductors extending beyond the foundations of buildings or structures shall have at least 18 inches of earth cover.

- C. Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to dominant surfaces.
- D. Conductors routed over concrete, steel, or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not to exceed 3 feet.
- E. Conductors passing through floor slabs shall be installed in conduit sleeves that extend above the floor slab, a minimum of 1-1/2 inches to provide protection. Sleeves shall be sealed to maintain fireproof integrity.
- F. Provide isolated grounding conductor for circuits supplying equipment and systems as shown on the drawings.
- G. Provide a separate equipment-grounding conductor for low voltage distribution systems, single or three phase feeder circuit and each branch circuit with single or three phase protective devices. Install a grounding conductor in conduit with phase and neutral conductors. Single-phase branch circuits for 120 and 277 volt lighting, receptacles, and motors shall have a phase, neutral, and ground conductors installed in the common conduit. Provide suitable bonding jumpers and approved grounding type bushings for flexible conduits used for equipment connection utilized in conjunction with the above branch circuits. Single-phase circuits for equipment and all branch circuits installed in non-metallic or flexible conduits shall be provided with a separate grounding conductor.
- H. Ground the neutral of separately derived systems with a bare copper conductor, installed in conduit, from the neutral directly to the building interior cold water pipe or nearest solidly grounded structural reinforcing steel, in accordance with the provisions of NEC Article 250-24. Use bolted accessible connections to the ground system so that the neutral ground can be disconnected for test. Ground the system ground conduit as detailed on drawing. Size the grounding electrode conductors in accordance with the NEC, Table 250-66, or as indicated.

### **3.5 CONNECTIONS**

- A. All connections shall be made by the exothermic welding process, except where otherwise indicated. The manufacturer's instructions on the use of exothermic welding materials shall be followed in all details. Powder and molds shall be kept dry and warm until use. Worn or damaged molds shall not be used.
- B. All surfaces to be joined by the welds shall be thoroughly cleaned. Paint, scale, and other deleterious substances shall be removed from surfaces of ungalvanized structural steel members by grinding. Galvanized steel surfaces shall be cleaned with emery paper.
- C. All exothermic welded connections shall successfully resist moderate hammer blows. Any connection which fails such test or which, upon inspection, indicates a porous or deformed weld, shall be remade.
- D. All exothermic welds shall encompass 100 percent of the ends of the materials being welded. Welds, which do not meet this requirement, shall be remade.
- E. Worn, damaged, incorrectly sized, or improperly shaped molds which, in the opinion of the Engineer, do not make satisfactory welds, shall be removed from the jobsite after being physically rendered inoperable.
- F. All contact surfaces of bolted and screwed connections shall be thoroughly cleaned and coated with oxide inhibitor before being securely tightened.

### **3.6 CONDUIT GROUNDING**

- A. All grounding bushings within all enclosures, including equipment enclosures, shall be wired together and connected internally to the enclosure grounding lug or grounding bus with a bare copper conductor. Grounding bushings shall be grounded with conductors sized in accordance with NEC, but not smaller than No. 8 AWG.

### **3.7 EQUIPMENT GROUNDING**

- A. Comply with NEC 250, except where larger sizes or more conductors are indicated.
  - 1. All electrical equipment shall be connected to the grounding system with an insulated, green, stranded or solid copper equipment-grounding conductor.
  - 2. Terminate each end on suitable lug, bus, or bushing. The term "electrical equipment", as used in this article, shall include, but not be limited to, all enclosures containing electrical connections or bare conductors, except that individual devices, such as solenoids, pressure switches, and limit switches, shall be exempt from this requirement, unless the device requires grounding for proper operation.
  - 3. Large equipment, such as metal-clad or metal-enclosed switchgear, will be furnished with a grounding bus that shall be connected to the grounding system.
  - 4. Most other equipment will be furnished with grounding pads and/or grounding lugs which shall be connected to the grounding system. All ground connection surfaces shall be cleaned immediately prior to connection.
  - 5. Contractor shall furnish all grounding material required, if not furnished with the equipment.
- B. Install equipment grounding system such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with electrical circuits will operate continuously at ground potential and provide a low impedance path for possible ground fault currents.
- C. Where grounding system extension stingers are indicated on the drawings to be provided for connection to electrical equipment, the Contractor shall connect the bare grounding conductor to the equipment ground bus, pad, or lug. Except where otherwise indicated on the drawings, all equipment ground conductors that are not an integral part of a cable assembly, shall be sized in accordance with the requirements of NEC. All ground conductors installed in conduit shall be insulated.
- D. Suitable grounding facilities, acceptable to the Engineer, shall be furnished on electrical equipment not so equipped. The grounding facilities shall consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.
- E. The conduit system is not considered to be a grounding conductor, except for lighting fixtures. No grounding conductor shall be smaller in size than No. 12 AWG, unless it is a part of an acceptable cable assembly.

### **3.8 GROUND SYSTEM RESISTANCE**

- A. Ground resistance of the system shall be no greater than five (5) ohms.

### **3.9 ANCHORS, FASTENERS AND SUPPORT**

A. Installation:

1. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
2. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
3. Do not use spring steel clips and clamps.
4. Do not use powder-actuated anchors.
5. Do not drill or cut structural members.

B. Supports:

1. Fabricate supports from structural steel or formed steel members. Rigidly weld members or install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface-mounted cabinets and panel board with minimum of four (4) anchors.
3. Use steel channel supports to stand cabinets and panel boards one (1) inch off wall.
4. Use sheet metal channel to bridge studs above and below cabinets and panel boards recessed in hollow partitions.

**3.10 ACCEPTANCE TESTING**

A. Grounding and Bonding: Perform inspections and tests as outlined below (NETA ATS, Section 7.13 – Grounding Systems).

1. Visual and Mechanical Inspection
  - a. Verify ground system is in compliance with drawings and specifications.
  - b. Electrical Tests
  - c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
2. Test Values
  - a. Investigate point-to-point resistance values which exceed 0.5 ohm.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Full compensation for grounding and bonding of electrical systems shall be considered as included in the various items of related work and no separate payment will be made therefor.

**END OF SECTION 26 05 26**

**SECTION 26 05 33**

**RACEWAYS AND BOXES**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. Conduit and tubing, surface and buried raceways, wireways, outlet boxes, pull boxes, and junction boxes.

**1.2 REFERENCES - CODES AND STANDARDS**

- A. ANSI C80.1 Rigid Steel Conduit, Zinc Coated.
- B. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated.
- C. ANSI C80.6 American National Standard for Electrical Intermediate Metal Conduit.
- D. ASTM A 48 Standard Specification for Grey Iron Castings.
- E. NECA (National Electrical Contractors Association) – “Standard of Installation.”
- F. NEMA FB 1 (National Electrical Manufacturers Association) – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- G. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit.
- H. NEMA TC 3 (National Electrical Manufacturers Association) – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- I. NEMA TC 6 - Non-Metallic Conduit.
- J. NEMA 250 (National Electrical Manufacturers Association) – Enclosures for Electrical Equipment (1,000 Volts Maximum).
- K. NFPA 70 National Electrical Code (NEC). Latest approved edition
- L. UL 1 Flexible Metal Conduit
- M. UL 6 Rigid Metal Conduit
- N. UL 514B Conduit, Tubing and Cable Fittings.
- O. UL 651 Rigid Non-Metallic Conduit
- P. UL 797 Electrical Metallic Tubing

**1.3 SYSTEM DESCRIPTION**

A. Acceptable raceway systems and their limitations of use are summarized in the following table:

LOCATION	RSC	RNC	EMT	FMC	LFMC
Exterior locations: Wet or subject to physical damage.	Yes	No	No	No	No (note c)
Exterior locations: Damp and not subject to physical damage.	Yes	No	No	No	Yes
Interior locations: Wet or subject to physical damage.	Yes	No	No	No	No (note c)
Interior locations: Exposed and not subject to physical damage.	Yes	No	Yes	Yes (note e)	Yes
Interior locations: Totally concealed.	Yes	No (note d)	Yes	Yes (note e)	Yes
Underground:	Yes	Yes	No	No	No

1. Notes for Conduit Application Table:

- a. RSC = rigid steel conduit, RNC = rigid nonmetallic conduit, EMT = electrical metallic tubing, FMC = flexible metal conduit, LFMC = liquidtight flexible metal conduit.
- b. For the purposes of these specifications, locations subject to physical damage include, but are not limited to, those areas less than 6 feet above the finished floor or grade.
- c. Liquidtight flexible metal conduit may also be use in wet or damp, exterior or interior locations not subject to physical damage, where used for flexible equipment connections in lengths not exceeding 3 feet.
- d. Rigid nonmetallic conduit may also be used above grade, where totally concealed in walls, for transitions from underground up to a height of 24 inches above the concrete sill.
- e. The use of flexible metal conduit is limited to lengths not exceeding 6 feet for flexible connections to equipment and lighting fixtures, or where necessitated by structural obstacles and explicitly approved by the Owner.

- B. Raceway, boxes and manholes located as indicated on drawings and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway, boxes and manholes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- C. Underground more than 5 feet (1,500 mm) outside foundation wall: Provide Schedule 40 non-metallic conduit. Raceway systems over 600-volts shall be encased in concrete.
- D. In or Under Slab on Grade: Provide Galvanized with tape wrap rigid steel factory bends greater than 22.5 degrees and for stub-ups through concrete slabs.
- E. Outdoor Locations, Above Grade: Provide cast metal outlet, pull, and junction boxes.
- F. In Slab above Grade: Provide cast or concrete-tight sheet metal boxes.
- G. Exposed Dry Locations: Provide cast boxes.
- H. Concealed Dry Locations: Provide cast or sheet metal boxes.
- I. Hazardous Locations (Per NEC Article 500): Provide Galvanized rigid steel conduit, cast iron boxes with threaded hubs for conduit entry, and appropriate sealing fittings.

**1.4 DESIGN REQUIREMENTS**

- A. Minimum acceptable conduit sizes are summarized in the following table:

	MINIMUM SIZE
Underground, site wiring	1"
Underground <ul style="list-style-type: none"> <li>• Building wiring</li> </ul> Aboveground <ul style="list-style-type: none"> <li>• Equipment or panel feeders</li> <li>• Telecommunications</li> </ul>	3/4"
Aboveground <ul style="list-style-type: none"> <li>• Lighting or branch circuit wiring</li> <li>• Fire alarm</li> <li>• Security</li> </ul>	1/2"
Other	3/4"

**1.5 SUBMITTALS**

- A. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by product testing agency having jurisdiction. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- B. Submit detailed conduit routing plan, for review and approval, prior to installation as follows:
  - 1. Exposed and/or concealed in building walls for conduits larger than 2-inch outside diameter.

2. All underground conduits (3/4-inch and larger) in duct bank; concealed in floor slabs, equipment pads and concrete slabs.

C. Product Data: Submit for the following:

1. Rigid Steel Conduit.
2. Electrical Metallic Tubing (EMT).
3. Flexible metal conduit.
4. Liquid tight flexible metal conduit.
5. Nonmetallic conduit.
6. Raceway fittings.
7. Conduit bodies.
8. Surface raceway.
9. Pull boxes, junction boxes.

D. Manufacturer's Installation Instructions:

1. Submit application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
2. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

## 1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents:

1. Record actual routing of conduits. Provide record (as-built) drawings marked in red to show actual routing of the underground raceway and cable when different from the original contract drawings. Prepare on new, clean set of contract drawings.
2. Record actual locations and mounting heights of outlet, pull boxes, junction boxes and manholes.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC conduit from sunlight.

## PART 2 - PRODUCTS

### 2.1 CONDUIT

- A. Galvanized Rigid Steel Conduit (GRSC or RGS), couplings and elbows shall be hot-dip galvanized, rigid mild steel in accordance with ANSI C80.1 and UL 6. The conduit interior and exterior surfaces shall have a continuous zinc coating with a transparent overcoat of enamel, lacquer, or zinc chromate. Conduit shall be formed with continuous welded seams with a uniform wall thickness, in minimum 10-foot lengths, with threaded ends.
- B. Electrical Metallic Tubing (EMT). Electrical metallic tubing, including elbows and bends, shall be zinc coated, mild steel in accordance with the requirements of ANSI C80.3 and UL 797. The

interior and exterior surfaces of the tubing shall have a continuous zinc coating. Conduit shall be formed with a continuous welded seam, with a uniform wall thickness, in minimum 10-foot lengths.

- C. Flexible Metal Conduit shall be galvanized steel meeting the requirements of UL 1. Flexible aluminum conduit is not permitted.
- D. Liquid-Tight Flexible Metal Conduit shall be plastic-jacketed, galvanized steel, "Sealtite" Type EF for general service areas or Type HC for high-temperature when used under raised floor or in air plenums. Conduit shall be UL listed.
- E. Non-Metallic Conduit shall be as follows:
  - 1. Schedule 40: Conduit shall be 90 degree Celsius, polyvinyl chloride in conformance with NEMA TC-2 and UL 651 requirements.
  - 2. Spacers used in duct bank installations shall be high impact plastic, interlocking bases, and intermediate type spacers. Place spacers between 6 and 10 feet apart.
- F. Rigid aluminum conduits and flexible aluminum or non-metallic conduits are not permitted on this project.

## 2.2 RACEWAY FITTINGS

- A. Couplings and Thread Protectors. Each length of threaded conduit shall be provided complete from the manufacturer with a coupling on one end and a thread protector on the other. The thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage.
- B. Metal Conduit Fittings shall conform to the requirements of UL 514B where this standard applies. Galvanized iron or galvanized steel fittings shall be used with steel conduit. Threaded fittings shall engage a minimum of five threads made up wrench-tight and be compatible with conduit.
- C. EMT Conduit Fittings shall be set screw steel with insulated throat for indoor applications and compression type, UL approved for rain tight applications for outdoor use. Die-cast or indent style fittings are not acceptable.
- D. Liquid-Tight Flexible Conduit Fittings shall be galvanized steel, T&B 53XX series insulated throat, and shall bear the UL label. Die-cast malleable fittings are not acceptable.
- E. Liquid-Tight Flexible Metal Conduit Fittings shall be galvanized steel similar to T&B "Tite-Bite".
- F. Non-Metallic Conduit Fittings shall be of same material and strength characteristics as the conduit and shall be solvent welded as recommended by manufacturer. End bells shall be plastic, high impact, tapered to fit. Where conduit transition from non-metallic to metallic is required, provide non-metallic female "terminal" adapter. Non-metallic "male" adapters are not acceptable.
- G. Special Fittings. Conduit sealing, explosion proof, dust proof, and other types of special fittings shall be provided as required and shall be consistent with the area and equipment with which they are associated. Fittings installed outdoors or in damp locations shall be sealed and gasketed. Outdoor fittings shall be of heavy cast construction. Hazardous area fittings and conduit sealing shall conform to NEC requirements for the area classification.

- H. Bushings shall be provided for the termination of all conduits not terminated in hubs, couplings or insulated throat connectors. Grounding type insulated bushings with insulating inserts in metal housings shall be provided for conduit 1-1/4 inches and larger. Standard bushings shall be galvanized steel or malleable iron in all sizes.
- I. Locknuts. One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond with the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.
- J. Unions. Watertight conduit unions shall be Appleton or Crouse-Hinds Type UNF or UNY, or approved equal.
- K. Raintight conduit terminating hubs, where indicated on the drawings or required by these specifications, shall be Meyer's rigid conduit hubs, or approved equal.

### **2.3 CONDUIT BODIES**

- A. Malleable iron conduit bodies shall be cast malleable iron with tensile strength meeting ASTM A 48, Class 30A requirements. Malleable conduit bodies shall be finished with an epoxy powder coating. Cover shall be malleable iron with captive screws.
- B. All conduit bodies' entrances shall be machined NPT threads with a smooth, rounded, internal conduit stop bushing.
- C. All conduit bodies shall be equipped with a sealed and gasketed cover. Cover shall be secured using stainless steel machine screws.

### **2.4 CONDUIT SUPPORTS**

- A. Conduit supports shall be furnished and installed in accordance with other section of these specifications. Conduits shall be supported so that fittings are accessible. Support systems shall be limited to electrical conduits only.
- B. Hanger rods shall be 3/8-inch diameter galvanized threaded steel rods, minimum. Conduit racks over 18-inch wide, over one level, or supporting 2-inch RSC or larger, shall be 1/2-inch diameter rod minimum.
- C. Conduit Clamps. Conduits in single runs or groups of two shall be supported by steel clamps and clamp backs. They shall be galvanized malleable iron or approved equal cast ferrous metal for steel conduit or tubing.
- D. Support Channels. Supports for banks of three or more conduits shall be constructed of formed steel support channels (Unistrut, Kindorf, Superstrut, B-Line or approved equal) with associated conduit or tubing clips. Support channels shall be steel, hot-dip galvanized after fabrication with galvanized steel clips for steel conduit or tubing.
- E. Wall Penetrations. All conduits, raceways, cables and sleeve penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed with a UL-approved fire stopping system.

### **2.5 OUTLET BOXES AND SWITCH BOXES**

- A. Manufacturers: Firms regularly engaged in the manufacturing of electrical raceways of the types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized flat rolled sheet steel outlet wiring boxes of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.
- C. Outlet boxes used in wet outdoor locations, surface mounted shall be cast metal (FS or FD type) with mounting lugs and gasketed covers.
- D. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported, per NEC requirements.
- E. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and meeting requirements of individual wiring situations.

## **2.6 PULL BOXES, JUNCTION BOXES**

- A. Underground pull boxes are specified in Section 260543 "Underground Ducts and raceways for electrical systems ."
- B. Sheet Metal Boxes shall be NEMA OS 1, NEMA rating as indicated on drawings. Minimum 16 gauge galvanized steel construction with stainless steel hinged cover and neoprene gasket. Cover shall be secured to the body with a continuous, full length, piano type hinge and stainless steel pin on one side and captive screw on the other side. Door shall be equipped with padlock hasp with sealing hole provisions.
  - 1. Provide #10-32 tapped hole provisions for optional ground lug kit.
  - 2. Provide 0.375-16 collar studs for mounting optional panel.
  - 3. Provide external mounting feet for secure wall mounting.
  - 4. Finish: Wash and phosphate undercoat with ANSI 61 gray polyester power finish.
- C. Surface-Mounted Cast Metal Box: NEMA 250, NEMA Type 3R or 4 as indicated, flat-flanged, surface-mounted junction box:
  - 1. Material: Cast Iron.
  - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

## **2.7 CLOSURE FOAM**

- A. All conduit, raceways, cables and sleeves penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed by closure foam as in Dow Corning #3-6548 silicone RTV, GE RTV 850 silicone foam, 3M, Hilti, or approved equal.

## **2.8 SEALING AND FIREPROOFING**

- A. Penetrations. All conduits, raceways, cables and sleeve penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed with a UL-approved fire stopping system.
- B. Furnish UL listed products or products tested by a nationally recognized independent testing laboratory. Select products with rating not less than the rating of the wall, ceiling or floor being penetrated.
- C. Manufacturers:
  - 1. 3M CP 25WB + Caulk
  - 2. 3M FS 195 wrap or strip with restricting collar
  - 3. 3M CS 195 composite sheets
  - 4. Proset Systems fire rated floor and wall penetrations
  - 5. Dow Corning Fire Stop System
- D. Use stamped steel, chrome plated, hinged, split ring escutcheons or floor/ceiling plates for covering openings in occupied areas where conduit is exposed.
- E. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and the cored opening or a water-stop type wall sleeve.
- F. At non-rated interior wall or floor openings use Tremco Fyre-Sil, Sika Corp. Sikaflex la, Sonneborn Sonolastic NPT, or Mameco Vulkem 116 urethane caulk or Approved Equal.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify outlet locations and routing and termination locations of raceway prior to rough in.

#### **3.2 EXISTING WORK**

- A. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- B. Clean and repair existing raceway and boxes to remain or to be reinstalled.

#### **3.3 INSTALLATION OF RACEWAYS**

- A. Routing
  - 1. Install raceway and boxes in accordance with NECA "Standard of Installation."
  - 2. Conduit routing shown on drawings is diagrammatic only. Contractor shall field route conduit and raceways between equipment and devices as required to obtain a complete wiring system.
  - 3. All exposed conduits shall be installed parallel or perpendicular to dominant surfaces with right-angle turns made of symmetrical bends or fittings.
  - 4. Conduit shall not be installed on the outside face of exposed columns, but shall be routed on the web or on the inside of a flange of the column.

5. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
  6. Conduit shall be located at least 6 inches from hot water or steam pipes and from other hot surfaces
- B. Moisture Pockets
1. Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a hole shall be drilled in the bottom of a pull box or a "C-type" conduit fitting provided in the low point of the conduit run.
- C. Couplings and Unions
1. Metal conduit shall be joined by threaded conduit couplings, with the conduit ends butted.
  2. The use of running threads, Erickson type couplings, split couplings or similar unions are not permitted.
- D. Conduit Bodies
1. Conduit bends shall meet the requirements of NEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
  2. Conduits or tubing deformed or crushed in any way shall be removed from the job site.
- E. Bends and Offsets
1. Changes in direction of conduits shall be made with fittings or bends.
  2. Conduit bends shall meet the requirements of NEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
  3. Bends shall be made using appropriate tools or mechanical equipment. The use of a pipe tee or vise for bending conduit or tubing will not be permitted.
  4. For non-metallic conduit or plastic coated steel, approved factory bends and offsets shall be used.
  5. Conduits or tubing deformed or crushed in any way shall be removed from the job site.
  6. Install no more than the equivalent of three 90 degree bends between boxes or outlets
- F. Cutting and Threading
1. The plane of all conduit ends shall be square with the centerline.
  2. Where threads are required, they shall be cut and cleaned prior to conduit reaming.
  3. The ends of all conduit and tubing shall be reamed to remove all rough edges and burrs.
  4. Cutting oil shall be used in threading operations; the dies shall be kept sharp, and provisions shall be made for chip clearance.
  5. Threads on conduits and fittings shall be lubricated with conducting and sealing compound.
  6. All steel conduits shall be coated after threading with cold-galvanized zinc coating. The Contractor shall supply this protective material and shall apply it in the field prior to installing conduit or fittings.
- G. All steel conduit, exposed to weather or in contact with earth, shall be re-galvanized after threading with "Galvanizing Powder M-321" as manufactured by the American Solder and Flux Company of Philadelphia, Pennsylvania; "Zincilate 810" as manufactured by Industrial Metal Protectives, Inc., of Dayton, Ohio; "Zinc Rich" coating as manufactured by ZRC Chemical Products Company, Quincy, Massachusetts; or approved equal. The Contractor shall supply this protective material and shall apply it in the field.

H. Connections to Boxes and Cabinets

1. Conduit shall be securely fastened to all boxes and cabinets.
2. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit.
3. The locknuts, both inside and outside, shall then be tightened sufficiently to bond the conduit securely to the box.
4. Locknuts on connectors shall be tightened securely to bond the connectors.

I. All conduits entering enclosures outdoors or in wet areas shall enter through Meyer's hubs, or approved equal, or threaded openings.

