

CITY OF SAN ANTONIO  
HAYS ST BRIDGE CONNECTIONS &  
EASTSIDE AREA STREETS  
PROJECT NOS.  
23-04053-06 & 23-03900

**GOVERNING SPECIFICATIONS, SPECIAL PROVISIONS AND SPECIAL SPECIFICATIONS**

ALL SPECIFICATIONS, SPECIAL PROVISIONS AND SPECIFICATIONS APPLICABLE TO THIS PROJECT ARE IDENTIFIED AS FOLLOWS:

STANDARD SPECIFICATIONS:

- CITY OF SAN ANTONIO - JUNE 2008 OR LATEST REVISIONS AND ADDITIONS. STANDARD SPECIFICATIONS AND SPECIAL PROVISIONS ARE INCORPORATED INTO THE CONTRACT BY REFERENCE.
- TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION AND MAINTENANCE OF HIGHWAYS, STREETS, AND BRIDGES (NOVEMBER 1, 2014).
- SAN ANTONIO WATER SYSTEM CONSTRUCTION SPECIFICATIONS DATED FEBRUARY 2021 OR LATEST REVISIONS.

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**ROADWAY**

**CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION**

ITEM	100	MOBILIZATION
ITEM	101	PREPARING RIGHT-OF-WAY
ITEM	104	STREET EXCAVATION
ITEM	108	LIME TREATED SUBGRADE
ITEM	109	CEMENT TREATED SUBGRADE
ITEM	202	PRIME COAT
ITEM	203	TACK COAT
ITEM	205	HOT MIX ASPHALTIC CONCRETE PAVEMENT
ITEM	208	SALVAGING, HAULING & STOCKPILING RECLAIMABLE ASPHALTIC PAVEMENT
ITEM	500	CONCRETE CURB, GUTTER, AND CONCRETE CURB AND GUTTER
ITEM	502	CONCRETE SIDEWALKS
ITEM	503	ASPHALTIC CONCRETE, PORTLAND CEMENT CONCRETE, AND GRAVEL DRIVEWAYS
ITEM	505	CONCRETE RIPRAP
ITEM	506	CONCRETE RETAINING WALL – COMBINATION TYPE
ITEM	507	CHAIN LINK WIRE FENCE
ITEM	515	TOPSOIL
ITEM	516	BERMUDA SODDING
ITEM	524	CONCRETE STEPS

**REMOVALS**

CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM 103 REMOVE CONCRETE

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**DRAINAGE**

CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM 401 REINFORCED CONCRETE PIPE  
ITEM 403 STORM SEWER JUNCTION BOXES AND INLETS  
ITEM 407 CONCRETE ENCASEMENT, CRADLES, SADDLES AND COLLARS

TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM 400 EXCAVATION AND BACKFILL FOR STRUCTURES  
ITEM 465 JUNCTION BOXES, MAHOLES, AND INLETS

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**SW3P**

CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM 515 TOPSOIL  
ITEM 516 SODDING  
ITEM 540 TEMPORARY EROSION, SEDIMENTATION AND WATER POLLUTION  
PREVENTION AND CONTROL

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**PEDESTRIAN ILLUMINATION**

CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM 618 CONDUIT  
ITEM 620 ELECTRICAL CONDUCTORS  
ITEM 622 DUCT CABLE  
ITEM 624 GROUND BOXES  
ITEM 628 ELECTRICAL SERVICES

TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM 416 DRILLED SHAFT FOUNDATIONS

TEXAS DEPARTMENT OF TRANSPORTATION SPECIAL SPECIFICATIONS FOR CONSTRUCTION

ITEM 6207 LED AESTHETIC ROADWAY ILLUMINATION  
ASSEMBLY  
ITEM 6238 DECORATIVE BRIDGE COLUMN LIGHTING  
ITEM 6239 LED DECORATIVE ILLUMINATION ASSEMBLY

SPECIAL SPECIFICATIONS FOR CONSTRUCTION

ITEM 600 6999 SURGE PROTECTIVE DEVICE

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**SIGNING AND PAVEMENT MARKINGS**

**SPECIAL SPECIFICATIONS FOR CONSTRUCTION**

ITEM 05-50-00 WAYFINDING SIGNAGE

**CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION**

ITEM 531 SIGNS

ITEM 535 HOT APPLIED THERMOSPLASTIC PAVEMENT MARKINGS

ITEM 537 RAISED PAVEMENT MARKERS

**CITY OF SAN ANTONIO STANDARD SPECIAL SPECIFICATIONS FOR CONSTRUCTION**

ITEM 536 PREFORMED PAVEMENT MARKINGS

**TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION**

ITEM 668 PREFABRICATED PAVEMENT MARKINGS

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**LANDSCAPE**

**SPECIAL SPECIFICATIONS FOR CONSTRUCTION**

ITEM 03-30-00 CAST-IN-PLACE CONCRETE

ITEM 32-14-43 PERMEABLE PAVERS

ITEM 32-33-00 MUTT MITT

ITEM 32-33-23 WASTE RECEPTACLE

ITEM 32-33-43 METAL BENCH

ITEM 32-39-13 BOLLARDS

**TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION**

ITE 528 COLORED TEXTURED CONCRETE AND LANDSCAPE  
PAVERS

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**IRRIGATION**

**SPECIAL SPECIFICATIONS FOR CONSTRUCTION**

ITEM 3284000 IRRIGATION

ITEM 32-94-51 SILVA CELLS

ITEM 329600 TRANSPLANTING

**TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION**

ITEM 192 LANDSCAPE PLANTING

**TEXAS DEPARTMENT OF TRANSPORTATION SPECIAL SPECIFICATIONS FOR CONSTRUCTION**

ITEM 5096 TREE GRATE

**SAWS**

**SEWER**

CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM	100	MOBILIZATION
ITEM	101	PREPARING RIGHT-OF-WAY
ITEM	203	TACK COAT
ITEM	205	HOT MIX ASPHALTIC CONCRETE PAVEMENT

SAWS STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM	550	TRENCH EXCAVATION SAFETY PROTECTION
ITEM	815	HDPE PIPE INSTALLATION DIRECT BURY FOR WATER
ITEM	822	CUSTOMER'S WATER YARD PIPE
ITEM	824	SERVICE SUPPLY LINES (WATER)
ITEM	826	EXISTING VALVE BOX ADJUSTMENTS
ITEM	828	GATE VALVES
ITEM	832	TAPPING SLEEVES AND VALVES
ITEM	833	METER AND METER BOX INSTALLATION
ITEM	834	FIRE HYDRANTS
ITEM	851	ADJUST EXISTING MANHOLES
ITEM	852	SANITARY SEWER MANHOLES
ITEM	854	SANITARY SEWER LATERALS
ITEM	855	RECONSTRUCTION OF EXISTING MANHOLES
ITEM	865	BYPASS PUMPING SMALL DIAMETER SANITARY SEWER MAINS
ITEM	866	SANITARY SEWER MAIN TELEVISION INSPECTION
ITEM	900	RECONSTRUCITON OF SANITARY SEWER BY PIPE BURSTING CRUSH
ITEM	1109	SANITARY SEWER LATERAL AND RECONNECTIONS
ITEM	3000	HANDLING ASBESTOS CEMENT PIPE

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**SAWS****WATER**CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION

ITEM	100	MOBILIZATION
ITEM	101	PREPARING RIGHT-OF-WAY
ITEM	205	HOT MIX ASPHALTIC CONCRETE PAVEMENT
ITEM	500	CONCRETE CURB, GUTTER, AND CONCRETE CURB AND GUTTER
ITEM	502	CONCRETE SIDEWALKS

SAWS STANDARDS SPECIFICATIONS FOR CONSTRUCTION

ITEM	299	FLOWABLE FILL
ITEM	550	TRENCH EXCAVATION SAFETY PROTECTION
ITEM	815	HDPE PIPE INSTALLATION DIRECT BURY FOR WATER
ITEM	824	SERVICE SUPPLY LINES (WATER)
ITEM	826	EXISTING VALVE BOX ADJUSTMENTS
ITEM	828	GATE VALVES
ITEM	833	METER AND METER BOX INSTALLATION
ITEM	834	FIRE HYDRANTS
ITEM	836	GREY IRON AND DUCTILE IRON FITTINGS
ITEM	840	WATER TIE-INS
ITEM	841	WATER AND RECLAIMED WATER MAINS HYDROSTATIC TESTING OPERATIONS
ITEM	844	TEMPORARY AND PERMANENT BLOW OFF ASSEMBLIES
ITEM	848	SANITARY SEWER
ITEM	851	EXISTING MANHOLE ADJUSTMENT
ITEM	852	SANITARY SEWER MANHOLES
ITEM	854	SANITARY SEWER LATERALS
ITEM	855	RECONSTRUCTION OF EXISTING MANHOLES
ITEM	856	PIPE JACKING
ITEM	858	CONCRETE ENCASEMENT, CRADLES, AND COLLARS
ITEM	866	SANITARY SEWER MAIN TELEVISION INSPECTION
ITEM	1109	SANITARY SEWER LATERALS AND RECONNECTIONS
ITEM	1020	WATER MAIN BREAK, LEAK REPAIRS

**CPS UNDERGROUND ELECTRIC**SPECIAL PROVISIONS FOR CONSTRUCTION

ITEM	SUP 1	UNDERGROUND DUCTBANK
ITEM	SUP 2	UNDERGROUND DUCTBANK MANHOLE
ITEM	SUP 3	UTILITY POLE BRACING
ITEM	SUP 4	UNDERGROUND DUCTBANK MANHOLE BLOCKOUTS
ITEM	SUP 5	UNDERGROUND ELECTRIC SERVICE CONDUIT RUNS
ITEM	SUP 6	UNDERGROUND ELECTRIC PULL BOXES
ITEM	SUP 7	RESIDENTIAL ELECTRIC METERS AND CONNECTIONS
ITEM	SUP 8	COMMERCIAL ELECTRIC METERS AND CONNECTIONS
ITEM	SUP 9	MAVERICK PARK – TRNSFORMERS & SWITCHGEAR

**2022 COSA Bond – Hays St. Bridge Connection &  
East Side Streets  
Construction Contract Special  
Specifications - Illumination**

## Table of Contents

16001	Basic Requirements for Electrical
16050.01	Exterior Solid State Lighting
600 699	Surge Protective Devices (SPDs) for Low Voltage Electrical Power Circuits

## SECTION 16001 - BASIC REQUIREMENTS FOR ELECTRICAL

### 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.
- B. Drawings and Specifications
  - 1. Division 16 specifications are written in imperative and streamlined format. This imperative language is directed to the Contractor. The word "shall be" shall be included by inference where a colon (:) is used within sentences and phrases.
- C. Codes, Permits and Standards
  - 1. Comply with the most recently revised versions of applicable laws, rules, regulations, and ordinances of federal, state, and local utilities and authorities.
  - 2. Obtain all applicable permits, licenses and inspections and pay all fees charged by above authorities.
  - 3. Work shall comply with the local city codes and ordinances, the regulations of state authorities having lawful jurisdiction and the codes, statues and reference standards identified within these Specifications. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule.
  - 4. Where alterations to and deviations from the Contract Documents are required to comply with interpretations of a Code Authority Having Jurisdiction (AHJ), report the requirements and secure approval before starting work. Contractor shall review any requested modifications with the Engineer and secure his approval before proceeding.
  - 5. Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern.

#### 1.2 DEFINITIONS & ABBREVIATIONS

- A. Definitions
  - 1. Contract Documents - Drawings and the project manual, including Specifications.
  - 2. Install: to set in place in position for service.
  - 3. Furnish: to supply.
  - 4. Provide: to install and furnish.
  - 5. City - When used in an otherwise non-specific reference anywhere in the Contract documents, City is defined to refer to the local municipal authority governing the project address or the City who's ETJ includes the project address.

## B. Abbreviations

1. ANSI American National Standards Institute.
2. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers
3. EIA Electronic Industry Association.
4. ETL Electrical Testing Laboratory.
5. ETJ Extra-Territorial Jurisdiction
6. FM Factory Mutual
7. IEEE Institute of Electrical and Electronics Engineers
8. IES Illuminating Engineering Society of North America
9. LPI Lightning Protection Institute.
10. NFPA National Fire Protection Association
11. NEC National Electric Code (NFPA-70)
12. NESC National Electric Safety Code
13. NECA National Electrical Contractor's Association
14. NEMA National Electrical Manufacturers Association
15. NETA InterNational Electrical Testing Association
16. NRTL Nationally Recognized Testing Laboratory
17. OSHA Occupational Safety Health Administration (US Department of Labor)
18. UL Underwriters Laboratories

## 1.3 SUMMARY ORGANIZATION

### A. PART 1 of This Section Includes:

1. Electrical Utilities and Service
2. Electrical equipment coordination and installation.
3. Submittal requirements.

### B. PART 2 of This Section Includes:

1. Substitution requirements.

### C. PART 3 of This Section Includes:

1. Common Requirements for Electrical Installation
2. Quality Assurance requirements.

## 1.4 ELECTRIC UTILITIES AND SERVICE

### A. Utilities: The Contract Documents reflect the general location and routing of utilities required for this project. Visit the site, and coordinate and confirm the exact requirements for electrical services. Refer to Division 01. [Electrical and utilities and service entrance equipment exist at the site and shall remain as installed].

1. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

- a. Notify the Owner's representative no fewer than (fourteen) (14) days in advance of proposed interruption of electric service.
  - b. Indicate method of providing temporary electric service.
  - c. Do not proceed with interruption of electric service without the Owner's representative's written permission.]
2. Temporary Services:
- a. Provide temporary electrical service and electric power distribution and temporary lighting throughout the construction site. Install and maintain in accordance with National Electrical Code and OSHA requirements. Make arrangements with the serving utility for point of service for temporary electric service and pay costs for delivery to and use at the site.
  - b. Existing electrical distributions systems at the site may be utilized for temporary construction power. Submit to the Owner in writing, documents identifying the locations and anticipated maximum demand at which power will be utilized, and obtain the Owner's approval, in writing, prior to connection and utilization.

## 1.5 ELECTRICAL EQUIPMENT COORDINATION AND INSTALLATION

- A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various conduit and raceway systems and equipment items and the sizes of the major interconnecting distribution, without showing exact details as to elevations, offsets, control lines, and installation details. All major feeders 1-1/2" diameter and over shall be shown on site and floor plans.
- 1. Arrange electrical work in a neat, plumb and straight well organized and workmanlike manner with services running parallel with primary lines of the roadway construction.
  - 2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.
- B. Pre-installation planning: Coordinate arrangement, mounting, and support of electrical equipment as follows:
- 1. The equipment shall be arranged to facilitate service, maintenance, and repair or replacement of components and equipment.
  - 2. Coordination submittal requirements

- a. Provide layouts, scaled to match plans for all areas or spaces containing electrical distribution equipment and light pole locations coordinated with civil work and field conditions. These shall be provided with the associated electrical distribution equipment submittals.

## 1.6 DRAWINGS AND SPECIFICATIONS

- A. General: The Drawings are schematic in nature and indicate approximate locations of the electrical systems, equipment, fixtures and devices, except where specific locations are noted and dimensioned on the Drawings. All items are shown to approximate scale with intent to depict how these items shall be integrated into the building. Locate all items by field measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.
- B. Location: Prior to locating electrical devices, light pole fixtures, and other items, obtain the Engineer's approval as to exact location. Locations shall not be determined by scaling Drawings. Where there is a question concerning the required location for items of electrical work, the Contractor shall submit a request for information to the Engineer requesting specific directions for locating the item. Contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.
  - 1. The Drawings show diagrammatic locations of the various outlets and apparatus. Exact locations of devices shall be determined by reference to the Landscape Architectural Drawings and to all detail Drawings, equipment Drawings, rough-in Drawings, etc., by measurements in the field, and in cooperation with the other trades. The Owner and Landscape Architect/Engineer reserve the right to make any reasonable change in location of any light pole or apparatus before installation, without additional cost to the Owner.
- C. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specifications are competent to fully explain, may not be mentioned on the Drawings.
- D. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made to the Engineer.

## 1.7 DISCREPANCIES

- A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof.
- B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or Specifications, then the Contractor shall submit a request for information to the Engineer for such further Drawings or explanations as may be necessary before proceeding, allowing a reasonable time for the Engineer to respond. The Contractor

shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.

- C. Interpretations: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. Undocumented statements will not be accepted as an excuse for inferior work.
- D. Contractor Agreement: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required for completion of the project.

## 1.8 SUBMITTAL REQUIREMENTS

- A. Provide all electrical shop drawing submittals at the same time.
- B. Submittals shall be provided in binders and arranged in sequence by Specification section number. Provide submittals only for specification sections that list this requirement.
  - 1. Provide tabs for each section, labeled to match the associated specification. The page after each tab section shall contain a typed list of any exceptions that the Contractor is proposing.
  - 2. Each page of the submittal shall be a clear copy or scan, indicating items and options proposed for use in the project with a graphical arrow. Items included on a submittal page that are not proposed for use shall be deleted with strike-through or other acceptable method that clearly distinguishes the proposed from non-relevant information.
- C. Subject to the requirements in Division 1, at the Contractor's option, submittals may be provided in PDF form.
  - 1. All format and informational requirements for submittals in binders apply to PDF submittals.
  - 2. Multiple files may be submitted; however, these must be organized into a consistent format.
  - 3. PDF submittal shall include a table of contents with page numbers listed for the beginning of each section.
  - 4. Additionally, the PDF shall be formatted to include tab or chapter shortcuts, labeled with the associated specification section. These shortcuts shall allow the reader to jump to a tab or chapter associated with beginning of each specification section with a single action.
  - 5. At the engineer's request, the contractor shall submit hard copy version in accordance with requirements outlined above.
- D. Provide closeout submittals for all products used. Refer to related specification section for additional requirements.
  - 1. Provide maintenance and warranty information with contact information for parts and service of equipment.

## PART 2 - PRODUCTS

### 2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

- A. Materials and equipment shall be new, of best grade and quality, and meet all requirements of the Contract Documents. Materials and equipment shall conform to National Electrical Code requirements and shall be listed by Underwriters Laboratories, Inc. (UL). UL listing will be accepted as evidence that the material or equipment conform to the standards of that agency. In lieu of this listing, submit a statement from a nationally recognized testing agency, indicating that products have been tested in accordance with UL criteria and that the materials and equipment comply with Contract requirements.
- B. Materials and equipment shall be standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications. Custom fabricated items shall be fully described using Drawings and technical data sufficient to demonstrate compliance with the Contract Documents.

### 2.2 SUBSTITUTIONS

- A. Basis of Design - For products specified in part 2.1 of the associated specification section, as "Basis of Design", that term is herein defined as the standard level of product that is required for the project.
  - 1. The use of term Basis of Design in these specifications is intended to allow the Contractor to propose use of non-specified manufacturer's products, provided that the proposed substitute is of equal or greater construction material, workmanship, quality, performance, and manufacturer support. If the product's proposed location is not concealed, aesthetic considerations are also considered as a significant factor.
  - 2. During the bid process, the Engineer will not evaluate products and provide approval prior to the bid date on proposed substitute products. If the Contractor wishes to propose substitutions, the Engineer will evaluate the successful Contractor's proposed alternates during the submittal review process. The Engineer will take no exception to the use of individual products determined to be equal. That decision may be the result of consultation and input from other members of the design team. If a product is not determined to be equal, it will be rejected and another product that is equal to the basis of design shall be re-submitted by the Contractor. The Engineer will not evaluate more than two substitution attempts before the Contractor is required to submit the specified product.
  - 3. If the Contractor proposes product substitutions that may not be equal to the specified product, and cost savings are associated with the use of the proposed substitute, then the Contractor should propose these as part of a VE (Value Engineering) process, with line item cost savings identified for each product substitution proposed. With information on line item costs, the design team may determine if the proposed substitutes, though not equal, represent a better value and these *may* be recommended for use.

- B. Substitutions are generally not allowed for products specified in the associated specification section when listed as "Provide products by one of the following". If there is a concern about delivery schedules from the manufacturers listed or other factors, these special case substitutions will be considered individually during the submittal phase.
  - 1. Substations will not be allowed for the pedestrian light poles and specified meter cabinets.

## PART 3 - EXECUTION

### 3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Workmanship: Work shall be executed, and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent, state licensed workmen, presenting a neat appearance when completed, straight and plumb.
- B. Manufacturer's Recommendations: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

### 3.2 SPACE REQUIREMENTS

- A. General: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate code clearances for adjustments, repair, or replacement and comply with code.
- B. Clearance: Allow adequate space for clearance in accordance with requirements of the Code and local inspection department.
- C. Scheduled Equipment: The design shown on the Drawings is based on the equipment scheduled.
- D. Responsibility: Space requirements and equipment arrangement may vary for each manufacturer, the responsibility for ensuring initial access and suitability rests with the Contractor.
- E. Review: Final arrangements of equipment to be installed shall be subject to the Architect's review.

### 3.3 SAFETY REGULATIONS

- A. All electrical work, including work associated with temporary power, shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the electrical work shall be provided by and operated by the Electrical contractor.

### 3.4 DELIVERY, STORAGE AND HANDLING OF MATERIALS

- A. General: Protect all materials and equipment to be installed under this Division from physical and weather damage.
- B. Scope: Work under this Division shall include, but not limited to:
  - 1. Shipping from point of manufacture to job site.
  - 2. Unloading, moving, and storage on site with proper safeguards as required to properly protect equipment from corrosion, drip, humidity, dust, and physical damage.
  - 3. Hoisting and scaffolding of materials and equipment included in this Division.
  - 4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.

### 3.5 ELECTRIC WIRING OF MOTORS AND EQUIPMENT

- A. The work of Division 16 includes:
  - 1. Installation and underground power conduit, in-grade boxes and wiring of light poles and power connections to irrigation controllers.
  - 2. Installation of CPS Energy meter cabinets and associated conduit and wiring as specified in drawings.
  - 3. Power and control wiring, of any voltage, of systems specified in Division 16.

### 3.6 QUALITY ASSURANCE TESTING

- A. Description of Work
  - 1. General: Provide testing of electrical work installed under Divisions 16, as specified herein. Feeders and equipment shall not be placed in service until they have been checked out and tested, as applicable.
- B. Personnel
  - 1. Personnel: Submit evidence to show that the personnel who will actually test the systems are qualified and state certified.
  - 2. The Engineer/Owner reserves the right to require that the originally approved personnel be replaced with other qualified personnel if, in his opinion, the original personnel are not qualified or are not properly conducting the system testing.
- C. Submittals
  - 1. Testing Procedures: Submit four copies of all proposed testing procedures to the Engineer for review at least 30 days prior to conducting any testing.
  - 2. Reporting Forms: Submit four copies of proposed forms to be used in recording testing data and results to the Engineer for review at least 30 days prior to conducting any testing on the project.
  - 3. Test Data and Results: Submit four copies of complete data and certified test results for each test performed, including, but not limited to:
    - a. Test performed.
    - b. Test procedure.

- c. System and area tested.
  - d. Date(s) and time(s) of test.
  - e. Weather conditions.
  - f. Test criteria.
  - g. Test results.
  - h. Additional pertinent information.
4. Operational Certification: Submit four certified copies of an operational certification which documents that all equipment and systems have been fully tested to verify proper operation in accordance with the design shown in the Construction Documents and manufacturer's recommendations.
  5. Certification: Certifications stating that submitted test data and results are true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.
  6. Calibration List: Submit four copies of a listing of testing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly and currently calibrated.
  7. Prepare test and inspection reports, including a certified report that identifies electrical distribution equipment included and that describes scan results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
  8. Test Log: The Contractor shall maintain a test log at the site to document the results of all successful and unsuccessful testing as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer and Owner's Representative prior to the Substantial Completion inspection. A space shall be provided on the test log for signoff by the Owner's Representative.

D. Notice

1. General: Notify the Engineer and the Owner's Representative in writing two weeks prior all scheduled testing to allow time for scheduling witness of testing, where elected by the Engineer and Owner's Representative.

E. Materials

1. General: Provide all materials and test equipment required for testing of specified electrical systems, including retesting until acceptable test results are obtained.

F. Preparation

1. Perform visual mechanical inspection and electrical tests for field connections  
Test insulation resistance for each electrical distribution equipment bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

G. Testing

1. General: Tests shall be made during the course of construction as specified and as required by authorities having jurisdiction. Such tests shall be conducted by

this Division as a part of the Work and shall include all personnel, material, and equipment required to perform tests until satisfactory results are obtained. Any defects detected during testing shall be satisfactorily repaired or the equipment involved shall be replaced and the tests re-executed.

2. Tests: Refer to the Table below for inspection and testing requirements associated with listed product specification sections:

Title	Inspect connections	Torque connections	Test Continuity	Insulation resistance	Thermographic scan	Voltage to Gnd @ at termi-	Notes
<b>LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES</b>	○		○	○			
<b>GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS</b>	○	○	○			○	
<b>PANELBOARDS</b>	○	○	○	○	○		

NOTES:

- a. Refer to individual specification section for additional testing requirement.