J. Cleaning

1. Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit.
2. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or, where such accumulation cannot be removed by methods acceptable to the Owner /Engineer, the conduit shall be replaced.
3. For conduits sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of foreign materials. For conduits less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles and foreign material.

K. Empty Conduit

1. All conduits installed for future use shall have a polypropylene pull line with a minimum tensile strength of 200 lbs., Jet Line, Cat. No. 232, polyolefin, or approved equal. Pull line shall be secured at both ends to ensure future accessibility.

L. Rooftop Conduits

1. Provide redwood sleepers on waterproof mastic base or pre-manufactured supports (i.e. caddy pyramid series) for all conduit runs exposed on roofs.

M. Identification

1. All conduits shall be identified in accordance with other section of these specifications.

N. Grounding

1. All conduits shall be grounded in accordance with specification Section 26 05 00 – Common Work Results for Electrical.
2. A solid or stranded bare copper or green insulated copper solid or stranded ground wire shall be provided in all conduits and raceways.

O. Galvanized Rigid Steel Conduit

1. Galvanized rigid steel conduit shall be installed in areas exposed to weather, vehicle traffic, in hazardous classified areas, for penetrations through foundations, and 10 feet before transition from below grade to 8 feet above grade, unless otherwise noted on the drawings.

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2. Steel conduit in contact with earth shall be protected by "Scotchwrap" 10 mil tape applied in double thickness using 50 percent lap turns to 6 inches above grade and 6 inches beyond transition.
3. Expansion joints shall be used where required.

P. Electrical Metallic Tubing

1. Electrical metallic tubing shall be installed for all circuits, indoors above concrete slab, where not subject to conditions outlined for rigid galvanized steel conduits.

Q. Rigid Aluminum Conduit

1. Not acceptable on this project.

R. Flexible Metal Conduit

1. Flexible conduit inserts not greater than 30 inches in length, shall be installed in all conduit runs, which are supported by both building steel and by structures subject to vibration or thermal expansion. This shall include locations where conduit supported by building steel enters or becomes supported by isolated structures on separate foundations.
2. Flexible conduit shall be installed in conduit runs, which cross expansion joints.
3. Special areas, such as plant office control rooms in which external noise is to be minimized, shall have flexible conduit in conduit runs where the runs cross from the main building framing to the control room or office framing.
4. Flexible conduit shall be installed adjacent to all equipment and devices, which move in relation to the supply conduit due to vibration, normal operation of the mechanism, or thermal expansion.
5. Conduit shall be connected to pressure switches, thermocouples, solenoids, and similar devices with flexible conduit. Flexible conduit shall be installed adjacent to the motor terminal housing for motors requiring 4-inch and smaller conduit.
6. Flexible metal conduit inserts not greater than 6 feet in length shall be installed for light fixture tap conductors.

S. Liquid-Tight Flexible Metal Conduit

1. Liquid-tight flexible metal conduit shall be used in place of regular flexible conduit for connections to motors and transformers, in areas exposed to weather, moisture or oil, and under raised floors.
2. Liquid-tight flexible metal conduit may be used in place of flexible metal conduit where not otherwise required.

T. Non-Metallic Conduit

1. Schedule 40 shall be used for all power, signal feeders and branch circuits, in earth or enclosed in concrete, unless otherwise noted on the drawings. Conduits must be buried in earth in accordance with the NEC.

U. Conduit Support

1. Fasten conduit supports to building structures and surfaces in accordance with these specifications.
2. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

3. Do not use wire, ceiling support wires or perforated pipe straps to support conduit. Remove any temporary installation support wire.

V. Spacing of Supports

1. All conduit runs shall be rigidly supported, except where buried in concrete,.
2. Each conduit shall be supported within one (1) foot of junction boxes and fittings.
3. Spacers used in duct bank installations shall be placed no more than 6 to 10 feet apart.
4. Support spacing along conduit runs shall be as follows.

Conduit Size	Maximum Distance Between Supports
½ inch through 1-1/4 inch	5 feet
1-1/2 inch and larger	8 feet

- W. Ground and bond raceway and boxes in accordance with Section 26 05 00 – Common Work Results for Electrical.

**3.4 CABINET AND BOX INSTALLATION**

- A. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- B. Locate boxes and conduit bodies so as to ensure ready accessibility of electrical wiring, maintain headroom and to present neat mechanical appearance.
- C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. In inaccessible ceiling areas, install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices with each other.
- E. Use flush mounting outlet boxes in finished areas.
  1. Do not install flush mounting boxes back-to-back in walls.
  2. Provide minimum 6-inch separation between adjacent boxes.
  3. Provide minimum 24-inch separation in acoustic rated walls.
  4. Use stamped steel bridges to fasten flush mounting outlet box between studs.
  5. Secure flush mounting box to interior wall and partition studs.
  6. Accurately position to allow for surface finish thickness.
  7. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
  8. Use adjustable steel channel fasteners for hung ceiling outlet box.
- F. Support boxes independently of conduits.
- G. Use code sized gang box where more than one device is mounted together. Do not use sectional box. Use code sized gang box with plaster ring for single device outlets.
- H. Use cast outlet box in exterior locations where exposed to the weather and wet locations (interior or exterior).
- I. Coordinate installation of electrical boxes and fittings with cable and raceway installation work. Provide knockout closures to cap unused knockout holes where blanks have been removed.

- J. Do not use round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections where fastened with a locknut or bushing on rounded surface.
- K. Fasten boxes rigidly to substrate or structural surfaces to which they are being mounted, or solidly embed electrical boxes in concrete or masonry as appropriate.
- L. Except as prevented by the location of other work, all junction boxes and outlet boxes shall be centered on structures.
- M. Conduit openings in boxes shall be made with a hole saw or shall be punched.
- N. Cabinets and boxes shall be rigidly mounted.
  - 1. Mounting on concrete shall be secured by self-drilling anchors.
  - 2. Mounting on steel shall be by drilled and tapped screw holes, or by special support channels welded to the steel, or by both.
  - 3. Cabinets shall be leveled and fastened to the mounting surface with not less than ¼-inch air space between the enclosure and mounting surface.
  - 4. All mounting holes in the enclosure shall be used.
- O. Large Pull Boxes - Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.
  - 1. Interior Dry Locations - Use hinged enclosure.
  - 2. Other Locations - Use surface mounted box of appropriate location classification.

### **3.5 ANCHORS**

- A. Where supports for raceways, boxes, and cabinets are mounted on concrete surfaces, they shall be fastened with self-drilling tubular expansion shell anchors with externally split expansion shells, single-cone expanders, and annular break-off grooved chucking cones. Anchors shall be Phillips "Red Head" or approved equal.

### **3.6 SEALING AND FIREPROOFING**

- A. Fire-Rated Surface:
  - 1. Where conduit penetrates fire rated surface, install fire-stopping product in accordance with manufacturer's published instructions.
  - 2. All openings through fire rated wall, floor, ceiling or roof must be sealed.
  - 3. Install galvanized sheet metal sleeves (minimum 12-gage) through opening and extending beyond minimum of one (1) inch on each side of building element.
  - 4. Pack void between sleeve and building element with backing material.
  - 5. Seal ends of sleeve with UL listed fire-resistive silicone compound to meet fire rating of structure penetrated.
- B. Non-Rated Surfaces:
  - 1. Opening through a non-fire rated wall, floor, ceiling or roof must be sealed using an approved type of material.
  - 2. Use galvanized sheet metal sleeves in hollow wall penetrations to provide a backing for the sealant. Grout area around sleeve in masonry construction.

3. Install escutcheons or floor/ceiling plates where raceway, penetrates non-fire rated surfaces in occupied spaces.
4. Install rubber links of mechanical seal tightened in place and sized for the pipe, in exterior wall openings below grade, in accordance with the manufacturer's instructions.
5. All pipe penetrations at interior partitions and/or walls, laboratory spaces, telephone, data and communication rooms and similar spaces where the room pressure or odor transmission must be controlled, shall be sealed. Sealant shall be applied to both sides of the penetration in such a manner that the annular space between the pipe sleeve and the pipe is completely filled.

**3.7 ADJUSTING**

- A. Install knockout closures in unused openings in boxes.

**3.8 CLEANING**

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore manufacturer's finish.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Full compensation for Raceways and Boxes shall be considered as included in the various items of related work and no separate payment will be made therefor.

**END OF SECTION 26 05 33**

**SECTION 26 05 43**

**UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. Ducts in concrete-encased duct banks.
- B. Hand-holes and hand-hole accessories.
- C. Manholes and manhole accessories.

**1.2 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Manhole and hand hole hardware.
  - 2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
  - 3. Duct-bank materials, including spacers and miscellaneous components.
  - 4. Warning tape.
- B. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:
  - 1. For manholes:
    - a. Duct sizes and locations of duct entries.
    - b. Reinforcement details.
    - c. Manholes cover design.
    - d. Step details.
    - e. Grounding details.
    - f. Dimensioned locations of cable rack inserts, pulling-in irons, and sumps.
  - 2. For precast manholes and hand holes, Shop Drawings shall be signed and sealed by a qualified professional engineer, and shall show the following:
    - a. Construction of individual segments.
    - b. Joint details.
    - c. Design calculations.
- C. Coordination Detailing Activity Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings.
- D. Product Certificates: For concrete and steel used in underground precast manholes, according to ASTM C 858.
- E. Product Test Reports: Indicate compliance of manholes with ASTM C 857 and ASTM C 858, based on factory inspection.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories Including Ducts for Communications and Telephone Service: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Owner's Representative, and marked for intended use.
- B. Comply with ANSI C2.
- C. Comply with California Electric Code (NFPA 70).

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

**1.5 PROJECT CONDITIONS**

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.
  - 1. Notify the Owner's Representative fourteen days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Owner Representative's written permission.

**1.6 COORDINATION**

- A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities and site grading, as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by the Owner's Representative.

**1.7 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of amount installed.

## **PART 2 - PRODUCTS**

### **2.1 PRODUCTS AND MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Underground Precast Concrete Utility Structures:
    - a. Carder Concrete Products.
    - b. Christy Concrete Products, Inc.
    - c. Elmhurst-Chicago Stone Co.
    - d. Jensen Precast.
    - e. Utility Vault Co.
    - f. Wausau Concrete Co.
    - g. Or equal.
  2. Frames and Covers:
    - a. Alhambra Foundry
    - b. Campbell Foundry Co.
    - c. East Jordan Iron Works, Inc.
    - d. McKinley Iron Works, Inc.
    - e. Neenah Foundry Co.
    - f. Or equal.
  3. Nonmetallic Ducts and Accessories:
    - a. Arnco Corp.
    - b. Beck Manufacturing Inc.
    - c. Cantex, Inc.
    - d. Certainteed Corp.; Pipe & Plastics Group.
    - e. ElecSys, Inc.
    - f. Electri-Flex Co.
    - g. Lamson & Sessions; Carlon Electrical Products.
    - h. Manhattan/CDT/Cole-Flex.
    - i. Spiraduct/AFC Cable Systems, Inc.
    - j. Or equal.
- B. Or Equal: Where products are specified by manufacturers name and accompanied by the term "or equal", comply with provisions in Division 01. Specific procedures must be followed before use of an unnamed product or manufacturer.

### **2.2 CONDUIT**

- A. Conduit and fittings are specified in Section 260533 "Raceways and Boxes for Electrical Systems."

### **2.3 DUCTS**

- A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

## 2.4 HAND HOLES

- A. Cast-Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and HS20 for roadways, parking lots and loading docks.
- B. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of hand hole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and HS20 for roadways, parking lots and loading docks.
- C. Cover Legend:
  - 1. "HIGH VOLTAGE"
  - 2. "ELECTRIC"
  - 3. "TELECOM"
  - 4. "FIRE ALARM"
  - 5. "CATV"
  - 6. Other distinct systems as applicable.

## 2.5 PRECAST MANHOLES

- A. Precast Units: ASTM 478, with interlocking mating sections, complete with accessories, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Diameter: 48 inches minimum.
- C. Design and fabricate structure according to ASTM C 858.
- D. Structural Design Loading: ASTM C 857, Class A-16 (AASHTO HS20).
- E. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
- F. Riser Sections: 4-inch minimum thickness, and lengths to provide required depth Approved by Owner Representative.
- G. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
- H. Steps: ASTM A 615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches.
- I. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
- J. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

- K. Protective Coating: Plant-applied, coal-tar, epoxy-polyamide paint 15-mil minimum thickness applied to exterior and interior surfaces.
- L. Source Quality Control: Inspect structures according to ASTM C 1037.

## 2.6 ACCESSORIES

- A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts.
- B. Manhole Frames and Covers: Comply with AASHTO loading specified for manhole; Ferrous frame 36 inch clear ID by 6 inch minimum riser with 4-inch-minimum width flange and 38 -inch-diameter cover.
  - 1. Provide cast covers with cast-in legend:
    - a. "LV-ELECTRIC" for duct systems with power wires and cables for systems operating at 600 V and less.
    - b. "HV-ELECTRIC" for duct systems with medium-voltage cables.
    - c. "TELECOM" for communications, data, and telephone duct systems.
  - 2. Cast iron with cast-in legend as indicated above subsection 1. Milled cover-to-frame bearing surfaces.
  - 3. Manhole Frames and Covers: ASTM A 48; Class 30B gray iron, 36-inch size, machine-finished with flat bearing surfaces.
- C. Sump Frame and Grate: ASTM A 48, Class 30B gray cast iron.
- D. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 2-inch- diameter eye and 1-by-4-inch bolt.
  - 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- E. Pulling and Lifting Irons in Floor: 7/8-inch- diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.
  - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- F. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
  - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- H. Cable Stanchions: Hot-rolled, hot-dip-galvanized, T-section steel; 2-1/4-inch size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
- I. Cable Arms: 3/16-inch- thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 12 inches wide by 14 inches long and arranged for secure mounting in horizontal position at any location on cable stanchions.

- J. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- K. Grounding Materials: Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."
- L. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- M. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

## 2.7 CONSTRUCTION MATERIALS

- A. Seal manhole section joints with sealing compound recommended by the manhole manufacturer.
- B. Damp proofing: Comply with Division 07 Thermal and Moisture Protection
- C. Mortar: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
- D. Brick for Manhole Chimney: Sewer and manhole brick, ASTM C 32, Grade MS.
- E. Concrete: Use 3000-psi- minimum, 28-day compressive strength and 1-inch maximum aggregate size. Concrete and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete." Provide red dye added to concrete during batching for medium voltage as follows:
  - 1. 2.0 lbs. of dye per 94 lb. bag of cement.
    - a. Color: Davis Color No. 1117.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Underground Ducts for Electrical Cables Higher than 600 V: Type EPC-40-PVC, concrete-encased duct bank.
- B. Underground Ducts for Telephone Utility Service: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-80-PVC when crossing roads.
- C. Underground Ducts for Communication Circuits: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-80-PVC when crossing roads.
- D. Manholes: Underground precast concrete utility structures.
- E. Manholes: Cast-in-place concrete.

### **3.2 EARTHWORK**

- A. Excavation and Backfill: Comply with Division 31 but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32.
- D. Restore disturbed pavement. Refer to Division 01 Section "Cutting and Patching."

### **3.3 CONDUIT AND DUCT INSTALLATION**

- A. Exercise care in excavating, trenching, and working near existing utilities. Locate any existing buried utilities before excavating.
- B. Duct bank trench shall be shored, framed and braced for installing ducts. Frames, forms, and braces shall be either wood or steel. Variations in outside dimensions of the installed duct bank shall not exceed 2 inches on the vertical or the horizontal from the design. Remove forms and bracing after 24 hours and before backfilling.
- C. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions. Duct banks shall be laid to a minimum grade slope of 4 inches per 100 feet. This slope may be from one manhole to the next or both ways from a high point between manholes, depending upon the contour of the finished grade.
- D. Duct banks shall be installed so that the top of the concrete encasement shall be no less than 36 inches below grade or pavement for primary 12K power, and not less 24 inches below finished grade or pavement for campus-wide communications. As a general rule, depths shall be a minimum of three feet, but not more than six feet.
- E. Curves and Bends: Use manufactured 60 inches minimum elbows for stub-ups at equipment, communication pull boxes or enclosures and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet, both horizontally and vertically, at other locations. Manufactured long radius bends may be used in runs of 100 feet or less on approval from the Owner's representative. Vertical feeder sweep into buildings shall be coated steel.
- F. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- G. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches o.c. for 5-inch ducts and vary proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Where connection to bulkhead of duct bank is made to vaults or existing duct banks, the concrete encasement shall be doweled with on No. 4 reinforcement rod 36 inches long per conduit to the existing encasement.
- H. Building Entrances: Make a transition from underground duct to conduit at least 10 feet outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
  2. Direct-Buried, Non-encased Ducts at Non-waterproofed Wall Penetrations: Install a Schedule 40, galvanized steel pipe sleeve for each duct. Calk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.
  3. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.
- I. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:
1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  2. Duct joints in concrete may be placed side by side horizontally, but shall be staggered at least 6 inches vertically. Joints shall be made in accordance with manufacturer's recommendations for the particular type of duct and coupling selected. In the absence of specific recommendations, plastic duct connections shall be made by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of duct's ends. The duct and fitting shall then be slipped together with a quick one-quarter turn to set the joint.
  3. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope. At connection to manholes, dowel concrete encasement with on No. 4 reinforcing bar 36 inches long per duct.
  4. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
  5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
  6. Minimum Clearances between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
  7. Depth: Install top of duct bank at least 24 inches below finished grade in no traffic areas and at least 30 inches below finished grade in vehicular traffic areas, unless otherwise indicated.
- J. Direct-Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:
1. Separator Installation: Space separators not more than 4 feet center-to-center along entire length of duct bank including top pipes.
  2. Install expansion fittings as shown on Shop Drawings.

3. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 for pipes less than 6 inches in nominal diameter.
  4. Backfill: Install backfill as specified in Division 31. After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally. Do not place backfill for a period of at least 24 hours after pouring of concrete.
  5. Minimum Clearances between Ducts: 3 inches between ducts for like services and 6 inches between power and signal ducts.
  6. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
- K. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.
- L. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete. Galvanized steel conduits installed below grade shall be painted with two coats of Koppers Bitumastic paint before installing in ground.
- M. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- N. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

### **3.4 MANHOLE AND HANDHOLE INSTALLATION**

- A. Elevation: Install manholes with rooftop at least 15 inches below finished grade. Install handholes with depth as indicated. Where indicated, cast hand hole cover frame directly into roof of hand hole and set roof surface 1 inch above grade. Place and align precast manholes to provide horizontal tolerance of 2 inches in any direction and vertical alignment with not greater than 1/8 inch maximum tolerance for 6 foot of depth. Completed manhole shall be rigid, true to dimensions and alignment, and shall be watertight.
- B. Drainage: Install drains in bottom of units where indicated. Coordinate with drainage provisions indicated. Sumps shall be knocked out at time of installation.
- C. Access: Install cast-iron frame and cover.
1. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
  2. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch above finished grade.
- D. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least three days. Apply according to Division 07 Thermal and Moisture Protection. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole and hand hole chimneys after brick mortar has cured at least three days. Seal manhole section joints with sealing compound recommended by the manhole manufacturer. Penetration into manholes and/or

boxes shall be sealed. Provide conduit duct plugs for unused terminator openings of spare conduits in manhole. Do not water seal top removable cover until cable pulling has been completed.

- E. Damp proofing: Apply damp proofing to exterior surfaces of units after concrete has cured at least three days. Apply according to Division 07 Thermal and Moisture Protection. After ducts have been connected and grouted, and before backfilling, damp proof joints and connections and touch up abrasions and scars. Damp proof exterior of manhole and hand hole chimneys after brick mortar has cured at least three days.
- F. Interior walls and ceiling shall be primed and painted with two coats flat white paint.
- G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- H. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- I. Grounding: Install ground rod through floor in each structure with top protruding 6 inches above floor. Seal floor opening against water penetration with waterproof nonshrink grout. Ground exposed metal components and hardware with bare-copper ground conductors. Train conductors neatly around corners. Use cable clamps secured with expansion anchors to attach ground conductors.
- J. Precast Concrete Manhole Installation: comply with ASTM C 891.
  - 1. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
  - 2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth. Provide a minimum 6-inch level base of  $\frac{3}{4}$  inch crushed rock under manhole to ensure uniform distribution of soil pressure on floor.

### **3.5 FIELD QUALITY CONTROL**

- A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
- B. Grounding: Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.
- D. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

### **3.6 CLEANING**

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.
- C. After the duct line has been completed, a brush with stiff bristles shall be pulled through each duct to make certain that no particles of earth, sand or gravel have been left in the line. (Mandrels not less than 12 inches long, having a diameter approximately 1/4 inch less than inside diameter of the duct, shall be pulled through each duct). Leave a 3/8"-inch minimum polypropylene pull rope in each duct for future use.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Pull Boxes will be paid at the contract unit price per each (EA), which price shall include full compensation for furnishing all labor, materials, tools, equipment and other incidentals necessary for the installation of pull boxes, backfill and surface restoration, and all incidental work involved, as designated by the Engineer and all other related work.
- B. Conduits below grade will be paid at the contract unit price per linear foot (LF) which price shall include full compensation for furnishing all labor, materials, tools, equipment and other incidentals necessary for the installation of schedule 40 PVC as noted on plans, including trenching, backfill, surface restoration, and fittings as required by California Electrical Code, and all incidental work involved, as designated by the Engineer and all other related work.

**END OF SECTION 26 05 43**

## SECTION 26 05 53

### IDENTIFICATION FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. The extent of the electrical systems and equipment requiring identification is shown on the drawings, and the extent of identification required is specified herein and in individual sections of work requiring identification. The types of electrical identification specified in this section include the following:
1. Exposed conduit color banding.
  2. Buried cable warnings.
  3. Cable/conductor identification.
  4. Operational instructions and warnings.
  5. Danger signs.
  6. Equipment/system identification signs.

##### 1.2 REFERENCES - CODES AND STANDARDS

- A. ANSI Z535.4-1998 – Product Safety Signs and Labels.
- B. APWA ULCC – Uniform Color Code for Buried Utilities.
- C. NFPA 70 – National Electrical Code (NEC). Latest approved edition.

##### 1.3 SYSTEM DESCRIPTION

- A. Label the following electrical equipment with nameplates which clearly identify each item, the function or use of the item, and the circuit identification of the feed to the item:
1. All transformers shall be identified by 1-inch high block letters cut in stencil and applied with yellow paint on a flat-black background. The transformer number, primary and secondary voltages, and the kVA shall be shown.
  2. All Metal-Clad Switchgear, Metal-Enclosed Switchgear, Switchboards, Distribution Panelboards, Power and Lighting Panels, Motor Control Centers, Local Control Panels, Terminal Cabinets and all electrical equipment enclosure shall be identified using laminated plastic nameplates. The equipment number, voltage rating, current rating, number of phases, connection type, short circuit interrupting rating, and circuit number shall be shown
  3. Identify all receptacles and lighting switches, by the circuit number shown on the drawings using ¼-inch high white characters on ½-inch wide black stick-on tape placed on the wall directly above the device if the device is wall mounted. Place the tape on the device enclosure if the device is not wall mounted.
  4. All motors, starters, disconnect switches, Time Switches, Special Function Pushbuttons and Switches, and miscellaneous control devices shall be identified by function and

circuit number, with ¼-inch high white characters on a ½-inch wide black stick-on tape where installed indoors and engraved plastic nameplates where installed outdoors.

5. All underground raceway or cable shall be marked with buried warning tape along its entire length.
6. All exposed raceway longer than 10 feet in length shall be identified.
7. Panelboard Directories: Furnish all panelboards with a complete 8-1/2-inch by 11-inch typewritten directory mounted in the inner door under a clear plastic cover set in a metal frame.

B. Branch circuits and devices:

1. Label all individual receptacle outlets at the outlet faceplate to indicate the panelboard of origin and branch circuit number. Label modular furniture feeds at the power pole drop in a visible and consistent location. Labels shall be self-adhesive, thermal machine printed type such as Brothers, Panduit, or T&B and shall be clear plastic with black lettering.
2. All branch circuits in outlet boxes shall be identified with circuit number using wrap-around labels (T&B, BRADY or 3M).
3. As an alternative to separate nameplates, device plates may be engraved directly with lettering filled with black enamel.

#### 1.4 SUBMITTALS

- A. Catalog data for nameplates, labels, and markers.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

#### 1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70 – National Electrical Code.
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, approved testing and listing agencies as suitable for the purpose specified and shown.

### PART 2 - PRODUCTS

#### 2.1 NAMEPLATES AND LABELS

- A. Nameplates
  1. Engraved three-layer laminated plastic, white letters on black background for normal power and white letters on red background for emergency power. Communications and control cabinets shall be labeled with white letters on green background.
  2. Locations
    - a. Each electrical distribution and control equipment enclosure.
    - b. Communication cabinets.
    - c. Motor control centers, including each combination module.
  3. Letter Size

- a. Use 1/8-inch letters for identifying individual equipment and loads.
- b. Use 1/4-inch letters for identifying grouped equipment, loads, panelboards, and transfer switch.
- c. Use 1/2-inch letters for identifying the main switchboard, motor control centers, and large distribution switchboards.

B. Labels

1. Embossed adhesive tape, with 3/16-inch white letters on colored background to match color scheme of plastic laminate labels in 2.1.1. Use only for identification of individual wall switches and receptacles, control device stations, and multi-outlet devices.
2. Thickness
  - a. 1/16-inch for units up to 20 square inches or 8-inch length; 1/8-inch for larger units.

## 2.2 WIRE MARKERS

A. Manufacturers

1. 3-M Co.
2. Equal

B. Description: Cloth, tape, split sleeve, or tubing type wire markers, self-adhesive.

C. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, control panels, motor controllers and starters, and each load connection.

D. Legend

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on contract drawings.
2. Control Circuits: Control wire number indicated on shop drawings.
3. Neutral Conductors: Clearly indicate the branch circuit or feeder number the neutral serves. In multi-wire circuits where the neutral is shared, mark the neutral with the circuit number of the "A" phase.

## 2.3 CONDUIT MARKERS

A. Provide manufacturer's standard preprinted, flexible or semi-rigid, permanent, plastic-sheet conduit markers, minimum of 3 mils thick and 1-1/2-inch wide extending 360 degrees around conduits; designed for self-adhesive attachment to conduit. Except as otherwise indicated, provide lettering that indicates the voltage of the conductor(s) in the conduit. Provide 8-inch minimum length for 2-inch and smaller conduit, 12-inch minimum length for larger conduit.

B. Identify conduits containing conductors above 600-volts with the following alternating markers

1. DANGER - HIGH VOLTAGE
2. The voltage, as applicable (i.e. – 12-kV, 4.16-kV, 480-Volts, 240-Volts, etc.)

C. Location: Furnish markers for each conduit longer than 10 feet, spaced 20 feet on center.

D. Color: Unless otherwise indicated or required by governing regulation, provide orange markers with black letters.

1. Fire Alarm System: Red w/black letters.

2. Telephone System: Green w/yellow letters.
3. Data/Communication. System: White w/black letters.
4. Emergency System: Orange w/black letters.

E. Legend:

1. 208 Volt System: Normal 208/120-volts.
2. Fire Alarm System: Fire alarm.
3. Telephone System: Telephone.
4. Data/Communication System: Data/communications.

## **2.4 FASTENERS**

- A. Secure all labels and nameplates with self-tapping stainless steel screws. Use contact type permanent adhesive where screws cannot or should not penetrate the substrate.

## **2.5 BAKED ENAMEL DANGER SIGNS**

- A. Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20 gage steel; of standard red, black and white graphics; 14-inch by 10-inch size except where 10-inch by 7-inch is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording (e.g. HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH).
1. At each entry doors of Electrical Rooms: "DANGER HIGH VOLTAGE – KEEP OUT, AUTHORIZED PERSONNEL ONLY"

## **2.6 LETTERING AND GRAPHICS**

- A. Coordinate names, abbreviations and other designations used in the electrical identification work, with the corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

## **2.7 UNDERGROUND WARNING TAPE**

- A. Three-inch minimum width, 5 mil thickness, foil bonded polyethylene tape, detectable type, with suitable continuous warning legend describing buried electrical lines. Tape color shall conform to APWA uniform color code using ANSI Z535.1 safety colors. Text shall be black, 2-inch minimum letters.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Degrease and clean surfaces to receive nameplates and labels.

- B. Coordination: Where identification is to be applied to surfaces that require finish, install identification after completion of painting.
- C. Regulations: Comply with governing regulations and the requests of governing authorities for the identification of electrical work.

### 3.2 APPLICATION

- A. Install nameplate and label parallel to equipment lines.
- B. Secure nameplate to equipment front using screws, rivets, or adhesive.
- C. Secure nameplate to outside moveable surface of door on panelboard.
- D. Conduit Identification:
  - 1. Where electrical conduit is exposed in spaces with exposed mechanical piping, which is identified by a color-coded method, apply color-coded identification on the electrical conduit in a manner similar to the piping identification. Except as otherwise indicated, use orange as the coded color for conduit.
  - 2. Paint red band or provide red tape on each fire alarm conduit longer than 10 feet, minimum 20 feet on center.
- E. Cable/Conductor Identification:
  - 1. Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where the wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided.
  - 2. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project electrical work.
- F. Operational Identification and Warnings
  - 1. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems, and electrically connected mechanical systems and general systems and equipment, including the prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes.
- G. Danger Signs
  - 1. In addition to the installation of danger signs required by governing regulations and authorities, install appropriate danger signs at the locations indicated and at locations subsequently identified by the Installer of electrical work as constituting similar dangers for persons in or about the project.
  - 2. High Voltage
    - a. Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
    - b. Critical Switches/Controls

- c. Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

H. Electrical Hazard Warning

1. Provide field marking of switchboards, switchgear, panelboards, control panels, meter socket enclosures, and motor control centers to warn of potential electric arc flash hazards in accordance with NEC 110.16 and NFPA 70E-2012.
  - a. Marking shall be in accordance with ANSI Z535.4-1998 with regards to design of safety labels and application to products.

I. Equipment/System Identification Signs

1. Install an engraved plastic-laminate sign on each major unit of electrical equipment in the building; including the central or master unit of each electrical system and the communication/signal systems, unless the unit is specified with its own self-explanatory identification or signal system.
2. Except as otherwise indicated or specified, provide single line of text, 1/2-inch high lettering on 1-1/2-inch high sign (2-inch high where two lines are required), white lettering in black field.
3. Provide text matching terminology and numbering of the contract documents and shop drawings.
4. Provide signs for each unit of the following categories of electrical work
  - a. Major electrical switchboard
  - b. Electrical substation
  - c. Motor control center
  - d. Fire alarm control panel and annunciators.

- J. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrata with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrata.

- K. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Full compensation for identification of electrical systems shall be considered as included in the various items of related work and no separate payment will be made therefor.

**END OF SECTION 26 05 53**

## **SECTION 26 24 16**

### **SERVICE PEDESTAL**

#### **PART 1 - GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Utility Service pedestals.

##### **1.2 SUBMITTALS**

- A. Product Data: For each type of pedestal, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard or pedestal and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Include evidence of NRTL listing for series rating of installed devices.
  - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

##### **1.3 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 - Operation and Maintenance Data, include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

##### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys: Two spares for each type of panelboard cabinet lock.

##### **1.5 QUALITY ASSURANCE**

- A. Source Limitations: Obtain panelboards, service pedestals, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install equipment until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## 1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## PART 2 - PRODUCTS

### 2.1 DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

- A. Manufacturers:
  - 1. Tesco
  - 2. Or Approved Equal.
- B. Product Description
  - 1. Tesco 27-000 Single Meter underground service pedestal NEMA 4X, circuit breaker type distribution, meter socket and main circuit breaker.
- C. Bus
  - 1. Silver plated copper current carrying components, ratings as indicated on drawings.
  - 2. Main bus ampacity shall be equal to the main circuit breaker frame size rating.
  - 3. Furnish copper ground bus in each panelboard.
- D. Minimum integrated short circuit rating
  - 1. Panelboards rated 240-Volts - 10,000 amperes RMS symmetrical
  - 2. Panelboards rated 480-Volts - 42,000 amperes RMS symmetrical

3. Circuit Breaker rating shall match or exceed the panel interrupting rating
4. Series rated circuit breakers are not acceptable

E. Enclosure:

1. Outdoor Installation:
  - a. NEMA, Type 4X, construction.

## **2.2 METERING**

- A. Single Meter Socket per PG&E requirements.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine equipment before installation. Reject pedestals that are damaged or rusted or have been subjected to water saturation.
- B. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from equipment.
- B. Install overcurrent protective devices and controllers not already factory installed.

### **3.3 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53.
- B. Nameplates: Label each pedestal with a nameplate complying with requirements for identification specified in Section 26 05 53.

### **3.4 ADJUSTING**

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. Service Pedestals will be paid at the contract unit price per Each (EA) and shall include circuit breakers, associated equipment and concrete equipment pad as shown on plans and mounting hardware, which price shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, storing, maintaining, transporting, and for doing all the work necessary for the intended operation.

**END OF SECTION 26 24 16**

## **SECTION 26 51 00**

### **LIGHTING**

#### **PART 1 - GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Lighting fixtures and drivers, and their installation.

##### **1.2 REFERENCES**

- A. ANSI/NFPA 101 - Life Safety Code.
- B. International Electrotechnical Commission (IEC)
  - 1. IEC 801-2 Electrostatic Discharge Testing Standard.
  - 2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- C. Illuminating Engineering Society of North America (IESNA)
  - 1. LM-79 – Electrical and Photometric Measurements of Solid State Lighting Products.
  - 2. LM-80 – Measuring Lumen Maintenance of LED Light Sources.
- D. National Electrical Manufacturer's Association (NEMA) SSL-1 – Electronic Drivers for LED Devices, Arrays, or Systems.
- E. Underwriters Laboratories, Inc. (UL) 8750 – Light Emitting Diode (LED) Light Sources for Use in Lighting Products

##### **1.3 SUBMITTALS**

- A. Product Data
  - 1. Light fixtures.

##### **1.4 EXTRA MATERIALS**

- A. LED Fixtures
  - 1. Provide one of each complete exterior LED fixture for Owner stock for future replacement.
  - 2. Provide 5 percent or two, whichever is greater of each plastic and other security lens type.

##### **1.5 WARRANTY**

- A. Fixtures and drivers shall have a minimum five year warrantee.

## **PART 2 - PRODUCTS**

### **2.1 LIGHT FIXTURES – GENERAL**

- A. Provide lighting fixtures and accessories complete and ready for operation. Furnish the fixtures as indicated on the Drawings and as listed in the fixture schedule. Verify in all cases, the lengths and quantity of fixtures necessary to achieve the indicated results.
- B. All lighting fixtures shall have published photometric tests conducted by Electrical Testing Laboratories. Make available the test results upon request. Testing shall include candlepower distribution curves, total fixture efficiency, brightness and shielding angles in longitudinal and transverse directions.
- C. Provide lighting fixtures in the finishes and colors as noted on the Drawings.
- D. Provide the UL and IBEW labels on all lighting fixtures.
- E. Observe the requirements of the CBC Section 2606 regarding plastic lighting diffusers. Fixtures and auxiliary equipment mounted against combustible material shall be approved for such installation.
- F. Make-up fixtures with Type AF or equal fixture wire. Provide an identified, approved landing lug for equipment ground wires.

### **2.2 LED LIGHT FIXTURES**

- A. General
  - 1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
  - 2. LED light fixtures shall be a factory assembled luminaire including all required driver and light engine modules integral to and within a single housing. Lead lengths between driver and light engine shall not exceed 3 feet. Remote luminaire/driver installations are not acceptable.
  - 3. LED light fixtures shall be Reduction of Hazardous Substances (RoHS) compliant.
- B. **LED Driver Modules**
  - 1. Description: Universal voltage switching-mode LED driver module with a rated lifetime of not less than 50,000 hours when operated at an ambient temperature of less than 60-degrees C.
  - 2. LED drivers shall include native 0-10V dimming capabilities without additional control devices or field-installed circuitry. Integral short-circuit, open-circuit and overload fault protection to prevent driver failure.
  - 3. LED drivers shall be capable of producing adequate output current to produce the specified light levels. Compatibility of driver and LED light engine must be tested and ensured by driver manufacturer.
  - 4. Minimum efficiency: 85% at full load.
  - 5. Minimum Operating Ambient Temperature: -20° C (-4° F).

6. Input Voltage: 120V to 277V ( $\pm 10\%$ ) AC at 60Hz. Drivers that require DC input shall include an integral converter that accepts standard line voltage AC.
7. Power Factor:  $\geq 0.95$ .
8. Total Harmonic Distortion:  $\leq 20\%$  and meet ANSI C82.11 maximum allowable THD requirements
9. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.
10. Electrolytic capacitors to operate at least 20 degrees C below the capacitor's maximum temperature rating when the driver is under fully-loaded conditions and case temperature is 62 degrees C.
11. Maximum inrush current of 2 amperes for 120-Volt and 277-Volt drivers.
12. Withstand up to a 4,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
13. Inaudible in a 27 dBA ambient.

**C. LED Light Engine Modules**

1. Minimum CRI: 80.
2. Color Temperature: 3000K, unless otherwise noted.
3. Minimum Rated Life: 50,000 hours as per LM79.

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. Install fixtures in straight, true lines and without visible gaps between fixtures and building surfaces and between fixtures in continuous rows. For linear wall mounted fixtures, ensure that the wall surface is finished flat, straight, and free of imperfections prior to mounting the fixtures. Replace or repair lighting fixture installations that are out of plumb or that have obvious gaps or misalignment.
- B. Refer to the Drawings in determining the mounting location and height of lighting fixtures.
- C. Provide final touchup painting to repair fixture finishes which are nicked or marred during installation. Obtain the paint from the fixture manufacturer.

**3.2 AUDIBILITY**

- A. Fixtures shall be free from any undesirable hum, vibration, or noise. Provide lighting equipment suitable for the intended ambient sound levels. Where necessary to meet this criteria, provide additional means of sound deadening, whether or not specifically indicated. Fixtures that are found to be unsatisfactory in the opinion of the Owner shall be removed and replaced at the Contractor's expense.

**3.3 SUPPORTS AND BLOCKING**

- A. Refer to the Drawings for specific mounting details for lighting fixtures.

**3.4 EXTERIOR POLE MOUNTED FIXTURES AND BOLLARDS**

- A. Provide pole base footings in accordance with the Drawings. Footings shall be reinforced concrete with anchor bolts sized and located in accordance with the manufacturer's recommendations for the geographic locality. Provide reinforced concrete in accordance with the requirements as stipulated elsewhere in these Specifications. Forms for pole bases shall be placed using resin-lined Sonotube concrete forms or Approved Equal to give a smooth finished appearance. Patch and sack cracks and voids in the bases to match the surrounding surface.
- B. Verify the exact location of underground facilities in the vicinity of pole bases prior to boring holes and bring potential conflicts to the attention of Owner. Use an anchor bolt template as provided by the manufacturer for the placement of anchor bolts and substantially brace the forms to ensure that the base remains straight and plumb. Refer to the Drawings for fixture orientation and alignment, and utilize a transit site or snap line to verify same.
- C. Exposed surfaces of concrete bases or footing shall be finished smooth without cracks, voids, or jagged edges. Chamfer and float the base after pouring concrete to achieve a finished appearance. In order to allow leveling of the pole, install the pole base-plate one inch above the top of the concrete footing. Level the pole plumb and pack the space under the base-plate with Embecco dry pack grout.
- D. For fixtures with adjustable aiming or reflectors, arrange to perform a final adjustment of aiming at night under the direction of Owner.

### **3.5 OBSTRUCTIONS**

- A. Verify throughout the Project that mounting locations and suspension systems remain free of obstructions. Suspended or pendant mounted fixtures must be free to swing 45 degrees in all directions without hitting obstructions or other fixtures. Provide seismic rated swivel ball hangars for pendant mounted lighting fixtures to achieve the proper swing.

### **PART 4 - MEASUREMENT AND PAYMENT**

- A. Light fixtures and concrete base will be paid at the contract unit price per each (EA), which price shall include full compensation for furnishing all labor, materials, tools, equipment and other incidentals necessary for the installation of (1) light fixture, type as indicated on the drawings, with pole, concrete pole base, arm(s), concrete reinforcing, anchoring, excavation, fill, and surface restoration, and associated fixture mounting hardware and all incidental work involved, as designated by the Engineer and all other related work.

**END OF SECTION 26 51 00**

**SECTION 26 27 43**

**ELECTRIC-VEHICLE SERVICE EQUIPMENT - AC LEVEL 2**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes EVSE that provides AC Level 2 EV charging.

**1.3 SUBMITTALS**

- A. Shop Drawings: For EVSE.
  - 1. Include plans, elevations, sections, mounting and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Detail fabrication and assembly of mounting assemblies for EV charging equipment.
  - 4. Include diagrams for power, signal, and control wiring.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.
- B. Sample warranty.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance data.
- B. Software and Firmware Operational Documentation:
  - 1. Software operating manuals.
  - 2. Program Software Backup: On USB, CD, Cloud, or approved media, complete with configuration files.
  - 3. Device address and password list.
  - 4. Printout of software application and graphic screens.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

**1.7 FIELD CONDITIONS**

- A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.

**1.8 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EVSE that fail(s) in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 3 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Source Limitations: Obtain EVSE from ChargePoint

**2.2 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: EVSE shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. Non-Operating Temperature: -40 deg F to 122 deg F
- C. Operating Temperature: -40 deg F to 140 deg F
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
- E. Surge Withstand: 6 kV at 3000 A.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- G. EV Charging Levels:
  - 1. Single vehicle, AC Level 2 at up to 7.2 kW per vehicle.
  - 2. Dual vehicle, AC Level 2 at up to 7.2 kW single vehicle or 3.8kw each when 2 vehicles are connected.

## 2.3 EVSE DESCRIPTION

- A. Comply with NFPA 70.
- B. Comply with:
  - 1. UL 2231-1.
  - 2. UL 2594.
  - 3. SAE J1772 for SAE combo chargers.
- C. Comply with ADA-ABA Accessibility Guidelines.
- D. Metering: Revenue grade meter.
- E. Control Power: 20 A, 110/120-V ac, 60 Hz, single phase per charger.
- F. Input Power:
  - 1. 40 A, 208/240-V ac, 60 Hz, single-phase services per charger.
- G. Integral GFCI.
- H. Auto-GFCI fault retry.
- I. EVSE Mounting: Pedestal mount.
- J. Enclosures:
  - 1. Rated for environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R.
    - b. Lockable.
    - c. Tamper resistant.
- K. EV Cable and Connectors:
  - 1. SAE J1772 connector.
  - 2. Single connectors with locking holster.
  - 3. 10-foot with cable management system.
  - 4. Field-replaceable connector and cable assembly.
- L. Status Indicators:
  - 1. LEDs to indicate power, charging, charging complete, system status, faults, and service.
- M. Display Screen:
  - 1. Daylight viewable, UV-protected display with human-machine interface capability.
  - 2. Displays power, charging, charging complete, remote control, system status, faults, and service.
- N. Networking:
  - 1. WAN Communications: Cellular.
  - 2. LAN Communications: 2.4GHz Wifi.
  - 3. Capable of remote configuration and reporting.

- O. Payment System:
  - 1. NFC reader.
  - 2. PCI compliant.
  - 3. Capable of remote control and authorization.
  
- P. Charging Network: Compatible with the Chargepoint EV charging network.
  - 1. Multiple units shall independently connect to charging network.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Comply with NECA 1 and NECA 413.
- B. Concrete Base Mounting:  
  
Per Manufacturer
- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking from enclosures and components.
- F. Secure covers to enclosure.

#### **3.2 CONNECTIONS**

- A. Connect wiring according to Section 26 05 19 "600 Volt Power Conductors and Cables."
- B. Comply with grounding requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Comply with requirements for installation of conduit in Section 26 05 33 "Raceways and Boxes." Drawings indicate general arrangement of conduit, fittings, and specialties.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- E. Verify that all electrical connections have been made according to the manufacturer's instructions. Remove all burrs, shavings, and detritus from inside the enclosure.
- F. After confirming all connections, install covers and tighten fasteners to according to manufacturer's instructions.

**3.3 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

**3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. For each unit of EVSE, perform the following tests and inspections:
    - a. Unit self-test.
    - b. Operation test with load bank.
    - c. Network communications test.
- D. EVSE will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. EVCS's will be paid at the contract unit price per each (EA) which price shall include full compensation for furnishing all labor, materials, tools, equipment and other incidentals necessary for the installation of EVCS as noted on plans, concrete base, and accessories for a complete system as required by California Electrical Code, and all incidental work involved, as designated by the Engineer and all other related work.

**END OF SECTION 26 27 43**

**SECTION 31 10 00**

**SITE CLEARING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Protecting existing vegetation to remain.
  2. Removing existing vegetation.
  3. Clearing and grubbing.
  4. Stripping and stockpiling topsoil.
  5. Removing above- and below-grade site improvements.
  6. Disconnecting, capping, or sealing site utilities.
  7. Temporary erosion and sedimentation control.

**1.2 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.3 MATERIAL OWNERSHIP**

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

**1.4 FIELD CONDITIONS**

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  2. Provide alternate routes around closed or obstructed trafficways, including pedestrian trafficways, if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises at the direction of the Engineer.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
- E. Plant-Protection Zones: Erect orange safety fencing or temporary chain link fencing around planted areas designated by the Engineer to be protected from construction activities.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
  - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

### **3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL**

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to Stormwater Pollution Control provisions of Section 01 57 00, "Temporary Controls" and as indicated on the plans.
- B. A Stormwater Pollution Prevention Plan is required for this project and shall be implemented at all times during construction of the project.
- C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- D. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### **3.3 PLANT PROTECTION**

- A. Erect orange safety fencing or temporary chain link fencing around planted areas designated by the Engineer to be protected from construction activities. Those areas include the existing biofiltration basin located on the west side of the parking lot and site.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations.