H. Thermographic Testing:

1. Provide a thermographic scan to measure equipment temperature and detect significant deviations from normal values.
2. Conduct a thermographic test of the main switchboards/switchgear, unit substations distribution panels, panelboards, automatic transfer switches, busway joints, motor control centers and other electrical distribution apparatus and connections using an infrared temperature scanning unit. The test shall be performed by an independent testing laboratory. Connections that are indicating higher temperature levels than acceptable shall be tightened, lugs replaced and/or OCPD replaced as required to eliminate the condition. Conduct test, using test reporting forms, between 6 and 8 months after beneficial occupancy, but in no case beyond the warranty period. Correct unacceptable conditions prior to end of the warranty period.
3. Prepare test and inspection reports, including a certified report that identifies electrical distribution equipment included with description of scan results. Provide calibration record for device. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

I. RESULTS AND DEFICIENCY CORRECTIONS:

1. Correct malfunctions on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
2. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Any resultant delay as a result of such necessary retest, does not relieve the Contractor of his responsibility under this contract.
4. Equipment will be considered defective if it does not pass tests and inspections. Tested products which fail to provide acceptable test results shall be repaired or replaced with suitable materials as required to obtain acceptable test results.

3.7 CONTRACTOR WARRANTIES AND GUARANTEES

- A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material for a period of 24 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.
- B. Equipment: All equipment bearing a manufacturer's guarantee in excess of the time requirement above, such as electrical equipment, devices, components, and similar items, shall be considered to have that guarantee extended directly to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be corrected by the Contractor in accordance with the manufacturer's guarantee.
- C. Start-up: The Electrical Contractor shall provide instructions and equipment starting service on new equipment for two complete years after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

END OF SECTION 160001

## SECTION 16050.01 - EXTERIOR SOLID STATE LIGHTING

### 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 DESCRIPTION OF WORK

- A. Section Includes:
  - 1. Exterior luminaires with LED lamps, and drivers.
  - 2. Poles and accessories.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. HID: High-intensity discharge.
- D. LED: Light Emitting Diode.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. Pole: Luminaire support structure, including tower used for large area illumination.
- H. Standard: Same definition as "Pole" above.

#### 1.4 REFERENCES

- A. ANSI/NFPA 70, National Electrical Code
- B. IEEE C62.41, Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
- C. FCC 47 CFR Part 15, Federal Code of Regulation (CFR) testing standard for electronic equipment
- D. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products
- E. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources

- F. IESNA TM-15, Luminaire Classification System for Outdoor Luminaires
- G. IESNA TM-21-11, Projecting Long Term Lumen Maintenance of LED Light Sources
- H. UL1598, Standard for Safety of Luminaires
- I. NEMA SSL 3-2010, High-Power White LED Binning for General Illumination
- J. TxDOT Construction Standards

#### 1.5 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
- D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
  - 1. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph.
    - a. Wind Importance Factor: 1.0
    - b. Minimum Design Life: 25 years
    - c. Velocity Conversion Factors: 1.0

#### 1.6 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - 2. Details of attaching luminaires and accessories.
  - 3. Details of installation and construction.
  - 4. Luminaire materials.
  - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    - b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  - 6. Photoelectric relays.
  - 7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.

8. Materials, dimensions, and finishes of poles.
9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
10. Anchor bolts for poles.
11. Manufactured pole foundations.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
4. Wiring Diagrams: For power, signal, and control wiring.

#### 1.7 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

#### 1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles, operation, and maintenance manuals.

#### 1.9 QUALITY ASSURANCE

A. 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.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

A. Package poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

#### 1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that

fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
  2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
  3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
  4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.
- B. Contractor Support Warranty: Contractor shall provide field replacement of failed fixtures. This includes all costs for labor, equipment, and miscellaneous items necessary to restore operation of the equipment. This warranty requirement shall be provided within the terms of this Contract regardless of the mode or cause of fixture failure.
1. The Contractor is responsible to provide support and coordination for determining cause of failure and report findings to the Owner, [Architect], and Engineer of Record.
  2. If fixture failure or nonoperation is caused by mis-installation, the Contractor shall provide remedial work to bring the installation into compliance with manufacturer's installation and Contractual requirements.
  3. If fixtures have failed and subsequently warranted by the manufacturer, then the Contractor shall install replacement equipment provided by the manufacturer.
  4. If fixtures have failed and are not warranted by the manufacturer for any reason other than mis-installation, then maintenance materials specified hereinabove shall be used as replacement equipment as necessary.
  5. Warranty Period for Contractor Support: One year from date of Substantial Completion or through duration of the manufacturer's warranty, whichever is longer.
  6. Timeliness: Contractor shall provide warranty support in a timely manner and provide the Owner with scheduled dates for remedial action necessary to restore operation.

## PART 2 PRODUCTS

### 2.1 LED LUMINAIRES

- A. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- B. Material and specifications for each luminaire are as follows:
  1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).

2. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 (wet location) for luminaires, or an approved equivalent standard from a nationally recognized testing laboratory.
3. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
4. L70 lamp life of 50,000 hours.
5. The rated operating temperature range shall be -40°C (-40°F) to +40°C (104°F).
6. Each luminaire is capable of operating above 104°F (40°C), but not expected to comply with photometric requirements at elevated temperatures.
7. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.
8. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average nighttime temperature.
9. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
10. Luminaire shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
11. Source Limitations: For luminaires, obtain each luminaire type designation from single source with resources to provide products of consistent quality in appearance and physical properties.

#### C. Technical Requirements

##### 1. Electrical

- a. Luminaire shall have a minimum efficacy of the scheduled fixture (basis of design). The luminaire shall not consume power in the off state.
- b. Operation Voltage: The luminaire shall operate from a 60 HZ  $\pm$ 3 HZ AC line over a voltage ranging from 108 VAC to 305 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
- c. Power Factor: The luminaire shall have a power factor of 0.90 or greater.
- d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
- e. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
- f. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
- g. Drivers shall be an IP66 rated UL class 2 power unit as per UL 1310 with a Class A sound rating and comply with FCC rules and regulations as per Title 47 CFR part 15.

##### 2. Thermal Management

- a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
- b. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
- c. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
- d. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

- e. The heat sink material shall be aluminum.
3. Physical and Mechanical Requirements
    - a. The housing shall meet the requirements for NEMA/UL wet location, be UL listed, IP66 rated.
    - b. The assembly and manufacturing process for the LED luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration. Luminaire vibration rating shall be 3G minimum.
    - c. The electronics/power supply enclosure shall meet the requirements for NEMA/UL wet location.
  4. Materials
    - a. Housing and door frame shall be aluminum with a nominal 2.5 mil thick paint finish able to withstand a 3000-hour salt spray test as specified in ASTM Designation: B117.
    - b. Each refractor or lens shall be made from UV inhibited high impact optical grade acrylic and be resistant to scratching.

## 2.2 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
  1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  1. Materials: Shall not cause galvanic action at contact points.
  2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
  3. Anchor-Bolt Template: steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange.
- E. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

## PART 3 -EXECUTION

### 3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.

- B. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

### 3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
  - 1. Fire Hydrants: 60 inches.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
  - 2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
  - 3. Install base covers unless otherwise indicated.
  - 4. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

### 3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

### 3.4 GROUNDING

- A. Ground metal poles and support structures.
  - 1. Install grounding electrode for each pole unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

### 3.5 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

### 3.6 MEASUREMENT

- A. This item will be measured by each installed complete pedestrian lighting pole assembly.

### 3.7 PAYMENT

- A. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the complete installation of the Pedestrian pole light assembly.
  - 1. Installation. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the pedestrian pole light assemblies; foundations; furnishing and placing anchor bolts, grounding rods, nuts, washers, and templates; installing and connection of internal wiring, light fixture heads and LED Lenses; GFCI receptacle and equipment, materials, labor, tools, and incidentals.
  - 2. Decorative Bridge Lighting with DMX system installation. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the complete color changing LED lighting system with all the lighting luminaire devices and DMX control system; foundations; furnishing and placing anchor bolts, grounding rods, nuts, washers, and templates; installing and connection of internal wiring, light fixture heads and LED Lenses; and equipment, materials, labor, tools, and incidentals.

### 3.8 BID ITEM

- A. 6207 - Aesthetic Pedestrian Light Pole complete pole assembly - each.
- B. 6238 – Decorative Bridge Lighting with DMX System – Complete installation.
- C. 6239 – Under bridge Lighting (Replacement) - each.

END OF SECTION 16050.01

## SECTION 600 6999 - SURGE PROTECTIVE DEVICES (SPDs) FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all AC electrical circuits.

#### 1.2 RELATED DOCUMENTS

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

#### 1.3 SUBMITTALS

- A. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.
- B. Submittals shall include UL 1449 3<sup>rd</sup> Edition Listing documentation verifiable by visiting [www.UL.com](http://www.UL.com), clicking "Certifications" link, searching using UL Category Code: VZCA and VZCA2:
  - 1. Short Circuit Current Rating (SCCR)
  - 2. Voltage Protection Ratings (VPRs) for all modes
  - 3. Maximum Continuous Operating Voltage rating (MCOV)
  - 4. I-nominal rating (I-n)
  - 5. SPD shall be UL listed and labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications
- C. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.
- D. Minimum of ten (10) year warranty.
- E. Product Certificates: For SPD devices, from manufacturer.
- F. Field quality-control reports.
- G. Warranties: Sample of special warranties.

#### 1.4 RELATED STANDARDS

- A. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,

- B. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,
- C. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
- D. National Electrical Code: Article 285, 700, and 708
- E. UL 1283 - Electromagnetic Interference Filters
- F. UL 1449, Third Edition, effective September 29, 2009 – Surge Protective Devices

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm with at least 5 years experience in manufacturing transient voltage surge suppressors.
- B. Manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.

#### 1.7 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. Replaceable Protection Modules: One of each size and type installed.

#### 1.8 DELIVERY, STORAGE AND HANDLING

- A. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

#### 1.9 PROJECT CONDITIONS

- A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

#### 1.10 COORDINATION

- A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Provide an internally mounted Surge Protective Devices (SPD), formally called Transient Voltage Suppressor (TVSS) by:
  1. Transector
  2. Eaton
  3. GE
  4. Schneider Electric
  5. Siemens Industry

#### 2.2 ELECTRICAL DISTRIBUTION EQUIPMENT

- A. Service Entrance

SPD shall be UL 1449 labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

SPD shall be externally mounted to electrical distribution equipment. Refer to drawings for additional information.

1. SPD shall be UL labeled with 20kA I-nominal (I-n) (verifiable at UL.com) as recommended for UL 96A Lightning Protection Master Labeling and NFPA 780.
2. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
3. Standard 7-Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
4. SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
5. SPD shall meet or exceed the following criteria:
  - a. Maximum surge current capability shall be 200kA per phase.

- b. UL 1449 - Third Edition Revision; effective September 29, 2009 Voltage Protection Ratings shall not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>	<u>MCOV</u>
120/240V	700V	700V	700V	1200V	150V

6. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

<u>System Voltage</u>	<u>Allowable System Voltage Fluctuation (%)</u>	<u>MCOV</u>
120/240V	25%	150V

7. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.
8. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
9. SPD shall include a serviceable, replaceable module.
10. Integral disconnect switch.
11. SPD shall be equipped with the following diagnostics:
- Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
  - Audible alarm with on/off silence function and diagnostic test function (excluding branch).
  - Form C dry contacts
  - Optional – Surge Counter
- No other test equipment shall be required for SPD monitoring or testing before or after installation.
12. SPD shall have a response time no greater than 1/2 nanosecond.
13. SPD shall have a 10 year warranty.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.
- Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
  - Provide, multi-pole circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

### 3.2 STARTUP SERVICE

- A. Do not energize or connect service entrance equipment or panelboards to their sources until SPD devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect equipment installation, including connections and to assist in field testing. Report results in writing.
  - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Perform the following field tests and inspections and prepare test reports:
  - 1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
  - 2. Complete startup checks according to manufacturer's written instructions.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.4 ADJUSTMENTS AND CLEANING

- A. Remove debris from installation site and wipe dust and dirt from all components.
- B. Repaint marred and scratched surfaces with touch up paint to match original finish.

### 3.5 TESTING

- A. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacturer's recommendations.
- B. Check all installed panels for proper grounding, fastening and alignment.

### 3.6 WARRANTY

- A. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain SPD devices. Refer to Division 01 Section "Project Closeout".

3.8 MEASUREMENT

- A. This item will be measured by each installed Surge Protection Device.

3.9 PAYMENT

- A. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the complete installation of the Surge Protection Device.
- B. Installation. This price is full compensation for furnishing, installing Surge Protection Device and equipment, materials, labor, tools, and incidentals.