### **3.4 EXISTING UTILITIES**

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be relocated, removed or abandoned in place.
  - 1. Arrange with Engineer and utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Engineer's written permission.
- C. Removal of underground utilities is included in earthwork sections; in electrical sections; and in Section 024116 "Demolition."

### **3.5 CLEARING AND GRUBBING**

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
  - 1. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
  - 2. Use only hand methods or air spade for grubbing within protection zones.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

### **3.6 TOPSOIL STRIPPING**

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth indicated on Drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

### **3.7 SITE IMPROVEMENTS**

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

**3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS**

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract lump sum price paid for CLEARING AND GRUBBING, includes full compensation for furnishing all labor, materials, tools, equipment, incidentals, and for doing all Work involved in Clearing and Grubbing, including hauling, complete in place, as specified herein, as shown on the plans, and as directed by the Engineer.

**END OF SECTION 31 10 00**

**SECTION 31 20 00**

**EARTH MOVING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses and plants.
3. Excavating and backfilling for structures.
4. Base course for walks and pavements.
5. Excavating and backfilling trenches for utilities and pits for buried utility structures.

**1.2 DEFINITIONS**

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subgrade and hot-mix asphalt or concrete paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

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- I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- J. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct preexcavation conference at Project site.

### 1.4 INFORMATIONAL SUBMITTALS

- A. Material test reports.

### 1.5 FIELD CONDITIONS

- A. Utility Locator Service: Notify 811 and City of Berkeley Public Works where Project is located before beginning earth-moving operations.
- B. Do not commence earth-moving operations until plant-protection measures specified in Section 311000 "Site Clearing" are in place.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- A. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
  - 1. Liquid Limit: No greater than 40.
  - 2. Plasticity Index: No greater than 15.
- B. General fill material should have an organic content of less than 3 percent by volume and should not contain environmental contaminants or rocks or lumps larger than 6 inches in greatest dimension. From a geotechnical standpoint, onsite materials can be reused as General Fill if they meet or can be processed (e.g. by sorting and/or crushing) to meet the above requirements stated for General Fill.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Base Course: Conform to Caltrans Standard Specifications Section 26 for Class 2 Aggregate Base.

- E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve. Must also comply with requirements for Satisfactory Soils.
- F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- G. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

## **2.2 ACCESSORIES**

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

### **3.2 EXCAVATION, GENERAL**

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include soil materials and obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials, replace with satisfactory soil materials.

### **3.3 EXCAVATION FOR STRUCTURES**

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
  - 2. Excavation for Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

### **3.4 EXCAVATION FOR WALKS AND PAVEMENTS**

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### **3.5 EXCAVATION FOR UTILITY TRENCHES**

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
  - 1. Clearance: 8 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

### **3.6 SUBGRADE INSPECTION**

- A. Proof-roll subgrade below pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

### **3.7 UNAUTHORIZED EXCAVATION**

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.
  - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

### **3.8 STORAGE OF SOIL MATERIALS**

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### **3.9 UTILITY TRENCH BACKFILL**

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches within treated subgrade areas: Backfill with controlled low strength material.
- D. Initial Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
  - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- E. Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
- F. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### **3.10 SOIL FILL**

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass and planted areas, use satisfactory soil material.
  - 2. Under walks and pavements, use satisfactory soil material.
  - 3. Under steps and ramps, use engineered fill.
  - 4. Under building slabs, use satisfactory soil material.

### **3.11 SOIL MOISTURE CONTROL**

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

**3.12 COMPACTION OF SOIL BACKFILLS AND FILLS**

- A. Place backfill and fill soil materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:
  - 1. Under structures, building slabs, steps, and pavements (except subgrade treated areas), scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
  - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
  - 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
  - 4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent. Under vehicular areas, compact final backfill to 95 percent.

**3.13 GRADING**

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
  - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
  - 2. Walks: Plus or minus 1 inch.
  - 3. Pavements: Plus or minus 1/2 inch.

**3.14 BASE COURSES UNDER PAVEMENTS AND WALKS**

- A. Place base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place base course under pavements and walks as follows:
  - 1. Shape base course to required elevations and cross-slope grades.
  - 2. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 3. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

**3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE**

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.

- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
  - 1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

### **3.16 FIELD QUALITY CONTROL**

- A. Special Inspections: Owner will engage a qualified special inspector to perform inspections:
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

### **3.17 PROTECTION**

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### **3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS**

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit prices paid per CUBIC YARD for ROUGH GRADING - CUT and for ROUGH GRADING - FILL shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with excavating and filling earth to the lines and grades of the proposed subgrade and stockpiling earth, moisture conditioning, placement in lifts and compaction, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- B. The Contract unit price paid per CUBIC YARD for OFF-HAUL EXCAVATED SOIL TO CLASS 2 LANDFILL shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with disposing contaminated soil, including sampling, testing and hauling, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- C. The Contract unit price paid per CUBIC YARD for CLASS 2 AGGREGATE BASE shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with placing and compacting aggregate base material beneath the asphalt concrete sidewalk, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- D. Full compensation for Class 2 aggregate beneath concrete flatwork items shall be considered as included in the various concrete paving related items of work and no separate payment will be made therefor.
- E. The Contract unit price paid per CUBIC YARD for PERMEABLE MATERIAL shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with placing permeable material in the biofiltration basins, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.

**END OF SECTION 31 20 00**

## **SECTION 31 20 17**

### **SUBGRADE STABILIZATION USING EMC SQUARED SYSTEM**

#### **PART 1 - GENERAL**

##### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

##### **1.2 SUMMARY**

- A. The stabilization of new and/or existing subgrade, by pulverizing, adding the liquid stabilizer dual component treatment, mixing and compacting the mixed material to the required density as specified herein and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Project Engineer. The liquid stabilizer treatment is applied to subgrade materials for reduction of permeability, moisture susceptibility and swell and to improve strength and stiffness.

##### **1.3 SUBMITTALS**

- A. General: Submit the following in accordance with the conditions of Contract and Division Specification Sections. Material Certificates: Certificates signed by supplier certifying that material is of the type, quality and grade specified.

#### **PART 2 - PRODUCTS**

##### **2.1 STABILIZER PRODUCTS**

- A. The liquid stabilizer DUAL COMPONENT TREATMENT™ used for soil stabilization and moisture barrier applications shall be the EMC SQUARED® System products known as EMC SQUARED Dual Component Treatment as supplied by Stabilization Products LLC, (800) 523-9992 or (209) 383-3296, info@stabilizationproducts.net. The products shall be nonhazardous, non-toxic, nonflammable, noncorrosive, and have a pH range of  $7 \pm 2$  with a Specific Gravity range of 1.00 to 1.09 and formulated for application at a rate of one gallon EMC SQUARED 2000 and two gallons of EMS® Earth Materials Sealant™ per fifteen cubic yards of soil material.
  - 1. The products are added to the compaction water for application as a dilute solution. Upon request, the supplier must be able to provide independent laboratory test reports from a certified analytical laboratory experienced in environmental acceptability testing documenting tests performed on product samples of the liquid stabilizer products. These tests must include the US EPA 7000 Series (TTLC or CAM17) for metals and Method 8270 testing which verify no organic solvents or identifiable EPA 8270 target compounds were detected in amounts which exceed US EPA regulatory standards as applicable to products whose intended use involves incorporation into compacted soil materials during construction operations.

2. When applied within the manufacturer's parameters for application, dilution, moisture control, processing, compaction, curing and documented field quality control testing, EMC SQUARED System products shall have demonstrated the capability to improve shear strength, bearing strength, and modulus as well as reduce the moisture susceptibility of virgin aggregate, recycled aggregate, and soil materials. Material engineering performance tests such as Dielectric Constant, Electrical Conductivity, Resilient Modulus, Unconfined Compression Strength, Shear Strength, and R-Value shall be available from independent materials testing laboratories demonstrating that the products have been effective. Falling Weight Deflectometer (FWD) test results shall be available from supplier to confirm that soil materials treated with the products have achieved improved modulus values when evaluated in engineering field studies of completed projects. The products shall have been previously utilized for interstate freeway and highway projects that have been in service for not less than ten years and without requirement for repair and used for stabilized aggregate surfaced roads and stabilized soil applications that remain effective for not less than twenty years.

## **2.2 MATERIALS**

- A. New or existing subgrade materials to be incorporated with the EMC SQUARED Dual Component System in the surface course shall be pulverized so that 100 percent shall pass the two-inch (2") sieve prior to treatment, unless otherwise approved in writing by the manufacturer of the stabilizer product.
- B. Water shall be furnished by the Contractor and shall be clean and free from industrial wastes and other objectionable matter.

## **2.3 MATERIALS HANDLING AND STORAGE**

- A. Unless otherwise approved by the Project Engineer, the liquid stabilizer products may be stored on site with no limitation on air temperature requirements. With proper transport and storage, EMC SQUARED 2000 and EMS Earth Materials Sealant have the capacity for extended storage. If products have been subjected to extended storage or frozen during transport or storage, they should be stirred before using. The products must be maintained with an airtight seal to protect against contamination. As portions of products are drawn for use from the containers, caps should be immediately replaced and tightened to maintain an airtight seal to protect against contamination.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verification of General Conditions: The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content for its full depth and shall have a smooth surface.
- B. Proof-roll subgrade with pneumatic-tired rollers or other rubber-tired equipment to locate areas which are unstable.
- C. Prior to treating existing material and/or placing any new material, the existing material shall be shaped to conform to the typical sections, as shown on the plans or as established by the Project Engineer. The Contractor will not be required to excavate to a secondary grade or

windrow the material if a tractor-drawn construction disc with depth gauge wheel is provided which will cut uniformly to the proper depth. The machine shall provide a visible indication of the depth of cut at all times. For plan depths greater than twelve (12) inches, the Contractor will be required to excavate to a secondary grade or windrow the material.

### **3.2 WEATHER LIMITATIONS**

- A. General: EMC SQUARED Dual Component System shall not be applied when it is raining or when rain is expected. Weather forecasts should indicate no rain during application procedures and for at least 24 hours following application. The EMC SQUARED Dual Component Stabilizer treatment shall not be started when the air temperature is below 40°F and falling but may be started when the air temperature is above 35°F and rising.
- B. Weather Events: Stabilization process may proceed when local weather indicates possible showers or scattered showers or when the local weather forecast calls for a 30% or less chance of precipitation during the next 24-hour period or with the approval of the Project Engineer. When possible showers or scattered showers are forecasted, the Contractor must work section sizes of one-half (½) the size that normally would be worked in dry weather. All grading and compaction equipment must be available for immediate mobilization and any sections that have given stabilization treatment must be immediately compacted if rain commences. The section area being treated must be immediately brought to a grade that will allow the rainwater to drain and compacted with all available equipment.
  - 1. Contingent upon the contractor having achieved drainage and compaction adequate to protect the newly applied stabilizer solution from excessive washing of product from the area of treatment by the unexpected rainfall event, and if the partially compacted area of stabilizer application becomes heavily saturated by rainfall while still in the construction phase, then the treated materials to the depth they contain excessive moisture content should be aerated and dried back by discing or by blade mixing with the motor grader blade until excess moisture has been evaporated.
  - 2. The full depth of the treated materials (the full compaction lift) should then be re-mixed full depth to a homogeneous moisture content, tested for moisture content to verify that the materials have been successfully adjusted within the tolerances required for compaction operations, shaped to grade and compacted per specifications.

### **3.3 EQUIPMENT FOR MIXING AND PLACEMENT**

- A. The subgrade soil and the stabilizer solution shall be thoroughly mixed by a tractor-drawn construction disc with depth gauge wheel as the primary mixing unit. In addition, a cross-shaft rotary mixer with built-in metering system for application of the stabilizer solution, with accuracy demonstrated to the satisfaction of the Project Engineer, may be used for mixing. The Contractor will be required to demonstrate, to the satisfaction of the Project Engineer, that the selected equipment and operator is capable of providing a uniform width and rate of application of a measured load of water to a measured area representative of the area to be treated.
- B. Distributor trucks, water trucks, water tankers and other water spray equipment, which will be used for the application of the stabilizer solution, must have water tanks with liquid volume capacity accurately measured and be equipped with spray equipment capable of delivering a constant rate in a uniform spray pattern. The Contractor will be required to demonstrate, to the satisfaction of the Project Engineer, that the selected equipment and operator is capable of providing a uniform width and rate of application of a measured load of water to a measured area representative of the area to be treated.

### 3.4 APPLICATION OF STABILIZER TREATMENT

- A. General: The completed course shall be uniformly treated, free from loose rock or segregated areas, of uniform density and moisture content for its full depth and shall have a smooth surface.
- B. Moisture Tolerance:
1. After pulverization is complete and prior to application of the stabilizer treatment, the moisture content of the subgrade material may not be more than two (2) percentage points below and not greater than one (1) percentage point above the optimum moisture content determined for the treated material (the optimum moisture content as determined for subgrade materials treated with the liquid stabilizer solution by Test Method ASTM D-1557. Moisture content should be checked at several locations in each section to be treated to ensure that the moisture content of the material is within tolerance throughout the length and width of the section. Materials that are drier than moisture content tolerances should be moisture conditioned by sprinkling with additional water to secure uniform moisture content throughout the layer that is within the required tolerances. Materials that are wetter than moisture content tolerances should be allowed to dry back through natural drying or aerated during suitable weather conditions with mixing equipment such as motor graders, tractor-drawn discs or cross-shaft rotary mixers. Aeration by compaction equipment, such as a Sheepsfoot roller, will not be permitted. It will be the responsibility of the contractor to adjust moisture content within the moisture content tolerances as necessary to achieve compaction specification requirements once the stabilizer product has been applied to the subgrade soils.
  2. The addition of cement as a drying agent preparatory to application of an EMC SQUARED System treatment should only be done with the approval of the project engineer. Laboratory testing is recommended preliminary to the use of cement in combination with the EMC SQUARED System treatment and the contractor will be fully responsible for the final constructed product. It is recommended that the addition rate of cement be limited to no more than two percent (2%) by dry weight of the soil in order to reduce the risk of shrinkage cracking generated by the addition of cement.
- C. Application Rate: The application rate for the liquid stabilizer products shall be one (1) gallon EMC SQUARED 2000 and two (2) gallons EMS per fifteen (15) cubic yards of soil. The tolerance from the specified application rate shall be plus or minus five (5) percent.
- D. Dilution Ratios: The dual component products shall be added to the load of dilution water at a rate of 135 parts water per one (1) part EMC SQUARED 2000 and two (2) parts EMS. The maximum variation from this dilution rate shall be plus or minus forty (40) percent. Based upon the application rate per cubic volume of soil as specified in section 3.4.C., application of the dilute stabilizer solution will be an addition of approximately two (2) percent moisture content by dry weight of the soil material being treated. The dilution ratio does not change the application rate of the EMC SQUARED System products. The application rate of one gallon (+/- 5%) of EMC SQUARED 2000 and two (2) gallons EMS per 15 cubic yards of soil materials is constant regardless of the dilution ratio used.
- E. Dilution Procedures: The liquid stabilizer products may be added separately, or simultaneously, to the dilution water by any method acceptable to the Project Engineer. Approximately 90% of the dilution water required to fill a single load of stabilizer solution shall first be added to the mixing tank before the liquid stabilizer products are added. The remainder of the dilution water for the load to be applied may then be added. For systems equipped with meters that can meter the stabilizer input throughout the water loading operations, the stabilizers can also be added on a continuous basis. After the addition of the dilution water, start and stop the distributor truck, water truck or water tanker several times to gently rock the mixing tank and provide a small

amount of additional mixing action for the stabilizer solution. For application equipment not outfitted with a re-circulating spray bar, the spray bar and connecting lines should be flushed of any water left therein that does not visibly contain the stabilizer product prior to preceding to the area planned for stabilization treatment. Once diluted, the stabilizer solution shall be applied to project materials the same day. Overnight storage will not be permitted.

- F. Applications Preparations: Unless otherwise approved by the Project Engineer, the treated subgrade material shall be constructed in successive layers for the full width of the individual roadway cross section and in such lengths as are best suited to the stabilizer application and compacting methods utilized. The Contractor shall prepare a written summary, for the Project Engineer's review, before stabilizer treatment of each section to be treated. The following information should be included:
1. In situ moisture content of the subgrade soil of each section to be treated and the treated optimum moisture content for this material.
  2. Liquid volume capacity and planned fill level for all spreader or water trucks and other equipment that will be used to transport, spread or otherwise distribute the stabilizer solution.
  3. Cubic yardage of subgrade soil to be treated for each section of the project.
  4. Calculated quantity of each of the liquid stabilizer products required for the cubic yardage of subgrade soil to be treated for each section.
  5. Calculated quantity of stabilizer solution (the total gallons of liquid stabilizer plus the total gallons of dilution water) required for each section to be treated.
- G. Application: Application of the stabilizer solution shall be limited to the area specifically shaped and sized to receive the treatment and shall be limited to a section of such an area such that all operations including mixing, compaction and grading are continuous and completed the same day. If overnight temperatures are not expected to drop below 32° F, it shall be the Project Engineer's option to allow treated soil material to remain in a stockpile or windrow overnight with the requirement that moisture content must be checked and properly adjusted within moisture tolerances for compaction when construction operations resume the following day.
1. Unless otherwise approved by the Project Engineer, stabilizer treatment shall not be started when the air temperature is below 40° F and falling but may be started when the air temperature is above 35° F and rising. The stabilizer solution shall not be applied during periods of rainfall. If rainfall is encountered during application of the stabilizer solution and excessive loss of solution occurs, the Contractor shall, at his expense, reapply the stabilizer solution to the affected area at a rate of one-half ( $\frac{1}{2}$ ) of the original application rate. The Contractor shall then re-mix and compact the material to the same specifications of the original application.
  2. During rapid drying conditions, five (5) percent of the stabilizer solution shall be retained and sprinkled on surface materials during final compaction and/or final grading operations to protect the materials from desiccation and segregation while still being worked. The five (5) percent stabilizer solution applied to the final surface will be calculated as part of the application applied to the full lift being treated.
  3. Lifts greater than eight (8) inches not to exceed twelve (12) inches will be permitted only with the approval of the Project Engineer. The Contractor shall, at his own expense, demonstrate the ability to provide not less than 95 percent of the optimum density as

determined by Test Method ASTM D-1557 while working within the requirements of this specification.

4. The stabilizer solution shall be distributed and applied at a uniform rate and in such a manner that the entire surface area is covered with the solution after visual inspection. If untreated areas are found after inspection, the Contractor may hand apply the stabilizer solution to the untreated areas to achieve full coverage. If the spray pattern is not uniform and failure to achieve full coverage occurs on a repetitive basis, then the Contractor will be required to re-mix the material by methods acceptable to the Project Engineer to achieve a homogeneously moisturized treated material. To prevent excessive application of stabilizer solution and moisture build up, the overlap of each pass shall not exceed twelve (12) inches.
  5. The Contractor shall take precautions when application occurs on unlevelled or sloping terrain or in any situation, such as channelization or rutting of the subgrade soil by the construction equipment, where the stabilizer solution flows and travels away from the area where it was applied. If during application of the stabilizer solution runoff results in loss of the stabilizer solution from the area to be treated or in excessive puddling, then modifications to the application procedure must be made immediately. The Contractor will be required to make an additional application and/or mixing passes in which a reduced quantity of stabilizer solution is applied with each application and/or mixing pass that results in applying the total amount specified without excessive runoff and puddling. Any other method of correction that does not rely on additional application and/or mixing passes must first be demonstrated to the satisfaction of the Project Engineer.
- H. Mixing: The subgrade soil and the stabilizer solution shall be thoroughly mixed by a tractor-drawn construction disc with depth gauge wheel as the primary mixing unit. In addition, a cross-shaft rotary mixer with built-in metering system for application of the stabilizer solution may be used for further mixing. The mixing shall continue until the treated material reaches a homogeneous mixture with a moisture content within specified compaction moisture tolerances as described in 3.4.I.
1. Weather conditions that increase the moisture content beyond specified tolerance, and prior to full and complete compaction, will require re-mixing and air-drying to reduce the moisture content of the treated subgrade soil. Weather conditions that decrease moisture content below specified tolerance, and prior to full and complete compaction, will require moisture conditioning by sprinkling with additional water. Prior to compacting the treated material, the moisture content of the material shall be within specified tolerances for compaction as described in 3.4.I.
  2. The operations of stabilizer application, mixing, compacting and finishing should be continuous. If the compacted lift is to be finished by milling or planing equipment, finishing may be completed at a later date as long as the surface is kept damp during the interim period.
  3. If the stabilizer solution is applied at a rate which exceeds the absorbency of the loosened subgrade soil, and ponding, or runoff and flow from the treated area is observed, then adjustments to construction operations should be made immediately, as described in 3.4.G.
- I. Compaction Methods: Prior to compaction, the Contractor shall aerate or sprinkle and test the treated subgrade soil as necessary to provide a moisture content not more than three (3) percentage points above and not less than the optimum moisture content for the treated material (as determined by Test Method ASTM D-1557) or unless otherwise approved by the Project Engineer. Aeration by compaction equipment, such as a sheepsfoot roller, will not be permitted. Compaction of the treated subgrade soil shall begin immediately after the mixing,

pulverization and compaction moisture content requirements are met. It will be the contractor's responsibility to adjust moisture content within the moisture content tolerances as necessary to achieve compaction specification requirements. If rutting or deformation in the treated subgrade is observed following final compaction, the moisture content should be reduced as necessary, while staying within tolerances, to produce a compacted subgrade that remains firm and solid under traffic.

1. Sheepsfoot, padfoot or smooth face vibratory rollers should be utilized for initial compaction operations, accompanied by other types of compaction equipment as necessary. The sheepsfoot and padfoot rollers should be operated in continuous passes over all treated areas until they "walk out" of the treated material leaving only minimal indentations in the surface. Unless smooth face vibratory rollers are used in lieu of sheepsfoot or pad foot rollers, grades should be left adequately high and compaction operations conducted so that the final grade is achieved by shaving and trimming with a motor grader to a hard uniform surface. All material removed should be bladed to the edge of the stabilized area and wasted.
2. Each layer shall be compacted uniformly to the extent necessary to provide not less than 95 percent of the optimum density as determined by Test Method ASTM D-1557. Field density determination will be made in accordance with Test Method ASTM D-2922. Throughout the compaction operation the shape of the compaction layer shall be kept leveled with suitable equipment to ensure uniform compaction over the entire layer. If the treated materials, due to any reason or cause, lose the required stability, density or finish before the next course is placed or the project is accepted, the affected area shall be reworked in accordance with section 3.4.J.