3.10 BID ITEM

- A. 600 6999 Surge Protection Device

END OF SECTION 600 6999

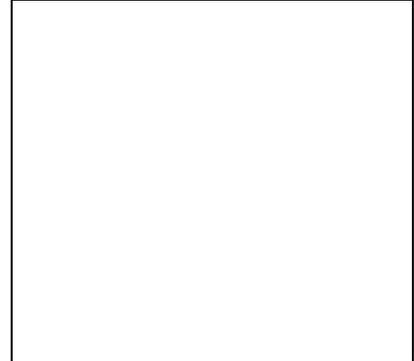
**2022 COSA Bond – Hays St. Bridge Connection &  
East Side Streets  
Construction Contract Special  
Specifications - Landscape**

DOCUMENT 000107 - PROFESSIONAL SEALS PAGE – LANDSCAPE ARCHITECT

The specification sections listed below were prepared by or under the direct supervision of the Landscape Architect:

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SEAL



Sarah Elaine Kearney #3109  
October 2, 2024

DIVISION 03 – CONCRETE  
033300 Cast-In-Place Concrete

DIVISION 32 – EXTERIOR IMPROVEMENTS  
320190 Operation and Maintenance of Planting  
321313 Concrete Paving  
321373 Concrete Paving Joint Sealants  
321400 Unit Paving  
323300 Site Furnishings  
328400 Irrigation  
329115 Soil Preparation (Performance Specification)  
329300 Plants

DIVISION 33 – Utilities  
334600 Subdrainage

END OF DOCUMENT

## SECTION 033000 - CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Concrete standards.
2. Concrete Materials.
3. Concrete formwork.
4. Concrete reinforcement.
5. Joint devices associated with concrete work.
6. Miscellaneous concrete elements, including equipment pads, light pole bases, footings, and exterior walls.
7. Concrete curing.

#### 1.3 REFERENCE STANDARDS

- A. American Concrete Institute

1. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
2. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
3. ACI 301 - Specifications for Structural Concrete.
4. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
5. ACI 305R - Guide to Hot Weather Concreting.
6. ACI 306R - Guide to Cold Weather Concreting.
7. ACI 308R - Guide to External Curing of Concrete.
8. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
9. ACI 347R - Guide to Formwork for Concrete.

- B. ASTM International

1. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
2. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
3. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
4. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
5. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
6. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
7. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
8. ASTM C150/C150M - Standard Specification for Portland Cement.
9. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

10. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.
11. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
12. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
13. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
14. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
15. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
16. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
17. ASTM D8139 - Standard Specification for Semi-Rigid, Closed-Cell Polypropylene Foam, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
18. ASTM D994/D994M - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

- C. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

#### 1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
- C. Mix Design: Submit proposed concrete mix design.
1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
- D. Test Reports: Submit report for each test or series of tests specified.

#### 1.5 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.

### PART 2 - PRODUCTS

#### 2.1 FORMWORK

- A. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.
  2. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.
  3. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches of concrete surface.

## 2.2 REINFORCEMENT MATERIALS

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
  - 1. Type: Deformed billet-steel bars.
  - 2. Finish: Unfinished, unless otherwise indicated.
- B. Reinforcement Accessories:
  - 1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch.
  - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
  - 3. Provide stainless steel, galvanized, plastic, or plastic coated steel components for placement within 1-1/2 inches of weathering surfaces.

## 2.3 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type I - Normal Portland type.
  - 1. Acquire cement for entire project from same source.
- B. Fly Ash: ASTM C618, Class C or F.
- C. Calcined Pozzolan: ASTM C618, Class N.
- D. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.
- E. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

## 2.4 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. Water Reducing Admixture: ASTM C494/C494M Type A.

## 2.5 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.
- B. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
- C. Dowel Sleeves: Plastic sleeve for smooth, round, steel load-transfer dowels.

## 2.6 CURING MATERIALS

- A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.

- B. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.

## 2.7 CONCRETE MIX DESIGN

- A. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
- B. Normal Weight Concrete:
  - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4000 pounds per square inch.
  - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
  - 3. Water-Cement Ratio: Maximum 40 percent by weight.
  - 4. Total Air Content: 4 to 6 percent, determined in accordance with ASTM C173/C173M.
  - 5. Maximum Slump: 4 inches.
  - 6. Maximum Aggregate Size: 5/8 inch.

## 2.8 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
- B. Transit Mixers: Comply with ASTM C94/C94M.
- C. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

### 3.2 PREPARATION

- A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.
- B. Verify that forms are clean before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- D. Prepare existing concrete surfaces to be repaired according to ICRI 310.2R.
- E. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in accordance with bonding agent manufacturer's instructions.
  - 1. Use latex bonding agent only for non-load-bearing applications.

### 3.3 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.

- B. Ensure reinforcement, inserts, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- C. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.

### 3.4 SLAB JOINTING

- A. Locate joints as indicated on drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
  - 1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
- D. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
- E. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

### 3.5 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
  - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.

### 3.6 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
  - 1. Normal concrete: Not less than seven days.
  - 2. High early strength concrete: Not less than four days.

### 3.7 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Landscape Architect and Contractor within 24 hours of test.

- B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Landscape Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Landscape Architect for each individual area.
- E. Remove and replace concrete pavement that is broken, damaged, graffitied, marred, defective, or does not meet requirements in this Section prior to Substantial Completion.

### 3.8 PROTECTION

- A. Do not permit traffic over unprotected concrete surface until fully cured.

END OF SECTION

## SECTION 320190 - OPERATION AND MAINTENANCE OF PLANTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Division 01 - General Requirements, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.2 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, operation and maintenance of planting as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. Section Includes: The work specified in this Section includes, but shall not be limited to, the operation and maintenance of planting, irrigation, and accessories.
- C. Description
  - 1. Provide labor, materials, and installation necessary to provide a one (1)-year maintenance period for trees, shrubs, ground covers, and lawn areas from date of final acceptance of substantial completion.
  - 2. Provide labor, materials, and installation necessary to provide a one (1)-year warranty period from date of final acceptance of substantial completion.
  - 3. Related work described elsewhere:
    - a. Section 328400 – "Irrigation."
    - b. Section 329300 – "Plants."

#### 1.3 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- B. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- C. American Association of Nurserymen, Inc. (AAN):
  - 1. ANSI/AAN Z60.1, "Nursery Stock" (copyrighted by AAN, ANSI approved).
- D. American Wood Preservers Bureau (AWPB):
  - 1. AWPB LP 22, "Standard for Softwood Lumber and Plywood, Pressure Treated With Water Borne Preservatives for Ground Contact Use."
- E. American Society of Testing and Materials (ASTM):
  - 1. ASTM C 33, "Standard Specification for Concrete Aggregates."
  - 2. ASTM D 5268, "Standard Specification for Topsoil Used for Landscaping Purposes."

#### 1.4 SUBMITTALS

- A. General: See Division 01 – General Requirements for Submittal Procedures.
- B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Product data shall include, but shall not be limited to, manufacturer's specifications for accessories, fertilizers, filter fabric, soil amendments, and prepared soil mixes.
- C. Samples: Submit a one (1) pound bag of each type of existing soil, humus, imported topsoil, mulch, drainage stone, planter fill, and lightweight soil mix.
- D. Quality Control Submittals:
  - 1. Qualification Data: Submit qualification data for firms and persons specified in Quality Assurance Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of landscape architects and owners, and other information specified.
  - 2. Soil Test Analysis: Provide soil test analysis from a qualified independent inspecting and testing agency. Collect samples from representative areas of the site (minimum of four). Analysis shall include, but shall not be limited to, the following:
    - a. Soil pH.
    - b. N, P, K, Mg, and Ca levels.
    - c. Percent organic matter.
    - d. Lead levels.
    - e. Petro chemicals.
    - f. Textural analysis (percent of sand, silt, and clay).
  - 3. Schedule of maintenance operations and monthly status reports including list of equipment, proposed materials for the job and watering schedule.
  - 4. Licenses, permits and insurance that pertain to maintenance work as required by City, State, or Federal government agencies.
  - 5. Monthly record of all herbicides, insecticides and disease control chemicals used for the project.
- E. Project Close-Out Submittal: Include in a single, 3-ring binder a Landscape Maintenance Manual containing an indexed collection of all schedules, records and permits listed above, as well as a documentation of accepted condition of planting and irrigation at Final Acceptance.

#### 1.5 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Experience: The Landscape Contractor or Maintenance Contractor shall have a full-time employee assigned to the job as foreman for the duration of the contract. The foreman shall have a minimum of four (4) years experience in landscape maintenance supervision, with experience or training in turf management, entomology, pest control, soils, fertilizers and plant identification.
  - 2. Labor Force: The landscape maintenance labor force shall be thoroughly familiar with and trained in the work to be accomplished and shall perform all tasks in a competent and efficient manner acceptable to Landscape Architect and Owner.
- B. Requirements:

1. Supervision: The foreman shall directly supervise the labor force at all times. Immediately notify Landscape Architect Owner of all changes in supervision.
2. Identification: Provide proper identification at all times for landscape maintenance firm's vehicles and labor force. The labor force shall be uniformly dressed in a manner satisfactory to Owner.

#### 1.6 PROJECT/SITE CONDITIONS

- A. Site Visit: At the beginning of Maintenance Period, visit and walk the site with Landscape Architect to clarify scope of work and understand existing project and site conditions.
- B. Documentation of Conditions: Document general condition of existing trees, shrubs, vines, ground covers and lawn, recording all plant materials that are healthy, thriving, damaged, dead or dying.

#### 1.7 SEQUENCING AND SCHEDULING

- A. Perform all maintenance during hours mutually agreed upon between Owner and Contractor.
- B. Work force shall be present at the Project Site daily, Monday through Friday, and as often as necessary to perform specified maintenance in accordance with the approved maintenance schedule.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. General: All materials and equipment shall be provided by Contractor as specified below.
- B. Fertilizers:
  1. Tightly compressed slow-release and long lasting complete fertilizer tablets bearing manufacturer's label of guaranteed analysis of chemicals present.
  2. Balanced, once-a-season application, controlled-release fertilizers with a blend of coated pills which supply controlled-release nitrogen, phosphorus and potassium, and uncoated, rapidly soluble pills containing nitrogen and phosphorus.
  3. Fertilize at the rate indicated.
- C. Herbicides, Insecticides, and Fungicides:
  1. Insect/Disease Prevention: Take all measures to prevent introduction of insect or disease-laden materials onto the site.
  2. Submit for approval by Owner's Representative labels for all proposed herbicides, insecticides, and fungicides to be used on-site. Specify what weeds, pests, and fungi they will be used to control and application rates.
  3. Best quality materials with original manufacturers' containers, properly labeled with guaranteed analysis.
  4. Use non-staining materials.
- D. Replacement Tree Staking and Guying Material: Match originally accepted existing materials on the site.

## 2.2 EQUIPMENT

- A. General: Use only the proper tool for each job. Maintain all tools in sharp and properly functioning condition. Clean and sterilize pruning tools prior to usage.

## PART 3 - EXECUTION

### 3.1 ACCEPTANCE OF INSTALLATION

- A. At the completion of all landscape installation, the Contractor shall request in writing an inspection for substantial completion in which the Contractor and Owner's Representative shall be present. After this inspection, the Contractor shall prepare a "Punch List". Upon completion of all punch list items, the Owner's Representative shall re-inspect the project and issue a written statement of final acceptance and establish the beginning of the Maintenance Period and beginning of the project warranty period.
- B. Date of Review: Notify Owner and landscape Architect at least five (5) working days prior to the anticipated date of review.
- C. Landscape work may be inspected for acceptance in a limited number of phases agreeable to the Owner's Representative provided work offered for inspection is completed, including maintenance as required.
- D. For work to be inspected for partial or phased acceptance, the contractor shall provide a drawing outlining work completed and supply a written statement-requesting acceptance of the work completed to date.

### 3.2 PROTECTION:

- A. Protect all new planting areas from damage of all kinds from commencement of work until Final Acceptance.
- B. Provide temporary protection fences, barriers, and signs as required for protection.

### 3.3 REPLACEMENTS

- A. Immediately treat or replace all plants that become damaged or injured as a result of Contractor's operations or negligence as directed by Landscape Architect and at no cost to Owner.
- B. Replacement plants shall match size, condition, variety, and character of plants to be replaced.

### 3.4 PROJECT WARRANTY

- A. The project warranty period shall begin upon written final acceptance of the project installation by the Owner's Representative.
- B. Tree Warranty:
  - 1. The Contractor shall warrant that all trees will be alive and in good health for a period of one (1) year after final acceptance except for defects resulting from neglect by the Owner, abuse, or damage by others.
  - 2. The Contractor shall be responsible to monitor the Owner's care and report any maintenance issues before problems occur.

3. The Contractor shall remove and replace dead, unhealthy or girdled trees or those that lose original form and size during the warranty period with material equal to that specified at no additional cost to the Owner. The Contractor shall replace any material that does not meet requirements within ten (10) days.
4. All replacement trees shall be subject to an additional one (1)-year warranty period.

C. Shrubs and Other Plantings Warranty:

1. The Contractor shall warrant all other planting to be alive and in satisfactory condition for a period of one (1) year from date of final acceptance except for defects resulting from neglect by the Owner, abuse, or damage by others.
2. The Contractor shall maintain all plant material in a healthy, sturdy condition during the warranty period.
3. The Contractor shall remove and replace dead or unhealthy shrubs, ground covers, vines and turf areas or those that lose original form and size during the warranty period with material equal to that specified at no additional cost to the Owner. The Contractor shall replace any material that does not meet requirements within ten (10) days.
4. All replacement plants, including shrubs, groundcovers, vines and perennials, shall be subject to an additional one (1)-year warranty period.

3.5 MAINTENANCE PERIOD

A. Maintenance shall begin immediately with the planting of each plant and continue one (1)-year after substantial completion.

1. The Landscape Contractor, in order to protect his guarantee, shall give typewritten to the Owner, a complete maintenance instruction booklet in the care and feeding of the landscape prior to Final Acceptance.
2. Contractor shall take every precaution to protect finished exterior surfaces from damage as result of his maintenance work and shall promptly report and repair any damage to the satisfaction of the Owner's Representative.

B. Replacements must meet specifications, i.e., quality, size, form, species of plant material and planting procedures, to receive approval of replacement.

C. To ensure warranty standards, the following maintenance procedures shall be executed during construction and for the full project maintenance period.

D. Response Time: When environment dictates, work may require weekend, after hours or holiday schedules. The Contractor agrees to respond to a call per the following schedule:

1. General Maintenance- Three (3) business days.
2. Irrigation Issues- 24 hours or less depending on severity.
3. Safety Issues (obstructions, etc.)- Immediately

E. Maintenance of Trees, Shrubs, Vines and Groundcovers:

1. Contractor shall be responsible for any and all replacement of any plant materials that are dead, are in an unhealthy or unsightly condition, or that have lost natural shape resulting from dieback, excessive pruning or inadequate or improper maintenance.
2. Replacements must meet specifications, i.e., quality, size, form, species of plant material and planting procedures, to receive approval of replacement.
3. Costs for replacements are assumed part of bid quotations and therefore will not result in an additional cost to the Owner.

4. The Contractor shall be responsible for watering all plantings and shall keep guy wires taut, raise tree rootballs that settle, and furnish chemicals and pesticides as necessary to keep the plantings free of disease and insects until the end of the maintenance period.
  5. Insecticide Application: Furnish and apply chemicals and pesticides as necessary to keep the plantings free of disease and insects throughout the maintenance period.
  6. Fertilize at the rate indicated.
  7. Weed Control: Project Area is to be maintained in a weed-free condition. All planting areas shall be kept clean bi-weekly of all noxious weeds and grasses.
  8. Remove and replace trees, shrubs, ground covers, vines, turf areas or other plants found to be dead or in an unhealthy condition. Remove rejected plants and materials promptly. Make replacements during the normal planting schedule. Replace all trees and shrubs where their health is in doubt, unless, in the opinion of Owner's Representative, it is advisable to extend warranty period. Remove all tree wrap paper, dead twigs and branches from tree and plant material at the end of the maintenance period. Keep planting beds free of weeds during maintenance period.
  9. Pruning:
    - a. Trees: The objective in tree pruning shall be to preserve the structural integrity, design purpose and natural beauty of trees. Branch collars shall not be removed. Stubs shall not be allowed to remain. All pruning shall be done in accordance with the guidelines of the Western Chapter of the International Society of Arboriculture.
    - b. Shrubs: Pruning shall be done with hand pruners or lopping shears. Hedge shears shall not be allowed. Shrubs shall be selectively pruned to remove old seed heads and stems. Shrubs shall be pruned on a very limited basis, only to maintain natural appearance. Shrubs shall not be pruned into ball or geometric shapes. Shrubs and groundcovers shall be pruned to remove all frost-damaged foliage and branches as soon as new buds appear. Shrubs shall be trimmed to prevent overhang at sidewalks and curbs.
  10. Staking and Planting:
    - a. Staking that has been installed shall be inspected monthly. The goal is to wean trees from stakes. As trees are strong enough to stand on their own, stakes shall be removed.
    - b. Stakes that are not judged to be ready for removal shall be maintained according to the detail in the Construction Documents. Rubber hose and wire encircling trunks shall be maintained so as not to cause girdling. Stakes and wire shall be maintained to prevent rubbing against trunks or branches. Materials for staking and/or restaking shall match original specification. The need for the stakes and guys to remain beyond the warranty period is to be determined at the end of the warranty period. Approval to remove the stakes and guys at that time will be determined by the contractor's arborist.
- F. Maintenance Acceptance.
1. If the Contractor's maintenance is unsatisfactory, the maintenance period shall be extended, at the Contractor's expense, until such time as all corrections are made and the work is inspected and approved by the Owner's Representative.
  2. Arrange with the Owner's Representative to walk the site monthly during warranty period to review maintenance standards.
  3. The Landscape Contractor shall notify the Owner's Representative five (5)-days prior to end of the maintenance period that a final inspection is requested. The Buyer shall make notations of any items not acceptable or requiring corrections and will notify the Landscape Contractor for immediate action. All corrections must be completed before the Subcontractor is released from the above maintenance requirement.

3.6 CLEANING

- A. Dispose of all pruned materials, vacuum all lawn clippings and leaves, sweep all walkways and rake smooth all mulched areas.
- B. Remove from site and legally dispose of evidence of maintenance activities including excess subsoil, unsuitable soil, all containers, trash and debris off of Owner's property at Contractor's cost.

3.7 CLOSE OUT

- A. Landscape Maintenance Record: Submit to Owner a binder with all documentation and records required and utilized during the Maintenance Period.
- B. Keys and Identification: Return all keys and identification materials supplied by Owner for the purpose of site access.

END OF SECTION

## SECTION 321313 - CONCRETE PAVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

1.2 Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.3 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for concrete curbs, walks, and paving as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. Section includes concrete paving including the following:
  - 1. Concrete Pedestrian Paving.
- C. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
  - 2. 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.

#### 1.4 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- B. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- C. Texas Department of Licensing and Regulation (TDLR):
  - 1. Texas Accessibility Standards (TAS).
  - 2. Elimination of Architectural Barriers.
- D. American Concrete Institute (ACI):
  - 1. ACI 301, "Specifications for Structural Concrete for Buildings."
  - 2. ACI 318, "Building Code Requirements for Structural Concrete."
- E. American Society for Testing and Materials (ASTM):
  - 1. ASTM C 881, "Standard Specification for Epoxy Resin Base Bonding Systems for Concrete."
  - 2. ASTM C 979, "Standard Specification for Pigments for Integrally Colored Concrete."
  - 3. ASTM C 1028, "Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Meter Method."

4. ASTM C 1059, "Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete."
5. ASTM C 1116, "Standard Specification for Fiber Reinforced Concrete and Shotcrete."
6. ASTM D 2047, "Standard Test Method for Static Coefficient of Friction of Polish Coated Floor Surfaces as Measured by the James Machine."
7. ASTM E 329, "Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction."

F. Code of Federal Regulation (CFR):

1. 28 CFR Part 36, "Americans With Disabilities Act" hereinafter referred to as ADA.

G. Concrete Reinforcing Steel Institute (CRSI):

1. CRSI MSP, "Manual of Standard Practice."

## 1.5 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.

## 1.6 PREINSTALLATION MEETINGS

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

## 1.7 ACTION SUBMITTALS

- A. General: See Division 01 – General Requirements for Submittal Procedures.
- B. Product Data: For each type of product.
- C. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
  1. Exposed Aggregate: 10-lb Sample of each mix.
- D. 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.

## 1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer of stamped detectable warnings ready-mix concrete manufacturer and testing agency.
- B. Material Certificates: For the following, from manufacturer:
  1. Cementitious materials.
  2. Steel reinforcement and reinforcement accessories.
  3. Fiber reinforcement.
  4. Admixtures.
  5. Curing compounds.
  6. Applied finish materials.

7. Bonding agent or epoxy adhesive.
8. Joint fillers.

#### 1.9 QUALITY ASSURANCE

- A. Stamped Pattern and Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
- B. 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. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
  1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
  2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Landscape Architect and not less than 96 inches by 96 inches. Include full-size detectable warning.
  3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
  4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
- F. Slip Resistance: Static coefficient of friction (COF) shall be as follows, in compliance with the ADA and TAS, as determined by testing per ASTM C1028 or ASTM D2047, as applicable, and per manufacturer's testing criteria.
  1. Level Surfaces: Minimum 0.60.
  2. Step Treads: Minimum 0.60.
  3. Sloped surfaces and ramps: Minimum 0.80.
- G. Concrete Standards: Comply with provisions of ACI 301, ACI 318, and CRSI MSP, except where more stringent requirements are indicated.
- H. Single Source Responsibility: Obtain each type or class of cementitious material of the same brand, and each aggregate, from a single source with resources to produce products of consistent quality in appearance and physical properties without delaying the Work.

#### 1.10 PRECONSTRUCTION TESTING

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

#### 1.11 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.
  - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
- D. Concrete Waste Management:
  - 1. Include concrete waste management procedures for concrete placement, saw cutting, sandblasting, and concrete washouts per local, state, or federal requirements and regulations.
  - 2. The Contractor is responsible for all concrete waste management procedures.
  - 3. Discharge of untreated waste is prohibited. Prior to the first concrete pour, predetermined concrete washout areas must be installed. More than one concrete washout area may be required.
  - 4. If construction of a concrete washout is planned, install per local, state, or federal requirements. If not required by regulations, the following design must be implemented – dig into ground or build above grade, place hay bales or an alternative BMP around the perimeter about 10" x 10", and overlay plastic sheeting free of tears or holes and secure to hay bales.
  - 5. Vinyl washout containers with filter bags are permitted which provide easier installation and maintenance and are reusable.
  - 6. Concrete washouts should be placed in easily accessible locations with solid (gravel or rock) approaches, a minimum of 50 feet from storm drains, open ditches, and surface waters.
  - 7. Slurry from concrete saw cutting should be continuously vacuumed or recovered for disposal.

8. Grit from sandblasting should be contained. Some procedures include, prohibit sandblasting during high winds, use misting equipment to remove grit from air, and install dust shielding around sandblasting areas.

## 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. Do not use notched and bent forms.
- B. Fiber board, Masonite, or other moisture absorbing materials shall not be used for formwork.
- C. 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. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- C. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.
- D. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 deformed bars.
- E. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.
- F. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.
- G. Plain-Steel Wire: ASTM A1064/A1064M.
- H. Deformed-Steel Wire: ASTM A1064/A1064M.
- I. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- J. Tie Bars: ASTM A615/A615M, Grade 60; deformed.
- K. Hook Bolts: ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

- L. 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, and as follows:
  - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

- M. Zinc Repair Material: ASTM A780/A780M.

## 2.4 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Portland Cement: ASTM C150/C150M, gray or white portland cement Type I, unless otherwise required or indicated.
- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source.
  - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
  - 1. Aggregate Sizes: 3/8 to 5/8 inch nominal.
  - 2. Aggregate Source, Shape, and Color: As indicated.
- E. Air-Entraining Admixture: ASTM C260/C260M.
- F. 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.
- G. Water: Potable and complying with ASTM C94/C94M.

## 2.5 FIBER REINFORCEMENT

- A. Color Blended Fiber: 100% Virgin Copolymer/polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, 1-1/2 to 2-1/4 inches long.

1. Fiber lengths are greater than 2.0 inches.
2. Before mixing, fibers are collated by twisting with an initial bundle aspect ratio less than 20.
3. Pre-mixing, macro monofilament fibers are bundled and have an aspect ratio of 80.
4. Post mixing, fibers are dispersed and have an aspect ratio of 80 or greater.
5. Fibers are made of copolymer virgin materials that are inert.
6. Fibers are sized to be flexible and not stiff to ensure fibers 'lay down' and are easy to finish.

- B. Fiber Dosage: Add fiber reinforcement at 7.5 lbs/cy.

## 2.6 CURING AND SEALING MATERIALS

- A. Curing Paper: Nonstaining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C171.
- B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- F. Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, nondissipating, non-yellowing, manufactured for use with colored concrete.
1. Curing compound shall be pigmented type matching color of integrally colored concrete and shall be approved by coloring admixture manufacturer.
  2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

## 2.7 RELATED MATERIALS

- A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
1. Types I and II, nonload bearing or Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

## 2.8 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.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
- B. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement.
- C. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- D. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 5 lb/cu. yd.
- E. Concrete Mixtures: Normal-weight concrete.
  - 1. Compressive Strength (28 Days): 3500 psi.
  - 2. Maximum W/C Ratio at Point of Placement: 0.45.
  - 3. Slump Limit: 4 inches, plus or minus 1 inch.