J. Reworking a Section:

1. When a section is reworked after application of the stabilizer treatment and within 24 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. After the 24-hour period following the completion of compaction, the section requiring rework shall be maintained at or above its optimum moisture content until the reworking operation begins.
2. When a section is reworked 24 hours after completion of compaction, which has been allowed to dry back below its optimum and cure to a dry and hardened state, then the Contractor shall reapply the stabilizer solution at a rate of one-half ( $\frac{1}{2}$ ) of the original application rate to the affected area and re-mix and compact the material to the same specifications of the original application. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with Test Method ASTM D-1557. Rework of treated materials shall be at the expense of the Contractor.

K. Finishing and Curing: All placing, compacting and finishing operations shall be completed within the guidelines in PART 3, EXECUTION. After the final layer or course of the treated subgrade soil has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.

L. Restoration of Traffic: If a treated surface must be rapidly returned to service under traffic, layer curing conditions should first be subjected to proof rolling and inspected to verify that the entire installation is adequately cured and firm enough to resist rutting, unraveling or damage by sharp turns and rapid acceleration and braking. The contractor is responsible for (1) protection of treated surfaces until adequately cured to support traffic, and (2) repair of any damage to the surface resulting from passage of heavy equipment, trucks or vehicular traffic while the surface is undergoing the first several days of curing. Once the treated material has reached the initial state of stability where the surface is not subject to damage, the stability of the treated layer will benefit from additional compaction by traffic when placed back into service.

### **3.5 TOLERANCES**

- A. Tolerances shall conform to the following:
1. Density Tolerance: The Project Engineer may accept the work providing not more than one (1) out of the most recent ten (10) density tests performed is below the specified density, provided the failing test is no more than three (3.0) pounds per cubic foot below the density specified in this Item as described in 3.4.1.2. If the material fails to meet the density requirements, it shall be reworked in accordance with section 3.4.J.
  2. Thickness Tolerances of Treated Subgrade: At no time during the mixing process shall the Contractor increase or decrease the depth of the subgrade section as detailed on the plans without the approval of the Project Engineer. If any deviation should occur, that section shall be reworked according to construction operations and testing described in 3.4.J.

### **PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit price paid per CUBIC YARD for EMC SQUARED STABILIZATION 18" THICK/9" LIFTS shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with stabilizing the subgrade, complete in place, including temporarily moving and stockpiling the top section of subgrade to treat the lower section, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.

**END OF SECTION 31 20 17**

## **SECTION 312319**

### **DEWATERING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section includes construction dewatering.

##### **1.2 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

##### **1.3 FIELD CONDITIONS**

- A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

#### **PART 2 - PRODUCTS**

##### **2.1 PERFORMANCE REQUIREMENTS**

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and legally dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

#### **PART 3 - EXECUTION**

##### **3.1 PREPARATION**

- A. Provide temporary grading to facilitate dewatering and control of surface water.
- B. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 311000 "Site Clearing," during dewatering operations.

##### **3.2 INSTALLATION**

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  - 1. Space well points or wells at intervals required to provide sufficient dewatering.

2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

### **3.3 OPERATION**

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
  2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.
- C. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction, or as specified by permit.

### **3.4 FIELD QUALITY CONTROL**

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

## **PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract LUMP SUM price paid for DEWATERING shall include full compensation for furnishing all labor, supervision, materials, tools, equipment, and incidentals and for doing all the work involved in dewatering deep excavations, complete in place, including storing water on site, permitting, testing and disposal, as shown on the plans, as specified in the State Standard Specifications and these Technical Specifications, and as directed by the engineer.

**END OF SECTION 31 23 19**

## **SECTION 315000**

### **EXCAVATION SUPPORT AND PROTECTION**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. Section includes temporary excavation support and protection systems.

##### 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

##### 1.3 INFORMATIONAL SUBMITTALS

- A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

##### 1.4 FIELD CONDITIONS

- A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

#### **PART 2 - PRODUCTS**

##### 2.1 PERFORMANCE REQUIREMENTS

- A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
  - 1. Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

#### **PART 3 - EXECUTION**

##### 3.1 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

## South Cove West Parking Lot Improvements

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- B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Cut tops of sheet piling to uniform elevation at top of excavation.

### 3.2 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
  - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Engineer.
  - 2. Install internal bracing if required to prevent spreading or distortion of braced frames.
  - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

### 3.3 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

### 3.4 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

## **PART 4 - MEASUREMENT AND PAYMENT**

- 4.1 The contract LUMP SUM price paid for SHEETING AND SHORING shall include full compensation for furnishing all labor, supervision, materials, tools, equipment, and incidentals and for doing all the work involved in sheeting and shoring, temporary excavation and support, complete in place, as shown on the plans, as specified in the Standard Specifications and these Special Provisions, and as directed by the engineer.

**END OF SECTION 315000**

**SECTION 32 12 16**

**ASPHALT PAVING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.

- B. Related Requirements:

1. Section 024116 "Demolition for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, and base courses.
3. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
4. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.
5. Caltrans Standard Specifications, 2018 edition.

**1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
  - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
  - b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

**1.4 ACTION SUBMITTALS**

- A. Product Data: Include technical data and tested physical and performance properties.

1. Tack Coat
2. Herbicide.
3. Joint sealant.

- B. Hot-Mix Asphalt Designs:

1. Certification, by authorities having jurisdiction, of approval of each hot-mix asphalt design proposed for the Work.
  2. For each hot-mix asphalt design proposed for the Work.
- C. Quality Control Plan per Section 39-2.01A(3)(c) of Caltrans Standard Specifications.

### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For paving-mix manufacturer and testing agency.
- B. Material Certificates: Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.
1. Aggregates.
  2. Asphalt binder.
  3. Tack coat.
- C. Field quality-control reports and Test Results per Section 39-2.01A(3)(d) of Caltrans Standard Specifications.

### **1.6 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by Caltrans.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Section 39-2.01A(4) of Caltrans Standard Specifications for asphalt paving work.
1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- C. Installer Qualifications: Selection and installation of hot-mix asphalt for pickleball courts shall be performed by qualified personnel with proven past experience and successes in selecting mix design and have a minimum of 5 years' experience in selecting appropriate mix designs and paving hot-mix asphalt for sports facilities.

### **1.7 FIELD CONDITIONS**

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
1. Tack Coat: Minimum surface temperature of 60 deg F.
  2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
  3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

## **PART 2 - PRODUCTS**

### **2.1 AGGREGATES**

- A. Aggregates shall conform with Section 39-2.02B(4) of Caltrans Standard Specifications.

### **2.2 ASPHALT MATERIALS**

- A. Asphalt Binder: ASTM D6373 or AASHTO M 320 binder designation PG 64-10 or as recommended by installer for pickleball courts.
- B. Tack Coat: Cationic emulsified asphalt, slow setting, diluted in water, Grade CSS-1 or CSS-1h.
- C. Water: Potable.

### **2.3 AUXILIARY MATERIALS**

- A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.
- B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.
- C. Joint Sealant: ASTM D6690, Type II or III, hot-applied, single-component, polymer-modified bituminous sealant.

### **2.4 MIXES**

- A. Hot-Mix Asphalt: Type A, dense-graded, hot-laid, hot-mix asphalt plant mixes designed according to procedures in Section 39-2.02B(2) of Caltrans Standard Specifications and complying with the following requirements:
  - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - 2. Base Course: 3/4" gradation.
  - 3. Surface Course: 1/2" gradation.

## **PART 3 - EXECUTION**

Refer to Section 39-2.01C of Caltrans Standard Specifications for construction related specifications. Caltrans Standard Specifications takes precedence over any discrepancies found between it and the provisions below.

### **3.1 EXAMINATION**

- A. Verify that subgrade is dry and in suitable condition to begin paving.

- B. Proceed with paving only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.
  - 1. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

### **3.3 PATCHING**

- A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Placing Two- or more Course Patch Material: Partially fill excavated pavements with hot-mix asphalt base course mix and, while still hot, compact. Cover asphalt base course with compacted layer of hot-mix asphalt surface course, finished flush with adjacent surfaces.

### **3.4 SURFACE PREPARATION**

- A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.
- B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### **3.5 HOT-MIX ASPHALT PLACEMENT**

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
  - 2. Place hot-mix asphalt surface course in single lift.
  - 3. Spread mix at a minimum temperature of 250 deg F.
  - 4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
  
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
  - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
  - 2. Complete a section of asphalt base course before placing asphalt surface course.
  
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### **3.6 JOINTS**

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
  - 1. Clean contact surfaces and apply tack coat to joints.
  - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
  - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
  - 4. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
  - 5. Compact asphalt at joints to a density within 2 percent of specified course density.

### **3.7 COMPACTION**

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 185 deg F.
  
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
  
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### **3.8 INSTALLATION TOLERANCES**

- A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:
  1. Base Course: Plus or minus 1/2 inch.
  2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
  1. Base Course: 1/4 inch.
  2. Surface Course: 1/8 inch.

### **3.9 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. Replace and compact hot-mix asphalt where core tests were taken.
- E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

**3.10 WASTE HANDLING**

- A. General: Handle asphalt-paving waste in accordance with approved waste management plan required in Section 017419 "Construction Waste Management."

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit price paid per TON for HOT MIX ASPHALT (TYPE A) PAVEMENT shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all Work involved in placement of asphalt concrete, complete in place, including compaction and quality control, as shown on the plans, as specified in the State Standard Specifications and in these Technical Specifications, and as directed by the Engineer.

**END OF SECTION 32 12 16**

**SECTION 32 13 13**  
**CONCRETE PAVING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes Concrete Paving. Including the Following:
  - 1. Driveways.
  - 2. Curbs and curbs & gutters.
  - 3. Walks.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
  - 2. Section 312000 "Earth Moving" for base course materials.
  - 3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
  - 4. Section 321713 "Wheel Stops."
  - 5. Section 321723 "Pavement Markings."
  - 6. Section 321726 "Tactile Warning Surfacing" for detectable warning tiles.

**1.3 DEFINITIONS**

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

**1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified installer of stamped concrete.
- B. Material Certificates: For the following, from manufacturer:
- C. Field quality-control reports.

## **1.7 QUALITY ASSURANCE**

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

## **1.8 PRECONSTRUCTION TESTING**

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

## **1.9 FIELD CONDITIONS**

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
  - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
  - 2. Do not use frozen materials or materials containing ice or snow.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
  - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

## **PART 2 - PRODUCTS**

### **2.1 CONCRETE, GENERAL**

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

### **2.2 FORMS**

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
  - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

### **2.3 STEEL REINFORCEMENT**

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from steel wire into flat sheets.
- B. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.
- C. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

### **2.4 CONCRETE MATERIALS**

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Portland Cement: ASTM C150/C150M, gray portland cement Type II.
  - 2. Fly Ash: ASTM C618, Class F.
  - 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C33/C33M, Class 4M, uniformly graded. Provide aggregates from a single source.
  - 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Air-Entraining Admixture: ASTM C260/C260M.

- D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
  - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  - 2. Retarding Admixture: ASTM C494/C494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- E. Water: Potable and complying with ASTM C94/C94M.

## **2.5 CURING MATERIALS**

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.

## **2.6 RELATED MATERIALS**

- A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

## **2.7 CONCRETE MIXTURES**

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
- B. Cementitious Materials: Use fly ash, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash: 25 percent.
  - 2. Slag Cement: 50 percent.
  - 3. Combined Fly Ash and Slag Cement: 50 percent, with fly ash not exceeding 25 percent.

- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
  - 1. Air Content, 1-1/2-inch Nominal Maximum Aggregate Size: 2-1/2 percent plus or minus 1-1/2 percent.
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing admixture or plasticizing and retarding admixture in concrete as required for placement and workability.
  - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- E. Concrete Mixtures: Normal-weight concrete.
  - 1. Compressive Strength (28 Days): 4000 psi.
  - 2. Maximum W/C Ratio at Point of Placement: 0.45.
  - 3. Slump Limit: 4 inches, plus or minus 1 inch.

## **2.8 CONCRETE MIXING**

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.
  - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
  - 1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.
  - 2. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

### **3.3 EDGE FORMS AND SCREED CONSTRUCTION**

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

### **3.4 INSTALLATION OF STEEL REINFORCEMENT**

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

### **3.5 JOINTS**

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
  - 1. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - 2. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
  - 1. Locate expansion joints at intervals of 60 feet unless otherwise indicated.
  - 2. Extend joint fillers full width and depth of joint.
  - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
  - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
  - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
  - 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
  2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
  3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

### **3.6 CONCRETE PLACEMENT**

- A. Before placing concrete, inspect and complete formwork installation and items to be embedded or cast-in.
- B. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- C. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- D. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- F. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
- G. Screed paving surface with a straightedge and strike off.
- H. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

### **3.7 FLOAT FINISHING**

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven

floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

### **3.8 INSTALLATION OF DETECTABLE WARNINGS**

- A. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

### **3.9 CONCRETE PROTECTION AND CURING**

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
  1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
  3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

### 3.10 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
1. Elevation: 1/2 inch.
  2. Thickness: Plus 3/8 inch, minus 1/4 inch.
  3. Surface: Gap below 10-feet- long; unlevelled straightedge not to exceed 1/2 inch.
  4. Joint Spacing: 3 inches.
  5. Contraction Joint Depth: Plus 1/4 inch, no minus.
  6. Joint Width: Plus 1/8 inch, no minus.

### 3.11 FIELD QUALITY CONTROL

- A. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
  5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
  6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
    - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- B. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- C. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

- E. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
- F. Concrete paving will be considered defective if it does not pass tests and inspections.
- G. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- H. Prepare test and inspection reports.

### **3.12 REPAIR AND PROTECTION**

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.
- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

### **PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit prices paid per SQUARE FOOT for CONCRETE SIDEWALK (INCLUDING AB) and for CONCRETE DRIVEWAY AND PLAZA (INCLUDING AB) shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals, and for doing all Work in installing PCC improvements, complete in place, including placing and compacting aggregate base, formwork, pouring, finishing and curing concrete, scoring, expansion joints, dowels, welded wire fabric and/or reinforcing bar when required, and curb ramps, as specified in these Technical Specifications, as shown on the Plans, and as directed by the Engineer.
- B. The Contract unit prices paid per LINEAR FOOT for 6" CONCRETE CURB and for CONCRETE CURB & GUTTER and for ROLLED CURB & GUTTER shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals, and for doing all Work in installing PCC improvements, complete in place, including placing and compacting aggregate base, formwork, pouring, finishing and curing concrete, scoring, expansion joints, dowels, welded wire fabric and/or reinforcing bar when required, as specified in these Technical Specifications, as shown on the Plans, and as directed by the Engineer.

**END OF SECTION 32 13 13**

**SECTION 32 13 73**  
**CONCRETE PAVING JOINT SEALANTS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Cold-applied joint sealants.
  - 2. Hot-applied joint sealants.
  - 3. Joint-sealant backer materials.
  - 4. Primers.

**1.2 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For each kind and color of joint sealant required.
- C. Paving-Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Product certificates.

**PART 2 - PRODUCTS**

**2.1 MATERIALS, GENERAL**

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

## **2.2 COLD-APPLIED JOINT SEALANTS**

- A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

## **2.3 HOT-APPLIED JOINT SEALANTS**

- A. Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I.

## **2.4 JOINT-SEALANT BACKER MATERIALS**

- A. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

## **2.5 PRIMERS**

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF JOINT SEALANTS**

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Cleaning of Joints: Clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
- C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer.
- D. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.
- E. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of joint-sealant backings.
  - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.

3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- F. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
1. Place joint sealants so they fully contact joint substrates.
  2. Completely fill recesses in each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- G. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
1. Remove excess joint sealant from surfaces adjacent to joints.
  2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- H. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
- I. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

#### **PART 4 - MEASUREMENT AND PAYMENT**

- A. Full compensation for concrete paving joint sealants shall be considered as included in the various concrete paving items and no separate payment will be made therefor.

**END OF SECTION 32 13 73**

## **SECTION 32 17 13**

### **WHEEL STOPS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Precast concrete wheel stops.

##### **1.2 ACTION SUBMITTALS**

- A. Product Data:
  - 1. Precast concrete wheel stops.

#### **PART 2 - PRODUCTS**

##### **2.1 WHEEL STOPS**

- A. Precast Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete; 4000-psi minimum compressive strength; dimensions as indicated on plans. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two three factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
  - 1. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
  - 2. Mounting Hardware: Galvanized-steel spike or dowel, size and length as indicated..

#### **PART 3 - EXECUTION**

##### **3.1 INSTALLATION**

- A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.
- B. Install wheel stops in accordance with manufacturer's written instructions unless otherwise indicated.
- C. Securely anchor wheel stops to substrate with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit price paid per EACH for WHEEL STOP shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals, and for doing all Work in installing precast wheel stops, including anchors, complete in place, as specified in these Technical Specifications, as shown on the Plans, and as directed by the Engineer.

**END OF SECTION 32 17 13**

**SECTION 32 17 23**  
**PAVEMENT MARKINGS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Painted markings applied to asphalt paving.
  - 2. Painted markings applied to concrete surfaces.

**1.2 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.3 ACTION SUBMITTALS**

- A. Product Data:
  - 1. Pavement-marking paint, acrylic.

**PART 2 - PRODUCTS**

**2.1 PERFORMANCE REQUIREMENTS**

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and the ABA standards of the Federal agency having jurisdiction.

**2.2 PAVEMENT-MARKING PAINT**

- A. Pavement-Marking Paint: Waterborne emulsion, lead and chromate free, ready mixed, complying with California State Specification PTWB-01R2.
  - 1. Color: As indicated.

**PART 3 - EXECUTION**

**3.1 PAVEMENT MARKING**

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

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- B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
  - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract lump sum price paid for PAVEMENT MARKINGS AND STRIPING shall include full compensation for furnishing all labor, supervision, materials, tools, equipment, and incidentals and for doing all the work involved in installing pavement markings and striping, complete in place, including parking stall stripes, markings and ADA stall markings, as shown on the plans, as specified in the State Standard Specifications and these Technical Specifications, and as directed by the engineer.

**END OF SECTION 32 17 23**

## **SECTION 32 17 26**

### **TACTILE WARNING SURFACING**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Cast-in-place detectable warning tiles.

##### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

#### **PART 2 - PRODUCTS**

##### **2.1 TACTILE WARNING SURFACING, GENERAL**

- A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities for tactile warning surfaces.
  - 1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

##### **2.2 DETECTABLE WARNING TILES**

- A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
  - 1. Material: Cast-fiber-reinforced polymer concrete tile.
  - 2. Color: Safety yellow or as selected by Engineer from manufacturer's full line.
  - 3. Shapes and Sizes:
    - a. Rectangular panel, 24 by 36 inches and other sizes as needed.
  - 4. Dome Spacing and Configuration: Manufacturer's standard compliant spacing, in manufacturer's standard pattern.
  - 5. Mounting:
    - a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.

## **2.3 ACCESSORIES**

- A. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF TACTILE WARNING SURFACING**

- A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.
- B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.
- C. Cast-in-Place Detectable Warning Tiles: Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. Set surface of tile flush with surrounding concrete and adjacent tiles. Remove concrete from tile surfaces and clean using methods recommended in writing by manufacturer.
- D. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Engineer. Replace using tactile warning surfacing installation methods acceptable to Engineer.
- E. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

## **PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit price paid per EACH for DETECTABLE WARNING SURFACE shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals, and for doing all Work in installing tactile warning surfacing, complete in place, as specified in these Technical Specifications, as shown on the Plans, and as directed by the Engineer.

**END OF SECTION 32 17 26**

## **SECTION 32 31 13**

### **CHAIN LINK FENCES AND GATES**

#### **PART 1 - GENERAL**

##### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Chain-link fences.
  - 2. Swing gates.
  - 3. Privacy slats.
  - 4. Bollards.
  - 5. Open Gate Posts
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete post footings.

##### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

##### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Fence and gate posts, rails, and fittings.
    - b. Chain-link fabric, reinforcements, and attachments.
    - c. Accessories: Privacy slats .
    - d. Gates and hardware.
- B. Shop Drawings: For each type of fence and gate assembly.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include accessories, hardware, gate operation, and operational clearances.
- C. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For professional engineer.
- B. Product Certificates: For each type of chain-link fence and gate.
- C. Product Test Reports: For framework strength according to ASTM F1043, for tests performed by a qualified testing agency.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

**1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

**1.7 FIELD CONDITIONS**

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

**1.8 WARRANTY**

- A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure to comply with performance requirements.
    - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS**

**2.1 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer to design chain-link fence and gate frameworks.
- B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.

1. Design Wind Load: 110 mph.
  - a. Minimum Post Size: Determine according to ASTM F1043 for post spacing not to exceed 10 feet for Material Group IA, ASTM F1043, Schedule 40 steel pipe.
  - b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

## 2.2 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:
  1. Fabric Height: As indicated on Drawings.
  2. Steel Wire for Fabric: Wire diameter of 0.148 inch.
    - a. Mesh Size: 2 inches.
    - b. Zinc-Coated Fabric: ASTM A392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied before weaving.
    - c. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.
  3. Selvage: Twisted top and knuckled bottom.

## 2.3 FENCE FRAMEWORK

- A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:
  1. Fence Height: As indicated on Drawings.
  2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40 or Group IV, Alternative Design.
    - a. Line Posts: For the 20-foot-high fence, diameters shall not be smaller than existing fence adjacent to the work.
    - b. End, Corner, and Pull Posts: For the 20-foot-high fence, diameters shall not be smaller than existing fence adjacent to the work.
  3. Horizontal Framework Members
    - a. Top Rail: Diameter per delegated design according to ASTM F1043.
  4. Brace Rails: ASTM F1043.
  5. Metallic Coating for Steel Framework:
    - a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. zinc coating according to ASTM A653/A653M.

## 2.4 TENSION WIRE

- A. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire according to ASTM A817 or ASTM A824, with the following metallic coating:
  - 1. Type II: Zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:
    - a. Class 5: Not less than 2 oz./sq. ft. of uncoated wire surface.

## 2.5 SWING GATES

- A. General: ASTM F900 for gate posts and double swing gate types.
  - 1. Gate Leaf Widths: As indicated.
  - 2. Framework Member Sizes and Strength: Based on gate fabric height of 72 inches or less.
- B. Pipe and Tubing:
  - 1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework.
- C. Frame Corner Construction: Welded.
- D. Hardware:
  - 1. Hinges: 180-degree outward swing.
  - 2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
  - 3. Closer: Manufacturer's standard.

## 2.6 FITTINGS

- A. Provide fittings according to ASTM F626.
- B. Post Caps: Provide for each post.
  - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
  - 1. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.
- E. Tension and Brace Bands: Pressed steel.
- F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

- H. Tie Wires, Clips, and Fasteners: According to ASTM F626.
  - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
    - a. Hot-Dip Galvanized Steel: 0.148-inch-diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

## **2.7 PRIVACY SLATS**

- A. Application: For all new fencing and gates.
  - 1. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than 0.06 inch thick, sized to fit mesh specified for direction indicated[, with vandal-resistant fasteners and lock strips].
  - 2. Tubular Polyethylene Slats: Minimum 0.023-inch-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with [vandal-resistant fasteners and lock strips] [fins for increased privacy factor].
  - 3. Color: Forest green or as selected by Engineer from manufacturer's full range.
- B. Pickleball Court Application: 9 feet high and fastened over chain link fencing.
  - 1. Material: Vinyl Coated Polyester with UV treatment, 16 x 17 weave, 10 oz. per square yard, with hems and grommets on all sides and center reinforcement. Minimum 85% windbreak.
  - 2. Color: As selected by Engineer from manufacturer's full range.

## **2.8 BOLLARDS AND OPEN GATE POSTS**

- A. Bollard Pipe: Galvanized Steel Pipe. Fill with concrete and paint as specified.
- B. Open Gate Posts: Reuse salvaged posts if not damaged or replace with new posts to match existing material.

## **2.9 GROUT AND ANCHORING CEMENT**

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
  - 1. Do not begin installation before final grading is completed unless otherwise permitted by Engineer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

#### **3.3 CHAIN-LINK FENCE INSTALLATION**

- A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
    - b. Concealed Concrete: Place top of concrete as indicated on Drawings to allow covering with surface material.
- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567.
- E. Line Posts: Space line posts as indicated.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
  - 1. Locate horizontal braces at top and bottom, and at midheight of fabric higher than 72 inches.
- G. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten perimeter netting to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24

inches o.c. Install tension wire in locations indicated before perimeter netting installation. Provide horizontal tension wire at the following locations:

1. As indicated on Drawings.
- H. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Secure to posts with fittings or run rail continuously through line post caps, as applicable, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- I. Intermediate and Bottom Rails: Secure to posts with fittings.
- J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2-inch bottom clearance between finish grade or surface and bottom selvage except leave 1-inch bottom clearance for pickleball courts. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.
- L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.
1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- N. Privacy Slats: Install slats in direction indicated, securely locked in place.
1. Vertically or diagonally, as selected by the Engineer.

### **3.4 GATE INSTALLATION**

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

### **3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests.
- B. Prepare test reports.

**3.6 ADJUSTING**

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit price paid per LINEAR FOOT for 6' CHAIN LINK FENCE WITH SLATS shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with fabricating and installing chain link fencing, including footings, posts and rails, fabric, tension wire and fittings, etc. as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- B. The Contract unit prices paid per EACH for 10' WIDE SWING GATE WITH SLATS and for 6' WIDE SWING GATE WITH SLATS shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with fabricating and installing chain link gates, including rails, fabric, tension wire and fittings, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.
- C. The Contract unit price paid per EACH for BOLLARD AND OPEN GATE POST shall include full compensation for furnishing all labor, material, tools, equipment and incidentals, and for doing all Work involved with fabricating and installing bollards and open gate posts, including concrete and paint, as shown on the Plans, as specified in these Technical Specifications and as directed by the Engineer.

**END OF SECTION 32 31 13**

**SECTION 32 84 00**

**PLANTING IRRIGATION**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including Standard and Special Provisions and Technical Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Conditions and Requirements: Refer to the Special Provisions and Additional Provisions of the specifications, and applicable provisions of the 2010 State of California Standard Specifications and Standard Plans.
- B. Related Documents: Review the Contract Documents for additional requirements and information that apply to work under this section.
- C. Section Includes: Contractor shall furnish all labor, tools, equipment, products, material and transportation; and perform all operations necessary and incidental to properly execute and complete all irrigation work in accordance with the Drawings and these Specifications.
- D. Related Sections:
  - 1. Section 329300: Plants & Maintenance: Note that City forces will be completing the Plants and Maintenance work. Contractor shall work closely with City to ensure that the irrigation and planting work are properly coordinated,
- E. Reference Data:
  - 1. Caltrans Standard Specification, May 2006: Erosion Control and Highway Planting.
  - 2. If the year of the adoption or the latest revision of the governing code is omitted, it shall mean the date in effect on the date the Notice to Proceed with the Work.
  - 3. ASTM: American Society for Testing and Materials
    - a. Index sheet stating Contractor's address and telephone number and list of equipment with name and addresses of local manufacturer's representatives.
    - b. ASTM D3350 - Polyethylene Plastic Pipe Fittings Method
    - c. ASTM D1248 - Specification for Polyethylene Plastic Molding and Extrusion Material
    - d. ASTM D2447 - Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on O.D.
    - e. ASTM D2837 "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
    - f. ASTM D2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
  - 4. NSF: National Sanitation Foundation
- F. All work and materials to be in full accordance with the latest rules and regulation of safety orders of the Division of Industrial Safety, the Uniform Plumbing Code and other applicable laws or regulations, including all local codes. Should the Contract Documents be at variance with the rules and regulations, notify the City.

### 1.3 GENERAL REQUIREMENTS

#### A. Drawings:

1. For purposes of clarity and legibility, Drawings are essentially diagrammatic to the extent that many offsets, bends, unions, special fittings, and exact locations of items are not indicated, unless specifically dimensioned.
2. Exact routing of piping, etc., shall be governed by structural conditions, obstructions. Contractor shall make use of data in Contract Documents and actual site conditions.
3. The Contractor shall not willfully install the irrigation system as shown on the Drawings when it is obvious in the field that differences in water pressure or flow, unknown obstructions, grade differences, discrepancies in area dimensions, or other site conditions exist which would cause revisions to be necessary. Such obstructions or differences shall be brought to the attention of the City. In the event this notification is not performed, the Contractor shall assume full responsibility for any revision necessary.

### 1.4 SITE VISIT

- #### A.
- Visti the construction site and shall take all measurements and obtain any other information as may be necessary for a complete and conclusive bid.

### 1.5 SUBMTTALS

#### A. Materials List:

1. Submit a complete material list prior to performing any work. The material list shall include the manufacturer, model number and description of all materials and equipment to be used. Do not perform work until materials have been accepted in writing.
2. Equipment or materials installed or furnished without prior acceptance may be rejected and if so shall be removed from the site by the Contractor.

#### B. Record Drawings:

1. Provide Record Drawings in accordance with requirements of Section 01010 and as follows:
2. Dimension from two permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following items:
  - a. Connection to existing water lines
  - b. Connection to existing irrigation controllers
  - c. Routing of pressure lines (dimension max. 100 feet long along routing)
  - d. Remote control valves
  - e. Routing of control wiring
  - f. Quick coupling valves
  - g. Other related equipment as directed by the City.
3. Prepare an as built drawing for each automatic controller showing the area covered and showing locations of all valves, lateral lines, irrigation head and routes of the control wires. Identify all valves as to size, station, number and type of planting irrigated. Submit as built drawing. As built drawings must be approved by the City before reduced diagrams are prepared. From the approved as built drawings provide two reduced diagrams at the maximum size controller housing doors will allow for each automatic controller. Controller chart diagram shall be a blackline print with a different color used to show area of coverage for each station. When completed and approved, hermetically seal between two sheets of plastic, each sheet being a minimum of 20 mils thick. The

- diagrams must be completed and installed prior to final acceptance of the project.
4. At Substantial Completion, submit Record Drawings. Delivery of the drawings shall not relieve the Contractor of the responsibilities of furnishing required information that may have been omitted.

C. Operation and Maintenance Manuals:

1. Submit Operation and Maintenance Manuals as per Section 01700. A copy of the Guarantee Form shall be included in the Operation and Maintenance Manuals.
2. The manuals shall contain complete exploded drawings, diagrams and spare parts lists of all equipment installed showing components and catalog numbers together with the manufacturer's name and address.
  - a. Index sheet indicating the Contractor's name, address, and phone number.
  - b. Copies of equipment warranties and certificates.
  - c. List of equipment with names, addresses and telephone numbers of all local manufacturer's representatives.
  - d. Complete operating and maintenance instructions in sufficient detail to permit operating personnel to understand, operate and maintain all equipment.
3. Provide a minimum of 4 hours instruction in operation of system to Owner's personnel in accordance with requirements of Section 01700.
  - a. Sequencing and scheduling: Coordinate irrigation installation work with the installation of other site improvements, including utility installation work and landscape installation.
  - b. Environmental conditions: Site work such as trenching and backfilling shall not be performed during wet, muddy or frozen conditions.
  - c. Protection of work.
4. The Contractor shall provide adequate protection for all work until completion and final acceptance. Contractor shall take particular precautions to protect: existing buildings, fencing, electroliers, overhead and under-ground utilities, and all existing trees to remain. All damaged, stained or disturbed items shall be replaced at the expense of the Contractor, prior to final acceptance. Prior to trenching call underground service alert, (1-800) 227-2600. Verify location of all utilities
5. The Contractor shall be responsible for damages to the grounds, walks, roads, build-ings, piping systems, electrical systems and their equipment and contents caused by leaks in the irrigation system being installed or having been installed by him. He shall re-pair at his own expense all damage so caused, to match existing undamaged work. All repair work shall be done as approved by the City.

D. Maintaining Traffic:

1. It is the responsibility of the Contractor to ensure adequate protection and controls for pedestrian and vehicular traffic in the vicinity of the Project area. The Contractor shall provide all signs, barricades, flagmen, etc., necessary to meet all traffic requirements for this Project as deemed necessary by the City, and at Contractor's expense.

**1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING**

A. Handling of Pipe and Fittings:

1. The Contractor is cautioned to exercise care in handling, loading, unloading, and storing of pipe and fittings. All pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at

any point. Any section of pipe that has been dented or damaged shall be removed from the site and, if installed, shall be replaced with new undamaged piping.

- B. During the Guarantee Period the City reserves the right to make necessary repairs to prevent damage to property. The exercise of this right shall not relieve the Contractor of the obligations of the Guarantee as specified.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Acceptable Manufacturers:

1. Products of manufacturers not listed may be proposed for substitution, provided that they are equal in design, product performance and warranty to the products specified.
2. The burden of proof of equality of proposed products is on the Contractor.

### **2.2 MATERIALS**

- A. HDPE Pressure Mainline Pipe and Fittings:

1. Pressure mainline piping ; HDPE 4710 I.P.S/S.I.D.R JM Eagle or Equal.
2. All HDPE pipe shall bear the following markings:
  - a. Manufacturer's name
  - b. Nominal pipe size
  - c. Schedule or class
  - d. Pressure rating in PSI
  - e. NSF
  - f. Date of extrusion
3. All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable I.P.S. schedule and NSF seal of approval.

- B. HDPE Non Pressure Lateral Line Piping:

1. Non pressure buried lateral line piping shall be HDPE 4710 with compression style fittings.
2. Except as specified otherwise, all requirements for non pressure lateral line pipe and fittings shall be the same as for pressure main line pipe and fittings as specified.

- C. Sleeving:

1. Material shall be HDPE 4710 I.P.S/S.I.D.R JM Eagle or Equal length as required.

- D. Pipe Fittings:

1. HDPE fittings shall be compression style as detailed.
2. Mainline fittings for remote control valve and quick coupling valve connections shall be threaded nipples and compression fittings as detailed.

- E. Lubricants, Solvents and Joint Compounds:

1. Tape for all threaded connections shall be 3/4" wide Teflon tape, or equal, UL listed.
2. Primer and solvent for all solvent weld connections shall be as recommended by the pipe manufacturers.

3. All cans shall have labels intact and stamped with the date of manufacture. No cans dated over two years old will be permitted.
4. No solvent or primer shall be thinned in any manner.
5. Primer and solvent shall be of different colors (transparent not allowed).

F. Control Wiring:

1. Direct burial copper wire: AWG U.F. 600 volt, 14 gauge minimum. Common wire to be 12- gauge.
2. Connector sealing packs: 3M-DBY Wire Connections, Bell System, or equal.

G. Control or Valve Boxes:

1. Provide rectangular black control valves box with locking lid for each remote control valve. Carson or equal.
2. For all quick coupler valves: Approximately 12 inches high x 12 inches black round box with locking lid, Carson or equal.

H. Miscellaneous Tools and Equipment: See Drawings for required operating equipment and accessories.

1. Fixtures shall Be as shown on the Drawings:
2. Remote control valves
3. Bubbler heads and drip components
4. Quick coupler valves

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Irrigation system shall be installed in accordance with all applicable local and state codes and ordinances by a licensed Landscape Contractor.
- B. Contractor to set up a coordination meeting with the City at least 10 days prior to irrigation installation.
- C. Follow manufacturer's directions except as shown or specified.

#### **3.2 INSPECTION**

- A. Site conditions:
  1. All scaled dimensions are approximate. The Contractor shall check and verify all size dimensions prior to proceeding with work under this Section.
  2. Exercise extreme care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities which are caused by his operations or neglect. Check existing utilities drawings for existing utility locations.
  3. Coordinate installation of irrigation materials, including pipe, so there shall be no interference with utilities or other construction or difficulty in planting trees, shrubs, and groundcovers.
  4. The Contractor shall carefully check all grades to satisfy him/herself that he may safely

- proceed before starting work on the sprinkler irrigation.
5. Coordinate the work of this Section with that of other Sections for the location of pipe sleeves through walls, paving, etc.
  6. The Landscape Contractor shall verify existing water pressure and available gallonage at Point of Connection (POC) prior to construction. If deficiencies are noted that will hinder the system's performance, notify the City for directions to correct deficiencies.
  7. The design is diagrammatic. All piping, valves, etc., shown within paved areas is design clarification only. Install piping, valves, etc., in planting areas except where piping is sleeved under paving.

### **3.3 PREPARATION**

#### **A. Physical Layout:**

1. Prior to installation, stake out all pressure supply lines, routing and location of sprinkler heads.
2. All layouts shall be reviewed by the City prior to installation.

### **3.4 INSTALLATION**

#### **A. Trenching:**

1. Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow layout shown on Drawings.
2. Provide for a minimum of 24 inches cover for all pressure supply lines.
3. Provide for a minimum cover of 18 inches for all non-pressure lines.
4. Provide for a minimum cover of 24 inches for all control wiring.
5. Provide for a minimum cover of 36 inches for all pipe and wiring under paving.
6. Avoid trenching in drip lines of existing trees. When unavoidable, hand trench and tunnel under roots over 2 inches in diameter.

#### **B. Backfilling:**

1. Do not backfill trenches until all required tests are performed. Carefully backfill trenches with specified materials for backfilling, consisting of earth, loam, sandy clay, sand, or other acceptable materials, free from large clods of earth or stones. Backfill shall be mechanically compacted in land-scaped areas to a dry density equal to adjacent undisturbed soil in planting areas. Backfill shall conform to adjacent grades without dips, sunken areas, humps or other surface irregularities.
2. Provide 3-inch clean sand backfill cushion under mainline pressure pipe and 3" over top of pipe.
3. If, within the warranty period, settlement occurs and subsequent adjustments in pipe, valves, sprinkler heads, lawn or planting, or other construction is necessary, the Contractor shall make all required adjustments at no increase in Contract Sum.
4. Install piping under existing walks in sleeves where provided.

#### **C. Pipe and Fitting Connections:**

1. Installation methods shall be as recommended by the pipe and fitting manufacturer.
2. On HDPE to metal connections, the Contractor shall work the metal connections first. Do not over tighten.

#### **D. Line Clearance:**

1. All lines shall have a minimum clearance of 6 inches from each other and from lines of other trades. Parallel lines shall not be installed directly over one another.

E. Remote Control Valves:

1. Install valve boxes flush with finish grade. Align boxes so that they are 12 inches apart and parallel to each other. Where boxes are adjacent to hardscape areas, locate 12 inches from hardscape and aligned with pavement edges.
2. Identify valves with pre-manufactured waterproof valve identification tags.

F. Control Wiring:

1. Make connections between existing automatic controls and electrical control valves with direct burial copper wire. Common wires shall be white. Install in accordance with valve manufacturer's specifications and wire chart.
2. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines wherever possible. Tape wire to bottom of pipe at intervals of 10 feet.
3. Where more than one wire is placed in a trench the wiring shall be taped together at intervals of 10 feet.
4. Provide expansion curl within 3 feet of each wire connection and at least every 100 feet of wire length on runs more than 100 feet in length. Form expansion curls by wrapping at least five turns of wire around a 1 inch diameter pipe, then withdrawing the pipe.
5. Make all splices with connector sealing packs. Use one splice per connector sealing pack. Line splices will be allowed only on runs of more than 500 feet. Splices, if necessary, shall occur in valve box.
6. Install one spare control wire for every 6 stations on the controller. Spare wire shall be of a different color and run along the entire main line.

G. Sleeving:

1. Install sleeves under all paving and for all locations required and where existing sleeves are not indicated or do not exist.
2. Install new sleeves prior to paving installation. Coordinate with paving Contractor to insure all sleeves are installed prior to paving operations.
3. Sleeving shall extend twelve inches (12") beyond edge of pavement or curb.
4. Provide removable non decaying plug at ends of sleeves to prevent entrance of earth. Ends of sleeve shall extend twelve inches (12") beyond edge of paving or curb.

H. Flushing of System:

1. After all new pipe lines and risers are in place and connected, all necessary diversion work has been completed, and prior to installation of sprinkler heads, dripline or emitters, open control valves and use a full head of water to flush out the system.
2. Install sprinkler heads and drip only after flushing of system has been accomplished and accepted.

I. Bubblers/Drip System:

1. Install bubblers and/or drip system as shown on Drawings.

J. Thrust Blocks:

1. Concrete thrust blocks shall be per pipe manufacturer's recommendations and specifications.

**3.5 FIELD QUALITY CONTROL**

A. Adjustment of the System:

1. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, the Contractor shall make such adjustments prior to planting. Lowering raised sprinkler heads by the Contractor shall be accomplished within ten days after notification by the City.

B. Testing of Irrigation System:

1. The Contractor shall request the presence of the City's Representative as specified in Testing Schedule.
2. Test all pressure lines under hydrostatic pressure of 125 pounds per square inch and prove watertight.
3. Note: Testing of pressure main lines shall occur prior to installation of electrical control valves.
4. Sustain pressure in lines for not less than 2 hours. If leaks develop, replace joints and repeat test until entire system is proven watertight. Maximum loss allowed is 4 PSI.
5. Test lateral lines with water at line pressure and visually inspect for leaks. Correct defects and retest as necessary until no loss of water is observed.
6. All hydrostatic tests shall be made only in the presence of the City's representative. No trench shall be backfilled until piping has been reviewed, tested and accepted.
7. Furnish necessary force pump and all other test equipment.
8. When the irrigation system is completed, perform a coverage test in the presence of the Irrigation Consultant to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all work required to correct any inadequacies of coverage due to deviation from Drawings. This test shall be accomplished before any groundcover or lawn is planted.
9. Upon completion of each phase of work, test and adjust entire system to meet site requirements.

**3.6 CLEANUP**

- A. Clean up shall be made as each portion of work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be broomed or washed down, and any damage sustained on the work of others shall be repaired to original conditions.

**3.7 FINAL REVIEW PRIOR TO ACCEPTANCE**

- A. Operate each system in its entirety for the Landscape Architect at time of final review. Any items deemed not acceptable shall be reworked.
- B. Final review shall take place after submission of all specified lists, Record Drawings, and manuals.

**3.8 TESTING SCHEDULE**

- A. Notify the Landscape Architect of the Testing According to the Time Indicated.
1. Pre job conference: 7 days.
  2. System layout: 48 hours.
  3. Trench depths: 48 hours.
  4. Coverage tests: 48 hours.
  5. Final inspection: 7 days.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The contract unit price paid per square foot for **Irrigation System** shall include full

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compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work necessary to provide a complete irrigation system, including but not limited to trenching, road and driveway sleeving crossings, installation, maintenance, materials, heads, valves, electrical wires, and controllers as shown on the plans, as specified in the Standard Specifications and these Special Provisions, and as directed by the engineer.

**END OF SECTION 32 84 00**

**SECTION 32 91 14**  
**BIORETENTION SOILS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Specifications for furnishing, placing, and compacting bioretention soils as indicated.
- B. All work shall comply with Appendix K. BSM Specification in the C.3 Stormwater Technical Guidance Version 8.1 of the Alameda Countywide Clean Water Program, 2024.
- C. Related Sections:
  - 31 20 00 Earth Moving
  - 33 41 00 Storm Utility Drainage Piping
  - 33 46 00 Subdrainage

**1.02 SUBMITTALS**

The contractor shall submit to the Engineer for approval:

- A. A minimum 1-gallon size sample of mixed bioretention soil.
- B. Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.
- C. Grain size analysis results of the fine sand component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
- D. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in Section 2.04.
- E. Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
- F. A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.
- G. Provide the following information about the testing laboratory(ies) name of laboratory(ies) including:
  - 1. Contact person(s)
    - a. Address(es)
    - b. Phone contact(s)
    - c. E-mail address(es)
    - d. Qualifications of laboratory(ies), and personnel including date of current certification by STA, ASTM, or approved equal

**PART 2 - PRODUCTS**

**2.01 General Requirements for Bioretention Soils**

- A. Shall achieve a long-term, in-place infiltration rate of at least 5 inches per hour.
- B. Support vigorous plant growth.
- C. Consist of the following mixture of fine sand and compost, measured on a per volume basis:
  - 1. 60%-70% Sand
  - 2. 30%-40% Compost

**2.02 SAND FOR BIORETENTION SOIL**

- A. General
  - 1. Sand shall be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size shall be non-plastic.
- B. Sand for Bioretention Soil Texture.
  - 1. Sand for Bioretention Soils shall be analyzed by an accredited lab using #200, #100, #40, #30, #16, #8, #4, and 3/8 inch sieves (ASTM D 422 or as approved by the Engineer), and meet the following gradation:

Sieve Size	Percentage Passing (by weight)	
	<i>Min</i>	<i>Max</i>
3/8 Inch	100	100
No. 4	90	100
No. 8	70	100
No. 16	40	95
No. 30	15	70
No. 40	5	55
No. 100	0	15
No. 2000		5

Note all sands complying with ASTM C33 for fine aggregate comply with the above gradation requirements.