## 2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. 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. Verification of Conditions: Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances. Notify the Owner of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.
  - 1. Beginning of the Work shall indicate acceptance of the areas and conditions as satisfactory by the installer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Ensure compaction meets requirements indicated, and the recommendations of the Project geotechnical report.

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

### 3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set forms to the required grades and lines, rigidly braced and secured. Provide grade stakes ten Feet (10'-0") apart, minimum. Provide 2% cross slope, maximum. Pitch walks as indicated on Drawings and make adjustments in slopes at walk intersections to provide drainage. Check completed formwork for grade and alignment. Adhere to all accessibility requirements. Ensure geometry matches design intent shown on drawings with smooth arc, tangents, radii, and perpendicular relationships. Undulating edges will be rejected.
- B. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- C. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.
- D. Ensure formwork, hardware, and mechanical fasteners will not be encased in concrete.

### 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.
  - 1. When joining existing paving, place transverse joints to align with previously placed joints 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. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
  - 2. Provide tie bars at sides of paving strips where indicated.
  - 3. 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 30 feet maximum 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.
  - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
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.
  - a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
  - b. Saw cut joints within the first six to eighteen hours after placing. Cut into 1/4 depth of slab thickness, accurately constructed true to alignment and location as shown on the Drawings.
  - c. Do not delay more than twenty-four hours after concrete pour. Failure can result in rejection and replacement of concrete poured.
  - d. Extend all saw cuts to the end of each concrete panel. Do not overlap cuts into adjacent concrete panels.

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, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. 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.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. 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.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
  - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater 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.
  - 2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

### 3.8 SPECIAL FINISHES

- A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
  - 1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
  - 2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
  - 3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
  - 4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

### 3.9 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. All site placed concrete shall be cured as described below. Concrete that is not properly cured shall be considered deficient.
- 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 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.

### 3.10 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
  - 1. Elevation: 3/4 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. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
  - 5. Lateral Alignment and Spacing of Dowels: 1 inch.
  - 6. Vertical Alignment of Dowels: 1/4 inch.
  - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
  - 8. Joint Spacing: 2 inches.
  - 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
  - 10. Joint Width: Plus 1/8 inch, no minus.
- B. No birdbaths or other surface irregularities will be permitted. Correct irregularities as directed.

### 3.11 RINSING TRUCKS

- A. Rinsing of transit mix trucks or other concrete mixing devices shall either be off of the Owner's site or onsite in a contained area, which does not allow run-off. If rinsed in a contained area onsite, run-off must be prevented until concrete dries, at which time it must be removed as solid debris for disposal. Remove all debris from site – keep site soil free of all cleaning by products and washout.

### 3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will 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 to 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 to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. 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.
- D. Test results to be reported in writing to Landscape Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to 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.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Landscape Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency will 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 Landscape Architect.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

- I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, graffitied, vandalized, 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 Landscape Architect.
- B. Drill test cores, where directed by Landscape Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. 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.
- D. 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.
- E. Any defective or deficient concrete work, which after corrective patching, rubbing, etc., fails to duplicate the appearance of unpatched work and/or conform to the standards set forth in these specifications shall be removed in its entirety and replaced at no additional cost to the Contract.

END OF SECTION

## SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

1.2 Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.3 SUMMARY

A. Section Includes:

1. Expansion and isolation joints in concrete paving
2. Cold-applied joint sealants.
3. Joint-sealant backer materials.
4. Primers.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

#### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

#### 1.5 ACTION SUBMITTALS

A. Product Data:

1. Concrete pavement joint sealants.
2. Joint-sealant backer materials.

B. Samples for Verification: Actual sample of finished products for each kind and color of joint sealant required.

1. Size: Joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

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.

#### 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For Installer.

## 1.7 QUALITY ASSURANCE

### A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

## 1.8 FIELD CONDITIONS

### A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- #### A. Obtain joint sealants from single manufacturer for each sealant type.

### 2.2 JOINT SEALANTS, GENERAL

- #### A. Compatibility: Provide joint sealants, backer 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.

### 2.3 COLD-APPLIED JOINT SEALANTS

- #### A. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 35, for Use T.

### 2.4 JOINT-SEALANT BACKER MATERIALS

- #### A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
- #### B. 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.
- #### C. 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.
- #### D. 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 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

### 3.3 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. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Install joint-sealant backers 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 backer materials.
  - 2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
  - 3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backer material 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.

- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with 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.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

#### 3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION

## SECTION 321400 - UNIT PAVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Concrete pavers.
  - 2. Curbs and edge restraints.
- B. Related Requirements:
  - 1. Section 321313 "Concrete Paving" for concrete base under unit pavers and for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers.

#### 1.3 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- B. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- C. American National Standards Institute (ANSI):
  - 1. ANSI A118.6 "Specifications for Ceramic Tile Grouts" (copyrighted by TCA, ANSI approved).
  - 2. ANSI A118.7, "Specifications for Polymer Modified Tile Grouts for Tile Installation" (copyrighted by TCA, ANSI approved).
- D. American Society for Testing and Materials (ASTM):
  - 1. ASTM A 185, "Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement."
  - 2. ASTM C 33, "Standard Specification for Concrete Aggregates."
  - 3. ASTM C 67, "Standard Test Methods of Sampling and Testing Brick and Structural Clay Tile."
  - 4. ASTM C 144, "Standard Specification for Aggregate for Masonry Mortar."
  - 5. ASTM C 150, "Standard Specification for Portland Cement."
  - 6. ASTM C 207, "Standard Specification for Hydrated Lime for Masonry Purposes."
  - 7. ASTM C 270, "Standard Specification for Mortar for Unit Masonry."
  - 8. ASTM C 615, "Standard Specification for Granite Dimension Stone."
  - 9. ASTM C 902, "Standard Specification for Pedestrian and Light Traffic Paving Brick."
  - 10. ASTM C 936, "Standard Specification for Solid Concrete Interlocking Paving Units."
  - 11. ASTM C 1028, "Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Meter Method."
  - 12. ASTM C 1272, "Standard Specification for Heavy Vehicular Paving Brick."
  - 13. ASTM D 312, "Standard Specification for Asphalt Used in Roofing."

14. ASTM D 448, "Standard Classification for Sizes of Aggregate for Road and Bridge Construction."
15. ASTM D 1073, "Standard Specification for Fine Aggregate for Bituminous Paving Mixtures."
16. ASTM D 1557, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft lbf/ft<sup>3</sup> [2700 kN m/m<sup>3</sup>])."
17. ASTM D 1751, "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non Extruding and Resilient Bituminous Types)."
18. ASTM D 1752, "Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."
19. ASTM D 2028, "Standard Specification for Cutback Asphalt (Rapid Curing Type)."
20. ASTM D 2047, "Standard Test Method for Static Coefficient of Friction of Polish Coated Floor Surfaces as Measured by the James Machine."
21. ASTM D 2940, "Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports."
22. ASTM D 3381, "Standard Specification for Viscosity Graded Asphalt Cement for Use in Pavement Construction."

E. Interlocking Concrete Pavement Institute (ICPI): Technical Specifications.

F. Texas Department of Licensing and Regulation (TDLR):

1. Texas Accessibility Standards.
2. Elimination of Architectural Barriers.

G. Code of Federal Regulation (CFR):

1. 28 CFR Part 36, "Americans With Disabilities Act" hereinafter referred to as ADA.

#### 1.4 SYSTEM DESCRIPTION

A. Compatibility: Provide only sealants and joint fillers which are compatible with the joint surfaces and each other, as stated in the manufacturer's published data or as certified by the manufacturer for each application. Confirm the compatibility of sealants to be in contact with each other.

#### 1.5 ACTION SUBMITTALS

A. Product Data:

1. Pavers.
2. Edge restraints.

B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

C. Samples for Verification: For full-size units of each type of unit paver indicated. Include Samples of the following:

1. Joint materials.
2. Exposed edge restraints.

#### 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

- B. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.
  - 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified unit paving installer. Installer's field supervisor must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with the following designations:
  - 1. Commercial Paver Technician Designation.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution. Provide 8'-0" by 8'-0" mockup of each unit paving type and pattern including edge restraints.
  - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

#### 1.9 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Mortar and Grout:
  - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
  - 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.
    - a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

### 2.2 CONCRETE PAVERS

- A. Concrete Pavers, Solid Interlocking Paving Units: Complying with ASTM C936/C936M and resistant to freezing and thawing when tested according to ASTM C67, made from normal-weight aggregates.
  - 1. Thickness: As indicated.
  - 2. Face Size and Shape: As indicated.
  - 3. Color: As indicated by manufacturer's designations.
  - 4. Average Compressive Strength: 8000 psi with no individual unit under 7200 psi.

### 2.3 CURBS AND EDGE RESTRAINTS

- A. Job-Built Concrete Edge Restraints: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.

### 2.4 ACCESSORIES

- A. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

### 2.5 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with [ASTM D448 for Size No. 8] [ASTM D2940/D2940M, base material] [requirements in Section 312000 "Earth Moving" for base course].
- B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
- C. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D448 for Size No. 10.
- D. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.
  - 1. Provide sand of color needed to produce required joint color.
- E. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - 1. Survivability: Class 2, AASHTO M 288.
  - 2. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
  - 3. Permittivity: 0.02 per second, minimum; ASTM D4491.
  - 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.

- F. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - 1. Survivability: Class 2, AASHTO M 288.
  - 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.
  - 3. Permittivity: 0.5 per second, minimum; ASTM D4491.
  - 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.
- G. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
- C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive [subbase] [and] [base] course for unit pavers.

#### 3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
  - 1. For concrete pavers, a block splitter may be used.
- D. Joint Pattern: As indicated.

- E. Tolerances:
  - 1. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- F. Expansion and Control Joints:
  - 1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."
  - 2. Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
- G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
  - 1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
  - 2. Install job-built concrete edge restraints to comply with requirements in Section 033000 "Cast-in-Place Concrete."
  - 3. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

### 3.4 AGGREGATE SETTING-BED APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D698 and ASTM D1557 laboratory density.
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Landscape Architect, and replace with compacted backfill or fill as directed.
- C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.
- D. Place aggregate subbase and base, compact by tamping with plate vibrator, and screed to depth indicated.
- E. Place aggregate subbase and base, compact to 100 percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.
- F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.
- G. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- H. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- I. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
  - J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
    1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
    2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
    3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
    4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
  - K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
  - L. Do not allow traffic on installed pavers until sand has been vibrated into joints.
  - M. Repeat joint-filling process 30 days later.
- 3.5 REPAIRING, POINTING, AND CLEANING
- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
  - B. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION

## SECTION 323300 - SITE FURNISHINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Seating
- 2. Pet waste stations.
- 3. Trash receptacles.
- 4. Other site furnishing items indicated.

- B. Related Requirements:

- 1. Section 013000 "Administrative Requirements" for submittal procedures.
- 2. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts cast in concrete footings.
- 3. Section 312000 "Earth Moving" for excavation for installing concrete footings.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, provide manufacturer's specifications, descriptive literature, installation instructions, and maintenance information.
- B. Samples for Verification: For each type of exposed finish, not less than 6-inch-long linear components and 4-inch-square sheet components.
- C. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For site furnishings manufactured with preservative-treated wood.
  - 1. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

#### 1.6 WARRANTY

- A. Manufacturer's Warranty: Contractor shall arrange manufacturer's warranty to the effect that manufactured products shall carry a minimum one-year manufacturer's warranty which shall be transferred to the owner at time of acceptance. The warranty period shall commence based on

written documentation to be provided by the Landscape Architect establishing the date of acceptance of the installation. Early delivery shall not limit the installed warranty period.

- B. Contractor's Warranty: Contractor shall warrant workmanship in addition to the manufacturer's warranty for a period of one year from the date of acceptance.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Provide furnishings as shown and indicated on plans.
- B. Alternate manufacturers if requested by contractor for consideration will be required to meet or exceed the selected manufacturer's finish design including shape and size, color, material, and warranty. Landscape Architect has sole discretion as to the approval of any substitutions.
- C. Products are to be new and in first class condition.

### 2.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:
1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B211.
  2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B221.
  3. Structural Pipe and Tube: ASTM B429/B429M.
  4. Sheet and Plate: ASTM B209.
  5. Castings: ASTM B26/B26M.
- B. Steel and Iron: Free of surface blemishes and complying with the following:
1. Plates, Shapes, and Bars: ASTM A36/A36M.
  2. Steel Pipe: Standard-weight steel pipe complying with ASTM A53/A53M, or electric-resistance-welded pipe complying with ASTM A135/A135M.
  3. Tubing: Cold-formed steel tubing complying with ASTM A500/A500M.
  4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A513/A513M, or steel tubing fabricated from steel complying with ASTM A1011/A1011M and complying with dimensional tolerances in ASTM A500/A500M; zinc coated internally and externally.
  5. Sheet: Commercial steel sheet complying with ASTM A1011/A1011M.
  6. Perforated Metal: From steel sheet not less than 0.120-inch nominal thickness; manufacturer's standard perforation pattern.
  7. Expanded Metal: Carbon-steel sheets, deburred after expansion, and complying with ASTM F1267.
  8. Malleable-Iron Castings: ASTM A47/A47M, grade as recommended by fabricator for type of use intended.
  9. Gray-Iron Castings: ASTM A48/A48M, Class 200.
- C. Stainless Steel: Free of surface blemishes and complying with the following:
1. Sheet, Strip, Plate, and Flat Bars: ASTM A240/A240M or ASTM A666.
  2. Pipe: Schedule 40 steel pipe complying with ASTM A312/A312M.
  3. Tubing: ASTM A554.

- D. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated.
  - 1. Wood Species: Manufacturer's standard.
  - 2. Finish: Manufacturer's standard stain and transparent wood-preservative treatment and sealer.
- E. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.
- F. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.
  - 1. Polyethylene: Fabricated from virgin plastic HDPE resin.
- G. Anchors, Fasteners, Fittings, and Hardware: Stainless steel, Galvanized steel, or Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality, tamperproof, vandal and theft resistant, concealed, recessed, and capped or plugged.
  - 1. Angle Anchors: For inconspicuously bolting legs of site furnishings to on-grade substrate; one per leg.
  - 2. Antitheft Hold-Down Brackets: For securing site furnishings to substrate; two per unit.
- H. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M; recommended in writing by manufacturer, for exterior applications.
- I. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.
- J. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:
  - 1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil thick.
  - 2. Hot-Dip Galvanizing: According to ASTM A123/A123M, ASTM A153/A153M, or ASTM A924/A924M.

### 2.3 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment: Pressure-treat wood according to AWPA U1, Use Category UC3b, and the following:
  - 1. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
  - 2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

## 2.4 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.
- E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- F. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.6 ALUMINUM FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

## 2.7 STEEL AND GALVANIZED-STEEL FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.
- B. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

## 2.8 IRON FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

## 2.9 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - 1. Run directional finishes with long dimension of each piece.
  - 2. Directional Satin Finish: ASTM A480/A480M, No 4.
  - 3. Dull Satin Finish: ASTM A480/A480M, No. 6.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.
- D. Guard against staining or damaging of existing pavements, planting, and other Project elements where site furnishings are to be installed.
- E. Provide concrete pads and footings as needed for installation other than on pavements. Provide attachment to footings or subslabs where unit paving is utilized.
- F. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
- G. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
- H. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

3.3 REPAIRS

- A. Replace all products, materials, and workmanship found to be defective through the end of the warranty period.
- B. Repair any scratches or other damages that can be repaired per the Manufacturer's recommendation. Landscape Architect shall have the sole discretion to approve the repair or require replacement. Repairs shall appear new prior to damage.
- C. Provide Owner with Manufacturer's touch up paint (1 US quart, minimum) for each painted furnishing. Supply literature necessary for ordering touch-up paint.

3.4 CLEANING

- A. Keep all areas of work clean, neat, and orderly at all times.
- B. Clean up and remove all stains, packing, and construction debris from Project site and dispose of off of Owner's property prior to Substantial Completion.

**END OF SECTION**

## SECTION 328400 - IRRIGATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.2 SUMMARY

- A. Irrigation system required for this work includes but is not limited to the furnishing of all labor, tools, materials, appliances, tests, permits, taxes, etc., necessary for the installation of a landscape irrigation system as herein specified and shown on the drawings, and the removal of all debris from the site.
  - 1. Locate, purchase, deliver and install piping, conduit, sleeves, 120 volt and low voltage electrical and water connections, valves, backflow preventer devices, controllers, rain sensors, spray and bubbler heads, drip irrigation lines, and associated accessories for a fully operational automatic irrigation system.
  - 2. Trenching and water settling of backfill material.
  - 3. Testing and startup of the irrigation system.
  - 4. Prepare an as built record set of drawings.
  - 5. Training of the Owner's maintenance personnel in the operational requirements of the Irrigation system.
  - 6. Clean up and disposal of all excess and surplus material.
  - 7. Maintenance of the irrigation system during the proscribed maintenance period.
- B. The system shall efficiently and evenly irrigate all areas and be complete in every respect and shall be left ready for operation to the satisfaction of the Owner's Representative.
- C. Coordinate with other trades, as needed to complete work, including but not limited to Water Meter, Point of Connection (POC) and Backflow Preventer Device (BFPD) location and electrical hookups.

#### 1.3 CONTRACT DOCUMENTS

- A. Contract Documents shall consist of specifications and its general conditions and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any part shall be as binding as if called for in all parts.

#### 1.4 RELATED DOCUMENTS AND REFERENCES

- A. Drawings and general provisions of contract, including general and supplementary conditions and Division I specifications, apply to work of this section.
- B. Related Specification Sections
  - 1. Section - Planting
  - 2. Section - Planting Soil
  - 3. Section - Lawn
  - 4. Sections - Mechanical/Plumbing

5. Section – Tree and Plant Protection
6. Sections - Electrical

C. References:

1. American Society of Testing Materials (ASTM): cited section numbers.
2. National Sanitation Foundation (NSF): rating system.
3. Irrigation Association: Turf & Landscape Irrigation Best Management Practices

1.5 VERIFICATION

- A. Irrigation piping and related equipment are drawn diagrammatically. Scaled dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions and immediately notify the Owner's Representative of discrepancies between the drawings or specifications and the actual conditions. Although sizes and locations of plants and or irrigation equipment are drawn to scale wherever possible, it is not within the scope of the drawings to show all necessary offsets, obstructions, or site conditions. The Contractor shall be responsible to install the work in such a manner that it will be in conformance to site conditions, complete, and in good working order.
- B. Piping and equipment is to be located within the designated planting areas wherever possible unless specifically defined or dimensioned otherwise.

1.6 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

1.7 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.8 CHANGES IN THE WORK

- A. The Owner's Representative may order changes in the work, and the contract sum being adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.
- B. All changes in the work, notifications and Contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.9 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest as possible time that can be coordinated with other work, and seasonal weather demands, but not more than 90 (ninety) days after notification.

1.10 DEFINITIONS

- A. Owner's Representative: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.
- B. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project.
- C. Final Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of specification. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrently.

1.11 SUBMITTALS

- A. See the contract General Conditions for policy and procedures related to submittals.

1.12 PRODUCT DATA

- A. Submit a minimum of (3) complete lists of all irrigation equipment to be used, manufacturer's brochures, maintenance manuals, warranties and operating instructions, within 15 days after the notice to proceed.
  - 1. This submission may be done digitally and all documents shall be submitted in one PDF document.
  - 2. The submittals shall be packaged and presented in an organized manner, in the quantity described in Division 1 of the specifications. Provide a table of contents of all submitted items.
  - 3. Clearly identify on each submitted sheet by underlining or highlighting (on each copy) the specific product being submitted for approval. Failure to clearly identify the specific product being submitted will result in a rejection for the entire submittal. No substitutions of material or procedures shall be made concerning these documents without the written consent of an accepted equivalent by the Owner's Representative.
  - 4. Equipment or materials installed or furnished without prior approval of the Owner's Representative, may be rejected by the Owner's Representative and the Contractor shall be required to remove such materials from the site at their own expense.
  - 5. Approval of substitution of material and/or products, other than those specified shall not relieve the Contractor from complying with the requirements of the contract documents and specifications. The Contractor shall be responsible, at their own expense, for all changes that may result from the approved substitutions, which affect the installation or operations other items of their own work and/or the work of other Contractors.
- B. Samples: Samples of the equipment may be required at the request of the Owner's Representative if the equipment is other than that specified.

C. Other Submittals: Submit for approval:

1. Documentation of the installer's qualifications.
2. As built record set of drawings.
3. Testing data from all required pressure testing.
4. Backflow prevention device certification: Certification from the manufacturer or their representative that the back flow prevention device has been installed correctly according to the manufactures requirements.
5. Booster pump certification: Certification from the manufacturer or their representative that the booster pump has been installed correctly according to the manufacturer's requirements.
6. Irrigation controller certification: Certification from the manufacturer or an authorized distributor that the Controller has been installed correctly according to the manufactures requirements.

1.13 OBSERVATION OF THE WORK

- A. The Owner's Representative may inspect the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Owner's Representative shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Owner's Representative shall be afforded sufficient time to schedule visit to the site. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
  1. Trenching, directional boring, and sleeving review.
  2. Hydrostatic pressure testing.
  3. Adjustment and coverage test.
  4. Pre-maintenance observation.
  5. Final acceptance / system malfunction corrections.

1.14 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.15 QUALITY ASSURANCE

- A. It is the intention of this specification to accomplish the work of installing an automatic irrigation system, which will operate in an efficient and satisfactory manner. The irrigation system shall be installed and made operational according to the workmanlike standards established for landscape installation and sprinkler irrigation operation as set forth by the most recent Best Management Practices (BMP) of the Irrigation Association.
- B. The specification can only indicate the intent of the work to be performed rather than a detailed description of the performance of the work. It shall be the responsibility of the Contractor to install said materials and equipment in such a manner that they shall operate efficiently and evenly and support optimum plant growth and health.
- C. The Owner's Representative shall be the sole judge of the true intent of the drawings and specifications and of the quality of all materials furnished in performance of the contract.

- D. The Contractor shall keep one copy of all drawings and specifications on the work site, in good order. The Contractor shall make these documents available to the Owner's Representative when requested.
- E. In the event of any discrepancies between the drawings and the specification, the final decision as to which shall be followed, shall be made by the Owner's Representative.
- F. In the event the installation is contradictory to the direction of the Owner's Representative, the installation shall be rectified by the Contractor at no additional cost to the Owner. The Contractor shall immediately bring any such discrepancies to the attention of the Owner's Representative.
- G. It shall be distinctly understood that no oral statement of any person shall be allowed in any manner to modify any of the contract provisions. Changes shall be made only on written authorization of the Owner's Representative.
- H. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work.
  - 1. Installer Field Supervision: The installer shall maintain on site an experienced full-time supervisor who can communicate in English with the Owner's Representative.
  - 2. Submit the installer's qualifications for approval.

#### 1.16 IRRIGATION SYSTEM WARRANTY:

- A. The Contractor shall Warrantee all workmanship and materials for a period of one (1) year following the acceptance of the work.
  - 1. Any parts of the irrigation work that fails or is defective shall be replaced or reconstructed at no expense to the Owner including but not limited to: restoring grades that have settled in trenches and excavations related to the work. Reconstruction shall include any plantings, soil, mulch or other parts of the constructed landscape that may be damaged during the repair or that results from soil settlement.
- B. The date of acceptance of the work and start of the Guarantee period shall be determined by the Owner's Representative, upon the finding that the entire irrigation system is installed as designed and specified, and found to be operating correctly, supplying water evenly to all planting and/or lawn areas.
- C. The system controller shall be warranted by the equipment manufacturer against equipment malfunction and defects for a period of 5 years, following the acceptance of the work.
- D. Neither the final acceptance nor any provision in the contract documents shall relieve the Contractor of responsibility for faulty materials or workmanship. The Contractor shall remedy any defects within a period of 7 days (s) from the date of notification of a defect.

#### 1.17 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the installation of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

#### 1.18 DELIVERY, STORAGE, AND HANDLING

- A. All materials and equipment shall be stored properly and protected as required by the Contractor. The Contractor shall be entirely responsible for damages or loss by weather or other cause to work under the contract. Materials shall be furnished in ample quantities and at such times as to ensure uninterrupted progress of the work.
- B. Deliver the products to the job site in their original unopened container with labels intact and legible at time of use.
- C. Store in accordance with the manufacturers' recommendations.