**2.03 COMPOSTED MATERIAL**

- A. Compost shall be a well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes or other organic material not including manure or biosolids meeting the standards developed by the US Composting Council (USCC). The product shall be certified through the USCC Seal of Testing Assurance (STA) Program (a compost testing and information disclosure program).
- B. Compost Quality Analysis Before delivery of the soil, the Contractor shall submit a copy of lab analysis performed by a laboratory that is enrolled in the US Composting Council's Compost Analysis Proficiency (CAP) program and using approved Test Methods for the Evaluation of Composting and Compost (TMECC). The lab report shall verify:

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1. Feedstock Materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
  2. Organic Matter Content: 35% - 75% by dry wt.
  3. Carbon and Nitrogen Ratio: C:N < 25:1 and C:N >15:1
  4. Maturity/Stability: shall have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120F) upon delivery or rewetting is not acceptable. In addition, any one of the following is required to indicate stability:
    - a. Oxygen Test < 1.3 O<sub>2</sub> /unit TS /hr
    - b. Specific oxy. Test < 1.5 O<sub>2</sub> / unit BVS / hr
    - c. Respiration test < 8 mg Co<sub>2</sub>-C / g OM / day
    - d. Dewar test < 20 Temp. rise (°C) e.
    - e. Solvita® > 5 Index value
  5. Toxicity: any one of the following measures is sufficient to indicate non-toxicity.
    - a. NH<sub>4</sub>- : NO<sub>3</sub>-N < 3
    - b. Ammonium < 500 ppm, dry basis
    - c. Seed Germination > 80 % of control
    - d. Plant Trials > 80% of control
    - e. Solvita® > 5 Index value
  6. Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.
    - a. Total Nitrogen content 0.9% or above preferred.
    - b. Boron: Total shall be <80 ppm; Soluble shall be <2.5 ppm
  7. Salinity: Must be reported; < 6.0 mmhos/cm
  8. pH shall be between 6.5 and 8. May vary with plant species.
- C. Particle size: Compost for bioretention soils shall be analyzed by an accredited lab using #200, ¼ inch, ½ inch and 1 inch sieves (ASTM D 422) and meet the following gradation:

Sieve Size	Percent Passing (by weight)	
	<i>Minimum</i>	<i>Maximum</i>
1 inch	99	100
½ inch	90	100
¼ inch	40	90
No. 200	1	10

- D. Bulk density: shall be between 500 and 1100 dry lbs/cubic yard
- E. Moisture Content shall be between 30% - 55% of dry solids
- F. Inerts: compost shall be relatively free of inert ingredients, including glass, plastic and paper, < 1 % by weight or volume
- G. Weed seed/pathogen destruction: provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach min. 55C for 15 days with at least 5 turnings during that period.
- H. Select Pathogens: Salmonella <3 MPN/4grams of TS, or Coliform Bacteria <10000 MPN/gram

- I. Trace Contaminants Metals (Lead, Mercury, Etc.) Product must meet US EPA, 40 CFR 503 regulations
- J. Compost Testing. The Contractor will test all compost products within 120 calendar days prior to application. Samples will be taken using the STA sample collection protocol. (The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741 Phone: 631-737-4931, [www.compostingcouncil.org](http://www.compostingcouncil.org)). The sample shall be sent to an independent STA Program approved lab. The Contractor will pay for the test.

### **PART 3 - EXECUTION**

#### **3.01 PLACEMENT AND COMPACTION OF BIORETENTION SOILS**

- A. Place the bioretention soil in 8" to 12" lifts. Lifts are not to be compacted but are placed to reduce the possibility of excessive settlement. Allow time for natural compaction and settlement prior to planting. Bioretention soil may be watered to encourage compaction.

### **PART 4 - MEASUREMENT AND PAYMENT**

#### **4.01 MEASUREMENT AND PAYMENT**

- A. The contract unit price paid per cubic yard for **Bioretention Soil** shall include full compensation for furnishing all labor, materials, tools, equipment, testing, clean-up and incidentals for providing and installing bioretention soil as noted on the plans, as specified herein, as specified in the Standard Specifications and these Special Provisions, and as directed by the engineer.
- B. Class 2 permeable virgin rock is paid under Bid Item 5.16 Permeable Material.

**END OF SECTION 32 91 14**

**SECTION 32 93 00**

**PLANTS & MAINTENANCE**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes, but is not limited to:
  - 1. Soil Preparation including Soils test, Topsoil, associated Soil Amendments and Compost
  - 2. Plant Material (by City)
  - 3. Mulches (by City)
  - 4. Weed Barrier (Sheet Mulch) (By City)
  - 5. Tree Staking (By City)
  - 6. 180 day/6 month Landscape Maintenance (By City)
- B. Note that several items of work are to be performed by City forces. Contractor shall coordinate closely with the City to ensure a complete and satisfactory installation. See Section 4. Measurement and Payment for description of Contractor pay items.

**1.2 RELATED DOCUMENTS**

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections:
  - 1. Section 31 10 00 Site Clearing
  - 2. Section 31 20 00 Earth Moving
  - 3. Section 32 84 00 Planting Irrigation
  - 4. Section 33 46 00 Subdrainage

**1.3 DEFINITIONS**

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- C. Finish Grade: Elevation of finished surface of planting soil.
- D. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- E. 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. Pesticides will not be used on this project without written approval by the City.

- F. 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.
- G. Planting Area: Areas to be planted.
- H. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with organic soil amendments and perhaps organic fertilizers, per soils testing, to produce a soil mixture best for plant growth.
- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- L. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- M. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- N. 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.
- O. Compost- Compost is the product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and processed to further reduce and stabilize it to the point that it is beneficial to plant growth.
- P. Integrated Pest Management (IPM) - A holistic approach to managing insects, plant disease, weeds and other pests so that their populations do not exceed a tolerable level by fostering an environment favorable for plants and other beneficial organisms and unfavorable for pests. If pest problems arise a variety of control techniques are considered, with least toxic pesticides being applied as a last resort.
- Q. Organic Materials Research Institute (OMRI) approves amendments and fertilizers for use in crop production. The OMRI Generic Materials List is a catalog of over 900 substances that are allowed, restricted, or prohibited for use in organic agriculture and food processing. Based on the National Organic Program, the list serves as a reference guide for organic farmers, handlers, processors, inspectors, certifiers, agricultural professionals, and all others with an interest in materials for use in organic production. Materials approved for use in organic production are appropriate for use in landscapes. [http://omri.org/OMRI\\_generic\\_list.html](http://omri.org/OMRI_generic_list.html)
- R. Pesticide – As defined in Section 12753 of the California food and Agricultural Code, a pesticide includes any of the following: "(a) Any spray adjuvant. (b) Any substance, or mixture of substances which is intended to be used for defoliating plants, regulating plant growth, or for

preventing, destroying, repelling, or mitigating any pest, which may infest or be detrimental to vegetation, man, animals, or households, or be present in any agricultural or nonagricultural environment whatsoever". Antimicrobial agents are excluded from the definition of pesticide.

- S. Sheet Mulching - A layered system of non-plastic weed barrier (e.g. recycled cardboard, newspaper) overlain by mulch that is used for soil improvement and weed control.

#### 1.4 SUBMITTALS

- A. Materials List:
  - 1. Submit to the City a complete list of materials prior to performing any work. The material list shall include a description of each item, the quantity of each item and the dealer source of each item.
  - 2. A complete plant list indicating species, variety, quantity and size shall be submitted to and accepted by the Engineer prior to locating plant material on-site.
  - 3. Materials installed or furnished without prior acceptance by the Engineer may be rejected and if so will be removed from the site by the Contractor.
- B. Record Drawings: During the course of the installation, carefully record in red line on a print of the planting plan, all changes to be made to the planting system layout during installation.
- C. Samples for Verification: For each of the following:
  - 1. Amendments and Compost- 1 cubic foot minimum volume of each amendment in sealed plastic bag or container. Submittal shall be labeled with weight and source of each item. Each submittal shall represent a true sample of material to be provided at the project site.
  - 2. Mulch: 1 cubic foot minimum volume of each mulch in sealed plastic bag or container. Submittal shall be labeled with weight and source of each item. Each submittal shall represent a true sample of material to be provided at the project site.
  - 3. Tree Staking materials: Sample of lodgepole pine (untreated), 2-inch diameter by 10 feet long minimum actual dimensions, of uniform size and pointed at one end.
  - 4. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
- D. Soils Test- see Section 2.2

#### 1.5 QUALITY ASSURANCE

- A. Contractor must have a valid California C-27 contractor's license authorized by the State of California.
- B. Contractor shall provide evidence of sufficient experience with similar projects. Provide list including a minimum of five recently installed projects with location, date completed, owner, contact person and phone number.
- C. Contractor must have assigned to the project at least one employee possessing a California State Chemical Applicator's License for the control of weeds, plant diseases and other pests.
- D. Contractor must have assigned to the project at least one employee who has successfully completed the Pollution Prevention Training & Certification Program For Surface Cleaners issued by the Bay Area StormWater Management Agencies Association (BASMAA).
- E. It is preferred that the Contractor have assigned to the project at least one employee who is a Certified Irrigation Contractor (Irrigation Association).

- F. It is preferred that the Contractor have assigned to the project at least one employee who is a Certified Arborist or Certified Tree Worker (International Society of Arboriculture)
- G. It is preferred that the Contractor have assigned to the project at least one employee who has experience or training in Integrated Pest Management (IPM) techniques.
- H. Plant materials: All plants shall have been grown in nurseries that have been inspected by State of California Department of Agriculture and will be tagged with correct names as per Standard Plant Names. All plant material will be inspected by the Engineer before being planted, and all plant material not meeting specification requirements will be rejected. Replace, at expense of Contractor, rejected trees, shrubs and groundcovers with plant materials of species and variety that meet specification requirements.
- I. Drawings: For the purposes of clarity and legibility, the drawings are essentially diagrammatic, exact location of items are not indicated unless specifically dimensioned. Do not willfully install the landscape materials as shown on the drawings when it is obvious in the field that unknown obstructions, grade differences or discrepancies in area dimensions exist. Such obstructions or differences shall be brought to the attention of the client. In the event this notification is not performed, the Contractor will assume full responsibility for any revision necessary.

#### **1.6 SUPPLIES AND EQUIPMENT**

- A. Fuel conservation and low emission equipment. The Contractor will implement strategies in work operations to reduce fossil fuel consumption and emissions, such as:
  - 1. Use hand-powered equipment when possible.
  - 2. Minimize use of gas-powered blowers, especially on planting beds.
  - 3. Select smallest, most fuel efficient equipment to accomplish task.
  - 4. Consider vehicles that operate on natural gas or biodiesel.
  - 5. Maintain all equipment properly and keep them well tuned.
  - 6. Emphasize employee carpooling to Project Site.
- B. Use local products and suppliers. The Contractor shall use local products and suppliers (produced within 150 miles from the project site) to the extent possible to minimize fuel consumption and emissions.
- C. Use recycled and salvaged materials. The Contractor shall use salvaged and recycled-content products where possible. Materials for reuse may be found by contacting the CalMax website at [www.ciwmb.ca.gov](http://www.ciwmb.ca.gov) or at [www.stopwaste.org](http://www.stopwaste.org).
- D. Equipment refueling and repair. The Contractor shall refuel and repair equipment in a safe manner to protect against accidental spills. Limit refueling to specific areas on a site. Measures shall be taken to prevent, control, and clean-up spills. Clean-ups should be immediate, automatic and routine and performed by a trained staff member or a licensed cleaning company.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Protect plant materials at all times during handling, shipping, storage and planting from extreme weather conditions, wind, drying roots and rootballs, and injury.
- B. Support root system of container plant materials when lifting and moving to minimize injury to the root system.

- C. Seed and Other Packaged Materials: 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.
- D. Plant materials showing damage from shipping, while in storage or during planting may be rejected by the Engineer. Replace rejected plant materials at the expense of the Contractor.

## **1.8 PROJECT CONDITIONS**

- A. Sequencing and Scheduling: Coordinate all phases of landscape installation with other phases of construction so as not to incur any scheduling or installation conflicts, and to maintain an efficient construction process.
- B. Environmental Conditions: Do not perform any site work and landscape installation in wet, muddy or frozen conditions.
- C. Protection of Work: Provide adequate protection for all work until completion and final acceptance. Take particular precautions to protect existing trees to remain, fencing, overhead and underground utilities. All damaged, stained or disturbed items will be replaced or repaired at the expense of the Contractor and to the satisfaction of the Engineer, prior to final acceptance.
- D. Maintaining Traffic: Ensure adequate protection and controls for pedestrian and vehicular traffic in the vicinity of the job area. Provide all signs, barricades, flagmen, etc. necessary to meet all traffic requirements for the project.
- E. Maintaining Conditions at Project Site:
  - 1. Keep project site reasonably free from accumulation of debris, topsoil, and other materials resulting from work specified under this section.
  - 2. Remove topsoil, fertilizers, textural soil amendments, and soil mixes from walks and paving on a daily basis.
  - 3. Broom down areas daily as necessary to maintain clean pavement.
  - 4. At completion of each area of work, remove debris, equipment and surplus materials.

## **1.9 GUARANTEE**

- A. Guarantee plant materials to remain alive and be in healthy, vigorous condition for a period of one year after completion and acceptance of entire project. The Engineer shall inspect plants at the completion of planting.
- B. Replace, in accordance with the drawings and specifications, all plants that are dead or, as determined by the Engineer, are in an unhealthy or unsightly condition and have lost their natural shape due to dead branches or other causes due to the Contractor's negligence. The cost of such replacement is at the Contractor's expense. Warrant all replacement plants for 90 days after installation.
- C. Warranty will not include damage or loss of plant materials caused by fires, floods, freezing rains, lightning storms, winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of the site.
- D. Remove and immediately replace all plants, as determined by the Engineer, to be unsatisfactory during the initial planting installation.

## 1.10 PLANT ESTABLISHMENT

- A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
  - 1. Maintenance Period: 180 days/6 months from date of planting acceptance.

## PART 2 - PRODUCTS

### 2.1 PLANT MATERIAL

- A. Provide plants typical of their species or variety, with normal, densely developed branches and vigorous, fibrous root systems. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sunscald injuries, frost cracks, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation. All plants shall have a fully developed form without voids and open spaces.
- B. Plants larger than those specified in the plant list may be used when acceptable to the Engineer. If the use of larger plants is acceptable, increase the spread of roots or rootball in proportion to the size of the plant.
- C. Plants planted in rows shall be matched in form.
- D. Meet all requirements of USA Standard for Nursery Stock, published by the American Association of Nurserymen, Inc., except as otherwise supplemented and modified under this specification section.
- E. Cold storage plants are not acceptable.
- F. Container plants, one gallon size and larger, shall have grown therein a minimum of six months and a maximum of two years, with roots filling the containers but not showing evidence of being or having been restricted, deformed or rootbound.
- G. Provide untapped, straight, single-leader trees except for multiple stem (clump) trees. Deciduous trees shall have heavier than normal top and balanced branching.
- H. Trees and shrubs shall have well-developed branch systems; shrubs shall be full-foliaged and not leggy.
- I. Thin, weak and leggy plants will be rejected by the Engineer.
- J. All plant material shall be legibly tagged by specie and variety with minimum of one tag per 10 trees, 10 shrubs and 100 ground covers.
- K. Nomenclature: Genus, species and variety as indicated on Plant Material Listing. Plant names are in accordance with those given in Standardized Plant Names, 1942 edition; names of varieties not included therein go by names generally accepted in nursery trade.
- L. Plant materials not meeting these requirements shall be removed from the site and replaced to the satisfaction of the Engineer at the Contractor's expense.

**2.2 SOILS TEST**

- A. Contractor shall arrange and pay for soil testing of imported topsoil and/or onsite soils by an accredited soils laboratory approved by the City. Laboratories that participate in the North American Proficiency Testing Program (NAPT) are recommended. See <http://www.naptprogram.org/about/participants> for participating laboratories
- B. **Soil submitted for testing should be Imported Planting Soil.** See 312000 Earth Moving for more information.
- C. At a minimum the soil analysis shall include:
  - 1. soil texture (% sand-silt-clay)
  - 2. infiltration rate (based on laboratory testing or soil texture infiltration rate table)
  - 3. pH
  - 4. total soluble salts/salinity/electrical conductivity (EC), units: dS/m or mmho/cm
  - 5. essential nutrients
  - 6. heavy metals
  - 7. percent organic matter content
- D. **Taking into consideration the project will install 6CY/1000sf of compost into all planting soils provide recommendations for amending the soil with additional organic fertilizers to recommended levels for planting area and planting type.** The amendments, and fertilizer rates and quantities listed in 3.3 are to be used for bid basis only.
  - 1. The base bid shall include cost of testing and amending the planting soil noted in this specification section. Adjustments to project costs resulting from the soil report recommendations shall be submitted as a modification to the base bid.
  - 2. Submit soil lab report and any proposed soil amendments and cost adjustments to City for written approval. After review and written approval by the City, amend the soils according to said laboratory's recommendations.

**2.3 SOIL AMENDMENTS**

- A. Compost shall be a well decomposed, stable and weed free. It shall be derived from one or more of the following materials: agricultural crop residues or herbivore animal manures or food waste or urban plant debris. It shall not contain mixed solid waste. The product shall contain no substances toxic to plants, will possess no objectionable odors and shall not resemble the feedstock (the original material from which it was derived). Compost shall be tested through the US Composting Councils USCC Seal of Testing Assurance Program (STA). A lab analysis shall be performed by a STA certified laboratory using the test methods used in the Seal of Testing Assurance program found in the Test Methods for Examination of Compost and Composting Manual (TMECC). Verifying current participation in the STA program can be confirmed by logging onto the USCC website at [www.compostingcouncil.com](http://www.compostingcouncil.com). The compost lab analysis shall be submitted as part of the "Compost Technical Data Sheet" before delivery of compost.
  - 1. **Type: The compost shall be Wondergrow compost meeting the requirements below or approved equal.**
  - 2. **Available from: Recology™ Grover Environmental Products 6133 Hammett Ct| Modesto, CA 95358 T: 209.545.8874 dramsey@recology.com**

Parameters <sup>1,6</sup>	Reported as (units of measure)	General Range
pH <sup>2</sup>	pH units	6.0-8.5

Soluble Salt Concentration	dS/m (mmhos/cm)	Maximum 10, less than 4 preferred
Boron	Ppm	Soluble shall be <2.5
Moisture Content	% wet weight basis	30-60 %
Organic Matter Content	% dry weight basis	30-65%
Carbon Nitrogen Ratio	ratio of Carbon to nitrogen	25:1
Bulk Density	dry lbs/cubic yard	Between 500-1,100
Particle Size	% pass in a select mesh size, dry weight basis	98% pass through 3/4" screen or smaller
Stability <sup>3</sup> Carbon Dioxide Evolution Rate	Mg CO <sub>2</sub> -Cper g OM per day	<8
Maturity <sup>3</sup> ( Bioassay) Seed Emergence and Seed Vigor	% , relative to positive control % , relative to positive control	Minimum 80% Minimum 80%
Physical Contaminants (in-erts)	% dry weight basis	<1%
Chemical Contaminants <sup>4</sup>	mg/kg (ppm)	Meet or exceed USEPA Class A standard, 40CFR: 503.13, Tables 1 and 3 levels
Biological Contaminants <sup>5</sup>  Select Pathogens Fecal Coliform Bacteria, or Salmonella	  MPN per gram per dry weight MPN per 4 grams per dry weight	  Meet or exceed US EPA Class A standard, 40 CFR, 503.32(a) levels

(Table modified from the US Composting Council Landscape Architectural Specifications)

<sup>1</sup> Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, The US Composting Council)

<sup>2</sup> It should be noted that the pH and soluble salt content of the amended soil mix is more relevant to the establishment and growth of a particular plant, than is the pH or soluble salt content of a specific compost (soil conditioner) used to amend the soil. Each specific plant species requires a specific pH range. Each plant also has a salinity tolerance rating, and maximum tolerable quantities are known. Most ornamental plants and turf species can tolerate a soil/media soluble salt level of 2.5 dS/m and 4 dS/m, respectively. Seeds, young seedlings and salt sensitive species often prefer soluble salt levels at half the afore mentioned levels. When specifying the establishment of any plant or turf species, it is important to understand their pH and soluble salt requirements, and how they relate to existing soil conditions.

<sup>3</sup> Stability/Maturity rating is an area of compost science that is still evolving, and as such, other various test methods could be considered. Also, never base compost quality conclusions on the result of a single stability/maturity test.

<sup>4</sup> US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels = Arsenic 41ppm, Cadmium 39ppm, Copper 1,500ppm, Lead 300ppm, Mercury 17ppm, Molybdenum 75ppm, Nickel 420ppm, Selenium 100ppm, Zinc 2,800ppm.

<sup>5</sup> US EPA Class A standard, 40 CFR § 503.32(a) levels = Salmonella <3 MPN/4grams of total solids or Fecal Coliform <1000 MPN/gram of total solids.

<sup>6</sup> Landscape architects and project (field) engineers may modify the allowable compost specification ranges based on specific field conditions and plant requirements.

- B. Fertilizers: Organic fertilizers as recommended by the soils report. Synthetic, quick-release fertilizers shall not be permitted. Fertilizers prohibited in the generic materials list by OMRI are prohibited in the project.

## **2.4 IMPORTED TOPSOIL**

- A. Contractor shall provide imported topsoil as specified in 3.3 SOIL PREPARATION AND FINE GRADING. See Specification Section 312000 Earth Moving for more information.
- B. Mulch shall be Arbor Mulch, 1½" minus ground tree chips, as manufactured by Recology Organics, Vernalis, California, or approved equal. Color shall be Blonde. Submit minimum 1 quart sample to engineer for approval.

## **2.5 INTEGRATED PEST MANAGEMENT**

- A. Integrated Pest Management (IPM) practices shall be used to control pests and diseases in the landscape.
- B. Synthetic pre emergents are prohibited.

## **2.6 PESTICIDES**

- A. General: 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. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pesticides that are not allowed by OMRI in its generic materials list are prohibited. Pesticides will not be used on this project without written approval by the City.

## **2.7 TREE STAKING MATERIALS**

- A. Staking Materials:
  - 1. Stakes: Lodgepole pine (untreated), 2-inch diameter by 10 feet long minimum actual dimensions, of uniform size and pointed at one end.
  - 2. Ties: recycled car tire straps, if available or equal as approved by landscape architect.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and 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. Contractor to arrange for a coordination meeting with the City at least 10 days prior to commencing work to coordinate tasks and schedule.

### 3.2 INSTALLATION

- A. Verify special protection instructions, clearance and pruning requirements with Engineer prior to planting installation.
- B. Install all areas of planting indicated on plans at specified spacings.
- C. Locate plants on site for acceptance by the Engineer prior to plant installation.

### 3.3 SOIL PREPARATION AND FINE GRADING

- A. Scarify or till subgrade to 6 inches prior to placing imported topsoil. Entire surface should be disturbed by scarifications. Do not scarify within drip line of existing trees to be retained. Do not scarify when soil is wet.
- B. Install imported topsoil 12" deep in all planting areas, Refer to Section 321000 Earth Moving for more information.
- C. Test imported planting topsoil per section 2.2.
- D. Shrub, tree and groundcover areas:
  1. Apply organic fertilizers and other amendments as indicated by the soils report. **Apply 3CY/1000sf of quality organic compost** to all areas to receive planting. Mix to the depth required to achieve 6 inches of settled soil/amendment mix. **NOTE: an additional 3CY/1000sf will be applied ABOVE the cardboard sheet mulch layer. See sheet mulching 3.9.**
- E. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off City's property. Grade soil surface at edges of planting areas within 1 foot of adjacent hardscape and drain inlets to an elevation of 3-4 inches below the finished surface of adjacent hardscape to allow adequate room for mulch.
- F. Before planting, obtain Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 WEED BARRIER (SHEET MULCH)

- A. Sheet mulch to be applied to ALL planting areas.
- B. Incorporate 3CY/1000sf of quality compost specified above in section 3.3 into the site soil.
- C. Install 5 gallon and larger plant materials.

- D. Apply a minimum of two layers of 100% recycled B flute cardboard as a biodegradable weed barrier to the entire planting area, completely covering all existing soil and remaining herbaceous vegetation, if any. All areas to receive mulch including areas under existing tree canopies shall utilize sheet mulching as described below.
  - 1. Wet cardboard while applying to prevent it from blowing away.
  - 2. Sheets of cardboard shall overlap a minimum of 8".
  - 3. Cardboard shall abut directly against edge of pavement, curbs, boulders or other site features. Cardboard shall not cover tree and shrub root crowns.
  - 4. Excess cardboard shall be folded under itself when abutting against hardscape objects or root crowns areas, as opposed to being cut, avoid excessive cardboard scraps. This folding under process is greatly aided when the cardboard is wet.
  - 5. All cardboard scraps shall remain separated from other construction debris and shall be disposed at the local recycling facility.
- E. Install an additional (3CY/1000sf) of compost on top of cardboard prior to planting to protect cardboard from tearing
- F. Plant 1 gallon and smaller plants by punching through cardboard. Flats should be planted directly into compost layer without punching through cardboard.
- G. Layout drip lines.
- H. Apply 3" of mulch on top of the compost

### **3.5 TREE AND SHRUB PLANTING**

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable.
- C. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
- D. Scarify sides of planting pit if smeared or smoothed during excavation.
- E. Excavate approximately three times as wide as ball diameter for trees and two times for shrubs.
- F. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
- G. Maintain supervision of excavations during working hours.
- H. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

- I. Imported topsoil removed from excavations may be used as backfill. Backfill mix should be amended per soils test.
- J. Obstructions: Notify Engineer if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- K. Drainage: **Notify Engineer if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.** Fill each pit with water, then observe drainage rate for problems prior to plant installation. If drainage problems are present, discuss with the Engineer.
- L. Fill excavations with water and allow to percolate away before positioning trees and shrubs.
- M. Root pruning/scarification: Matted roots on all sides of root ball are to be shaved off using a razor, sharp shovel or carpenter saw. Large circling roots are to be cut with hand shears. If there are no matted or circling roots, the root ball only requires surface scarification to 1/2" to allow for roots to pass into site soil more readily.
- N. Sugar solution: Immediately after root pruning, a sugar solution is applied to the freshly cut roots. Solution is mixed at the rate of 3/4 cup sugar to 1 gallon of water. Solution is applied with a pump sprayer. A 24" box tree requires an estimated 1 quart of sugar solution. Sugar solution is only required for freshly severed roots.
- O. Set trees and shrubs 1" above finished grade. Finish grade is soil level, not including compost and mulch.
- P. Space 1-gallon groundcover and shrubs evenly as indicated on the drawings, staggering the spaces around larger shrubs and trees.
- Q. A four-inch-high water basin shall be constructed around each shrub and tree. After planting, water each plant by filling basin twice.
- R. All trees shall be staked and tied as per detail immediately after planting. Trees will stand plumb after staking.
- S. Water plantings thoroughly every two to three days as required to establish proper rooting.
- T. Groundcovers in Flats: Supply delivery tags to help confirm adequacy of plant spacing's. Engineer will take particular care in ensuring that these plants are spaced as specified on plans.

### 3.6 TREE AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Landscape Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. All tree species shall have one singular leader unless specified as multi stem. Trees with multiple leaders may be rejected by Landscape Architect; if approved, contractor will preserve the leader that will best promote the symmetry of the plant. Cut branches flush with the trunk or

main branch, at a point beyond a lateral shoot or bud a distance of not less than one-half the diameter of the supporting branch. Make cut on an angle.

- E. Do not apply pruning paint to wounds.

### **3.7 TREE STAKING**

- A. Install trunk stabilization as follows unless otherwise indicated:  
Staking: Stake all trees per plan and details.

### **3.8 PLANT ESTABLISHMENT**

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as approved by City to keep trees and shrubs free of insects and disease.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence. Replant trees and/or shrubs that may have settled.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents as approved in writing by City.

### **3.9 INSPECTION**

- A. A written notice or phone call requesting an inspection should be given to the Engineer at least two days prior to any anticipated inspection date.
- B. The following progress inspections will be required:
  1. Inspection and approval of all plant materials prior to installation.
  2. Inspection and approval of plants at site after being spotted by Contractor.
  3. The actual planting operations of all plants and sheet mulching installation.

### **3.10 ACCEPTANCE**

- A. Planted areas will be accepted provided all requirements have been complied with and plant materials are alive and in a healthy, vigorous condition.
- B. Upon acceptance, begin plant maintenance for a period of 180 days.

### **3.11 MAINTENANCE PERIOD**

- A. Pruning

1. Selective pruning. Plants shall be pruned selectively to remove individual stems or branches that extend beyond the natural conformation of the plant to a lateral branch or at the point of attachment. Woody groundcovers shall be selectively pruned to control growth towards pavements rather than edged.
  2. Hedging and shearing. Contractor shall not shear plants into formal shapes as this destroys the natural form of the plant and generates excessive waste.
- B. Structural Pruning for Trees
1. Tree pruning shall be performed only by trained, experienced personnel. An I.S.A. Certified Arborist or Tree Worker is to be present at all times during pruning.
  2. Structural pruning shall occur twice a year, generally at the end of summer and during winter.
  3. Pruning Guidelines:
    - a. The height of the first permanent branch shall be 8' on sidewalk side and 12-16' on street side.
    - b. Prune to maintain dominant central leader.
    - c. Remove included bark stems before pruning wound reaches ½" diameter.
    - d. When branches with bark inclusions are larger than 1" diameter, radically subordinate for future removal.
    - e. Lateral temporary branches shall be regularly subordinated and removed when the size of the pruning wound reaches ¾-1" in diameter.
    - f. Subordinate lateral branches with or nearing high aspect ratios .
    - g. Subordination cuts not to exceed ½".
    - h. Selective removal of largest temporary branches before they reach ¾ - 1" in diameter.
    - i. No more than (2) temporary branches are removed at one time.
    - j. If two temporary branches requiring removal are in proximity, remove only one and subordinate the other for later removal.
    - k. Do not remove temporary branches below first permanent branch until they attain ¾".
    - l. Select permanent branches with wider angle of attachment.
    - m. Promote radial branch distribution and natural branch spacing.
    - n. Remove crossing/rubbing branches and branches that are directed inward.
- C. Produce mulch from plant debris. Leaves and/or plant debris less than 4" including cut or chipped woody prunings shall be re-incorporated into the mulch layer of landscape areas away from storm drain.
- D. Utilize Integrated Pest Management- see section 3.12.
- E. Soil subsidence- fill in any soil subsidence that may occur, replant trees and or shrubs that may have settled, and replace mulch materials and restore plant saucers.
- F. Adjust and repair tree staking materials.
- G. Perform other operations as required to establish healthy viable plantings.
- H. Water Management. All plants shall be irrigated to provide adequate water to maintain an attractive, green, healthy and moderate growth rate during its growing season. The contractor shall comply with the water budget approach to irrigation scheduling to match plant need with water application and avoid over-irrigation.

- I. Mulching. Contractor shall maintain a minimum of 3" of mulch at all times over soil surface that is not covered by vegetation. Keep mulch 6" away of tree trunks and 4" away from shrub stems. Restore plant basins.
- J. All exported plant debris that cannot be incorporated into the mulch layer on site shall be separated from other refuse and taken to a facility where it will be used to produce compost or mulch.
- K. Soil shall not be worked when wet- generally October through April.
- L. Fertilizer- ongoing maintenance must use compost, compost tea or other naturally occurring non-synthetic fertilizers. Fertilizers prohibited by OMRI may not be used.
- M. Irrigation
  - 1. Irrigation scheduling: Irrigation frequency shall be adjusted at least monthly to reflect ET expected in next month
  - 2. Irrigation Monitoring: record the meter reading at each site visit and report water use to City of Berkeley. Monitor soil moisture within plant root zones using a soil probe and adjust the schedules accordingly
  - 3. Contractor shall maintain the irrigation system for optimum performance, as per manufacturer specifications, all malfunctioning equipment shall be repaired immediately. All irrigation replacement parts shall be of the same manufacturer, type, and application rates as existing, or approved equals or upgrades.
  - 4. Contractor shall inspect and repair the following weekly April through October and monthly November through March:
    - a. Clean and adjust all sprinkler and bubbler heads, drip emitters and valves for proper coverage
    - b. Check and adjust irrigation system pressure.
  - 5. Contractor shall inspect and repair the following twice a year, at a minimum:
    - a. Ensure all flush valve/cap locations and valve boxes are visible and can be opened.
    - b. Inspect valves, filters, and pressure regulators for damage or leaks.
    - c. Check wire splices.
    - d. Clean valve boxes of dirt and debris.
    - e. Inspect, clean and flush filters and replace damaged or torn filters.
    - f. Flush laterals.
    - g. Make sure plants have adequate numbers of drip emitters for their size.
    - h. Test backflow preventers.
    - i. Task last completed on: \_\_/\_\_/\_\_\_\_
- N. Oil leaks must be repaired immediately and repairs must not be done at the landscape site.

### **3.12 INTEGRATED PEST MANAGEMENT**

- A. Contractor shall utilize integrated pest management (IPM) practices during installation and maintenance to control pests and disease in the landscape. IPM uses cultural, mechanical, physical, and biological control methods before using pesticides. Chemical controls are applied only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. When pesticides are required, the least toxic and the least persistent pesticide that will provide adequate pest control is applied. Refer to BFL Guidelines and Maintenance Specification for more information.
- B. Controls

1. Cultural/Mechanical/physical methods will be used as the first choice in weed management.
  - a. Monitor planting areas frequently to identify and eradicate weeds early in the growth stage prior to their setting seed.
  - b. Cut or pull weeds using hand operated equipment where possible.
  - c. Mulches shall be maintained at all times over soil surface that is not covered by vegetation.
  - d. Propane-fueled flamers may be used in winter and spring with required permits and approval by the Fire Marshall to kill early-season, non-grass weeds by heating the cells until they burst. The weed quickly wilts and dies.
  
- C. If allowed on this project, Contractor shall apply all chemicals in a safe manner and according to label instructions and Agency, State and Federal requirements. A California Chemical Applicators license is required by the Contractor for chemical applications. The Contractor shall mix and apply chemicals to protect against accidental spills and drift to non-target areas, and to insure safety of the applicator. Any spilled chemicals, as well as contaminated soil, water, and/or landscape materials must be removed from the Project and disposed of in accordance with the Agency requirements. The Contractor shall maintain applicator's licenses and records of applications as required by the State.
  
- D. A Chemical Work Report shall be completed for each chemical application. The Contractor is responsible for submitting chemical usage reports to the County Agricultural Department.
  1. Contractor shall maintain records of all pest management activities. Each record shall include the following information:
    - a. target pest;
    - b. type and quantity of pesticide used;
    - c. site of the pesticide application;
    - d. date the pesticide was used;
    - e. name of the pesticide applicator;
    - f. application equipment used;
    - g. prevention and other non-chemical methods of control used.
  2. Contractor shall submit the pest management record to City on monthly basis.
  
- E. Herbicides
  1. Least toxic herbicides may be employed by Contractor as a last resort. (Trade names are used only as examples and are not intended as an endorsement) Examples are:
    - a. Fatty acid potassium salts (herbicidal soaps e.g. Safer's Superfast Weed and Grass Killer® Dr. Bronner's Peppermint Anti-Bacterial Soap)<sup>1</sup>
    - b. Acetic and citric acids (e.g. Nature's Glory Weed and Grass Killer RTU®)
    - c. Clove, citrus, mint and thyme oil (e.g. Matran II®, Xpress®)
    - d. Corn gluten
    - e. Low-toxic, low-residual herbicide [e.g. glyphosate (Round-up®), glufosinate-ammonium (Finale®), pelargoic acid (Scythe®)]
  2. Restricted herbicides that may not be used because they have been identified as ground water contaminants are (trade names in parentheses):
    - a. Atrazine (Aatrex)
    - b. Simazine (Princep)
    - c. Bromacil (Hyvar, Krovar)
    - d. Prometon (Pramitol)
    - e. Bentazon (Basagran)
    - f. Norflurazon (Solicam, Predict, Zorial)

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3. Restricted herbicides that may not be used because they have been identified as a compost contaminant are:
  - a. Picloram
  - b. Clopyralid

### **3.13 CLEANUP AND PROTECTION**

- A. Keep project site reasonably free from accumulation of debris resulting from work specified under this section. Broom-clean pavement daily. Remove dirt and overspray from building walls, pavement and curbs immediately.
- B. At completion of planting, remove all debris, equipment and surplus materials; thoroughly clean adjacent pavement, curbs, walls, walks, etc.
- C. Provide barriers, adequately marked with white flags, throughout the duration of the planting and maintenance periods to protect the planted areas from traffic.

### **3.14 DISPOSAL**

- A. Recycle all waste per C&D water requirements elsewhere in these specifications. Reuse or return unused items such as palettes, flats and pots. All greenwaste shall be separated from other refuse and taken to a facility where it will be used to produce compost or mulch.

## **PART 4 - MEASUREMENT AND PAYMENT-**

- A. The contract unit price per square foot for **Soil Preparation & Fine Grading (Landscaped Areas)** shall include soils tests, topsoil, providing and incorporating compost and amendments, and other incidental tasks as required to install each plant, complete in places as shown on the plans, as specified in the Standard Specifications and these Special Provisions, and as directed by the engineer.
- B. All work associated with Plants & Maintenance except for Soil Preparation and Fine Grading (Landscape Areas) is not included in this contract. Therefore, no additional compensation will be made for any work in this section other than Soil Preparation and Fine Grading (Landscape Areas).

**END OF SECTION 32 93 00**

## **SECTION 33 05 00**

### **COMMON WORK RESULTS FOR UTILITIES**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Piping joining materials.
  - 2. Sleeves.
  - 3. Grout.
  - 4. Piping system common requirements.
  - 5. Equipment installation common requirements.
  - 6. Concrete bases.

##### **1.2 DEFINITIONS**

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

#### **PART 2 - PRODUCTS**

##### **2.1 PIPING JOINING MATERIALS**

- A. Solvent Cements for Joining Plastic Piping:
  - 1. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
  - 2. PVC to ABS Piping Transition: ASTM D3138.

##### **2.2 SLEEVES**

- A. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

##### **2.3 GROUT**

- A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

### **PART 3 - EXECUTION**

#### **3.1 PIPING INSTALLATION**

- A. Install piping according to the following requirements and utilities Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
  1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.
  2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
    - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
- J. Verify final equipment locations for roughing-in.
- K. Refer to equipment specifications in other Sections for roughing-in requirements.

#### **3.2 PIPING JOINT CONSTRUCTION**

- A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.
  - 3. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
  - 4. PVC Nonpressure Piping: Join according to ASTM D2855.
  - 5. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138 Appendix.
- F. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- G. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.
- H. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
  - 1. Plain-End PE Pipe and Fittings: Use butt fusion.
  - 2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
- I. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### **3.3 PIPING CONNECTIONS**

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### **3.4 EQUIPMENT INSTALLATION**

- A. Install equipment level and plumb, unless otherwise indicated.

- B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
- C. Install equipment to allow right of way to piping systems installed at required slope.

### **3.5 CONCRETE BASES**

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

### **3.6 GROUTING**

- A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

## **PART 4 - MEASUREMENT AND PAYMENT**

- A. Full compensation for common work results for utilities shall be considered as included in the various items of related work and no separate payment will be made therefor.

**END OF SECTION 33 05 00**

**SECTION 33 41 00**

**STORM UTILITY DRAINAGE PIPING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Pipe and fittings.
  - 2. Sidewalk undrain pipe.
  - 3. Manholes.
  - 4. Cleanouts.
  - 5. Nonpressure transition couplings.
  - 6. Catch basins.
  - 7. Sidewalk underdrain covers.

**1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
  - 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
  - 2. Catch basins. Include plans, elevations, sections, details, frames, covers, and grates.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- B. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- C. Field quality-control reports.

**1.4 PROJECT CONDITIONS**

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
  - 1. Notify Engineer no fewer than two days in advance of proposed interruption of service.
  - 2. Do not proceed with interruption of service without Engineer's written permission.

## **PART 2 - PRODUCTS**

### **2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

### **2.2 PE PIPE AND FITTINGS**

- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
  - 1. Watertight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.

### **2.3 NONPRESSURE TRANSITION COUPLINGS**

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
  - 1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  - 2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded, Flexible Couplings:
  - 1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

### **2.4 CLEANOUTS**

- A. Cast-Iron Cleanouts:
  - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
  - 2. Top-Loading Classification(s): Medium Duty.
  - 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

### **2.5 MANHOLES**

- A. Standard Precast Concrete Manholes:

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1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM DRAIN."
2. Material: ASTM A 536, Grade 60-40-18 ductile or ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

## 2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

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1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
    - a. Invert Slope: 2 percent through manhole.
  2. Benches: Concrete, sloped to drain into channel.
    - a. Slope: 8 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
  2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

## **2.7 CATCH BASINS**

- A. Standard Precast Concrete Catch Basins:
1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
  3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
  4. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
  5. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
  6. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
  7. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.
  8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
1. Size: 24 by 24 inches minimum unless otherwise indicated.
  2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

## **2.8 SIDEWALK UNDERDRAIN COVER**

- A. Cover materials shall be galvanized steel as indicated.

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**2.9 PIPE OUTLETS**

- A. Cobble Stone: River rock, 4 inches average diameter.
- B. Energy Dissipaters: As indicated.

**PART 3 - EXECUTION**

**3.1 EARTHWORK**

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

**3.2 PIPING INSTALLATION**

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure drainage piping according to the following:
  - 1. Install piping pitched down in direction of flow.
  - 2. Install piping with 36-inch minimum cover unless concrete encased as indicated.
  - 3. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - 4. Install PE corrugated sewer piping according to ASTM D 2321.

**3.3 PIPE JOINT CONSTRUCTION**

- A. Join gravity-flow, nonpressure drainage piping according to the following:
  - 1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - 2. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
  - 3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

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**3.4 CLEANOUT INSTALLATION**

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
  - 1. Use Medium-Duty, top-loading classification cleanouts for all stormwater related areas.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 12 by 12 by 4 inches deep. Set with tops 2 inches above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

**3.5 MANHOLE INSTALLATION**

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

**3.6 CATCH BASIN INSTALLATION**

- A. Set frames and grates to elevations indicated.

**3.7 STORMWATER OUTLET INSTALLATION**

- A. Construct energy dissipaters at outlets, as indicated.

**3.8 CONCRETE PLACEMENT**

- A. Place cast-in-place concrete according to ACI 318.

**3.9 CONNECTIONS**

- A. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
  - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

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3. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- B. Pipe couplings and expansion joints with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - a. Shielded flexible couplings for same or minor difference OD pipes.

**3.10 SIDEWALK UNDERDRAIN COVER**

- A. Install as indicated.

**3.11 IDENTIFICATION**

- A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

**3.12 FIELD QUALITY CONTROL**

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate reports for each system inspection.
  2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
  2. Test completed piping systems according to requirements of authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  4. Submit separate report for each test.

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5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
  - a. Option: Test plastic piping according to ASTM F 1417.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit prices paid per LINEAR FOOT for 10" HDPE STORM DRAIN PIPE and for 3" x 12.5" CAST IRON SIDEWALK UNDERDRAIN PIPE shall include full compensation for furnishing all labor, supervision, materials, tools, equipment, and incidentals and for doing all the work involved in installing storm drain pipe, complete in place, including surface demolition, excavation, bedding, backfill, compaction and surface restoration, tracing wire and utility tape, quality control, as shown on the plans, as specified in these Technical Specifications, and as directed by the engineer.
- B. The Contract unit prices paid per EACH for STORM DRAIN INLET and for STORM DRAIN MANHOLE and for STORM DRAIN CLEANOUT shall include full compensation for furnishing all labor, supervision, materials, tools, equipment, and incidentals and for doing all the work involved in installing inlets and manholes, complete in place, including excavation, backfill and compaction, placing miscellaneous concrete and formwork, frame and grate and frame and cover, precast structure elements, pipe connections, structure seals, as shown on the plans, as specified in these Technical Specifications, and as directed by the engineer.
- C. The Contract lump sum price paid for SIDEWALK UNDERDRAIN COVER shall include full compensation for furnishing all labor, supervision, materials, tools, equipment, and incidentals and for doing all the work involved in installing the sidewalk underdrain cover, complete in place, including cover support frame and fasteners, as shown on the plans, as specified in these Technical Specifications, and as directed by the engineer.
- D. The Contract lump sum price paid for COBBLESTONE ENERGY DISSIPATER shall include full compensation for furnishing all labor, supervision, materials, tools, equipment, and incidentals and for doing all the work involved in installing the energy dissipater, complete in place, including concrete mortar base, as shown on the plans, as specified in these Technical Specifications, and as directed by the engineer.

**END OF SECTION 33 41 00**

**SECTION 33 46 00**

**SUBDRAINAGE**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Perforated-wall pipe and fittings.
  - 2. Geotextile filter fabrics.

**1.2 ACTION SUBMITTALS**

- A. Product Data: For geotextile filter fabrics.

**PART 2 - PRODUCTS**

**2.1 PERFORATED-WALL PIPES AND FITTINGS**

- A. Perforated PE Pipe and Fittings: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.

**2.2 SOIL MATERIALS**

- A. Soil materials are specified in Section 312000 "Earth Moving."

**2.3 GEOTEXTILE FILTER FABRICS**

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
  - 1. Survivability: AASHTO M 288 Class 2.
  - 2. Styles: Flat and sock.

**PART 3 - EXECUTION**

**3.1 EARTHWORK**

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

### **3.2 PIPING INSTALLATION**

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
  - 1. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install thermoplastic piping according to ASTM D2321.

### **3.3 PIPE JOINT CONSTRUCTION**

- A. Join perforated PE pipe and fittings with couplings according to ASTM D3212 with loose banded, coupled, or push-on joints.
- B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

### **3.4 CLEANOUT INSTALLATION**

- A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."
- B. Cleanouts for Subdrainage:
  - 1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
  - 2. In nonvehicular-traffic areas, use NPS 4 cast-iron pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches deep. Set top of cleanout 2 inches above grade.
  - 3. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

### **3.5 CONNECTIONS**

- A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

### **3.6 FIELD QUALITY CONTROL**

- A. Tests and Inspections:
  - 1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.

2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### **3.7 CLEANING**

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

### **PART 4 - MEASUREMENT AND PAYMENT**

- A. The Contract unit prices paid per LINEAR FOOT for 6" HDPE PIPE (SLOTTED PIPE) and for 8" HDPE PIPE (SLOTTED PIPE) shall include full compensation for furnishing all labor, supervision, materials, tools, equipment, and incidentals and for doing all the work involved in installing storm drain pipe, complete in place, including excavation, filter fabric, backfill, as shown on the plans, as specified in these Technical Specifications, and as directed by the engineer.

**END OF SECTION 33 46 00**