#### 1.19 PROTECTION

- A. The Contractor shall continuously maintain adequate protection of all their work from damage, destruction, or loss, and shall protect the owner's property from damage arising in connection with this contract. Contractor shall make good any such damage, destruction, loss or injury. Contractor shall adequately protect adjacent property as provided by law and the contract documents.
- B. The Contractor shall maintain sufficient safeguards, such as railings, temporary walks, lights, etc., against the occurrence of accidents, injuries or damage to any person or property resulting from their work, and shall alone be responsible for the same if such occurs.
- C. All existing paving, structures, equipment or plant material shall be protected at all times, including the irrigation system related to plants, from damage by workers and equipment. The Contractor shall follow all protection requirements including plant protection provision of the general contract documents. All damages shall be repaired or replaced at the Contractor's expense. Repairs and or replacement shall be to the satisfaction of the Owner's Representative, including the selection of a Contractor to undertake the repair or maintenance. Repairs shall be at no cost to the owner.
  - 1. For trees damaged to the point where they will not be expected to survive or which are severely disfigured and that are too large to replace, the cost of damages shall be as determined by the Owner's arborist using accepted tree value evaluation methods.
- D. The Contractor shall refrain from trenching within the drip line of any existing tree to remain. The Owner's Representative may require the Contractor to relocate proposed irrigation work, bore lines beneath roots or use air spade technology to dig trenches through and under the root system to avoid damage to existing tree root areas.

#### 1.20 EXCAVATING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
  - 1. Do not begin any excavation until all underground utilities have been located and marked.
- B. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain stakes and or markings set by others until parties concerned mutually agree to their removal.
- C. Notification of Local Utility Locator Service, is required for all excavation around utilities. The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the Local Utility Locator Service.

#### 1.21 POINT OF CONNECTION

- A. The point of connection of the irrigation system to its electrical power sources shall be provided by the General Contractor's licensed electrical Contractor per governing codes at the location shown on the drawings. The irrigation Contractor will connect the power to provided junction box or grounded plug receptacle.
- B. The point of connection of the irrigation system to its potable and or non-potable water sources, including the main shutoff valve and backflow preventer shall be provided by the General Contractor's licensed plumbing Contractor per governing codes at the location shown on the drawings. The minimum size and water pressure of the pressurized line will be as noted on the irrigation drawing.

#### 1.22 TEMPORARY UTILITIES

- A. All temporary piping, wiring, meters, panels and other related appurtenances required between source of supply and point of use shall be provided by the Contractor and coordinated with the Owner's Representative. Existing utilities may be used with the written permission of the owner.

#### 1.23 CUTTING, PATCHING, TRENCHING AND DIGGING

- A. The Contractor shall do all cutting, fitting, trenching or patching of their work that may be required to make its several parts come together as shown upon, or implied by, the drawings and specifications for the completed project.
- B. Digging and trenching operations shall be suspended when the soil moisture is above field capacity.

#### 1.24 USE OF PREMISES

- A. The Contractor shall confine their apparatus; the storage of materials, and the operations of their workers to limits indicated by the law, ordinances, or permits and shall not unreasonably encumber the premises with their materials.
- B. Contractor parking, and material and equipment storage shall in areas approved by the Owner's Representative.

#### 1.25 AS BUILT RECORD SET OF DRAWINGS

- A. Immediately upon the installation of any buried pipe or equipment, the Contractor shall indicate on the progress record drawings the locations of said pipe or equipment. The progress record drawings shall be made available at any time for review by the Owner's Representative.
- B. Before final acceptance of work, the Contractor shall provide an as built record set of drawings showing the irrigation system work as built. The drawings shall be transmitted to the Owner's Representative in paper format and as a pdf file of each document on compact disk or flash drive. The drawings shall include all information shown on the original contract document and revised to reflect all changes in the work. The drawings shall include the following additional information
  - 1. All valves shall be numbered by station and corresponding numbers shall be shown on the as built record set of drawings.
  - 2. All main line pipe or irrigation equipment including sleeves, valves, controllers, irrigation wire runs which deviate from the mainline location, backflow preventers, remote control valves, grounding rods, shut-off valves, rain sensors, wire splice locations, and quick coupling valves shall be located by two (2) measured dimensions, to the nearest one-half foot. Dimensions shall be given from permanent objects such as buildings, sidewalks,

curbs, walls, structures and driveways. All changes in direction and depth of main line pipe shall be noted exactly as installed. Dimensions for pipes shall be shown at no greater than a 50 ft. maximum interval.

3. As built record set of drawings shall be signed and dated by the Contractor attesting to and certifying the accuracy of the as built record set of drawings. As built record set of drawings shall have "As Built Record Set of Drawings", company name, address, phone number and the name of the person who created the drawing and the contact name (if different).

- C. The Owner shall make the original contract drawing files available to the Contractor.

#### 1.26 CONTROLLER CHARTS:

- A. Provide one controller chart for each automatic controller installed.
  1. On the inside surface of the cover of each automatic controller, prepare and mount a color-coded chart showing the valves, main line, and systems serviced by that particular controller. All valves shall be numbered to match the operation schedule and the drawings. Only those areas controlled by that controller shall be shown. This chart shall be a plot plan, entire or partial, showing building, walks, roads and walls. The plan, reduced as necessary and legible in all details, shall be made to a size that will fit into the controller cover. This print shall be approved by the Owner's Representative and shall be protected in laminated in a plastic cover and be secured to the inside back of the controller cabinet door.
  2. The controller chart shall be completed and approved prior to acceptance of the work.

#### 1.27 TESTING

- A. Provide all required system testing with written reports as described in part 3.

#### 1.28 OPERATION AND MAINTENANCE MANUALS AND GUARANTEES

- A. Prepare and deliver to the Owner's Representative within ten calendar days prior to completion of construction, two 3-ring hard cover binders containing the following information:
  1. Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturers' representatives.
  2. Catalog and parts sheets on all material and equipment.
  3. Guarantee statement. The start of the guarantee period shall be the date the irrigation system is accepted by the Owner.
  4. Complete operating and maintenance instruction for all major equipment.
  5. Irrigation product manufacturers warranties.
- B. In addition to the above-mentioned maintenance manuals, provide the Owner's maintenance personnel with instructions for maintaining major equipment and show evidence in writing to the Owner's Representative at the conclusion of the project that this has been rendered.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS GENERAL

- A. All materials shall be of standard, approved and first grade quality and shall be new and in perfect condition when installed and accepted.
- B. See the parts schedule on the drawings for specific components and manufacturers.

- C. Approval of any items or substitutions indicates only that the product(s) apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted. The Contractor shall be responsible for the performance of substituted items. If the substitution proves to be unsatisfactory or not compatible with other parts of the system, the Contractor shall replace said items with the originally specified items, including all necessary work and modifications to replace the items, at no cost to the owner.

## 2.2 RECLAIMED WATER SYSTEM DESIGNATION

- A. Where irrigation systems use reclaimed water, all products including valve boxes, lateral and main line pipe, etc. where applicable and/or required by local code shall have the reclaimed water purple color designation.

## 2.3 PIPING MATERIAL

- A. Individual types of pipe and fittings supplied are to be of compatible manufacturer unless otherwise approved. Pipe sizes shown are nominal inside diameter unless otherwise noted.
- B. Plastic pipe:
  - 1. All pipe shall be free of blisters, internal striations, cracks, or any other defects or imperfections. The pipe shall be continuously and permanently marked with the following information: manufacturer's name or trade mark, size, class and type of pipe pressure rating, quality control identifications, date of extrusion, and National Sanitation Foundation (NSF) rating.
  - 2. Pressure main line for piping upstream of remote control valves and quick coupling valves:
    - a. Pipe smaller than 2 inch diameter shall be plastic pipe for use with solvent weld or threaded fittings. Shall be manufactured rigid virgin polyvinyl chloride (PVC) 1220, Type 1, Grade 2 conforming to ASTM D 1785, designated as Schedule 40.
    - b. Pipe 2 - 3 inch diameter shall be manufactured rigid virgin polyvinyl chloride (PVC), Type 1, Grade 2 conforming to ASTM D 1785, designated as bell gasket Class 315.
    - c. Pipe larger than 3 inch diameter shall be manufactured rigid virgin polyvinyl chloride (PVC), Type 1, Grade 2 conforming to ASTM D 1785, designated as bell gasket Class 200 PVC.
  - 3. Non-pressure lateral line for piping downstream of remote control valves: plastic pipe for use with solvent weld or threaded fittings. Shall be manufactured rigid virgin polyvinyl chloride PVC 1220 (type 1, grade 2) conforming to ASTM d 1785, designated as Class 200, 3/4" minimum size.
- C. Galvanized pipe shall be used for above ground connections to, backflow prevention device assemblies, hose bibs, and booster pumps and as shown on the plans and details.
  - 1. Pipe shall be hot dip galvanized continuous welded, seamless, Schedule 40 conforming to applicable current ASTM standards.

## 2.4 FITTINGS AND CONNECTIONS:

- A. Polyvinyl chloride pipe fittings and connections: Type II, Grade 1, Schedule 40, high impact molded fittings, manufactured from virgin compounds as specified for piping tapered socket or molded thread type, suitable for either solvent weld or screwed connections. Machine threaded fittings and plastic saddle and flange fittings are not acceptable. Furnish fittings permanently

marked with following information: nominal pipe size, type and schedule of material, and National Sanitation Foundation (NSF) seal of approval. PVC fittings shall conform to ASTM D2464 and D2466.

- B. Brass pipe fittings, unions and connections: standard 125 pound class 85% red brass fittings and connections, IPS threaded.
- C. PVC Schedule 80 threaded risers and nipples: Type I, grade 1, Schedule 80, high impact molded, manufactured from virgin compounds as specified for piping and conforming to ASTM D-2464. Threaded ends shall be molded threads only. Machined threads are not acceptable.
- D. Galvanized pipe fittings shall be galvanized malleable iron ground joint Schedule 40 conforming to applicable current ASTM standards.

## 2.5 SOLVENT CEMENTS AND THREAD LUBRICANT

- A. Solvent cements shall comply with ASTM D2564. Socket joints shall be made per recommended procedures for joining PVC plastic pipe and fittings with PVC solvent cement and primer by the pipe and fitting manufacturer and procedures outlined in the appendix of ASTM D2564.
- B. Thread lubricant shall be Teflon ribbon-type, or approved equal, suitable for threaded installations as per manufacturer's recommendations.
- C. Pipe Joint Compound (Pipe dope) shall be used on all galvanized threaded connections. Pipe Joint Compound is a white colored, non-separating thread sealant compound designed to seal threaded connections against leakage due to internal pressure. It shall contain PTFE (Polytetrafluoroethylene) to permit a tighter assembly with lower torque, secure permanent sealing of all threaded connections and allow for easy disassembly without stripping or damaging threads.

## 2.6 BACKFLOW PREVENTION DEVICES

- A. The backflow prevention device shall be certified to NSF/ANSI 372 shall be ASSE Listed 1013, rated to 180 degree F, and supplied with full port ball valves.
- B. The main body and access covers shall be low lead bronze (ASTM B 584)
- C. The seat ring and all internal polymers shall be NSF Listed Noryl and the seat disc elastomers shall be silicone.
- D. Backflow Preventer shall be as indicated on the drawings.

## 2.7 PRESSURE REGULATOR

- A. Pressure regulator shall certified to NSF/ANSI 372, consisting of low lead bronze body bell housing, a separate access cap shall be threaded to the body and shall not require the use of ferrous screws.
- B. The main valve body shall be cast bronze (ASTM B 584).
- C. The access covers shall be bronze (ASTM B 584 or Brass ASTM B 16)
- D. The assembly shall be of the balanced piston design and shall reduce the pressure in both flow and no flow conditions.

- E. Pressure regulator shall be as indicated on the drawings.

#### 2.8 WYE STRAINER

- A. Strainer shall conform to MIL –S-16293, and be ANSI 3rd party certified to comply with the states lead plumbing law 0.25% maximum weighted average lead content.
- B. The main body shall be low lead bronze (ASTM B 584)
- C. The access covers shall be yellow brass or cast bronze (ASTM B 16 or ASTM B 584)
- D. Strainer screen shall be 300 series stainless steel available in 20, 40, 60, 80, or 100 mesh.
- E. Wye strainer shall be as indicated on the plans.

#### 2.9 BACKFLOW PREVENTER CAGE

- A. A heavy-duty steel mesh cage with rust proof finish. The caging shall be sized to allow space for the entire piping assembly associated with the Backflow Preventer unit, and all associated equipment.
- B. The cage shall include the manufacturers' standard tamper proof locking mechanism.
- C. Provide a concrete base as detailed on the drawings.
- D. Backflow Preventer Cage type, manufacturer and color shall be as indicated on the plans.

#### 2.10 BOOSTER PUMP

- A. Booster pump shall be housed in a sturdy, locking, weather-resistant case, furnished for maximum exterior protection.
- B. Booster pump shall be as indicated on the drawings.

#### 2.11 BALL VALVES

- A. Ball valves for 3/4 inch through 2-1/2 inch shall be of PVC, block, tru-union design with EDPDM seals and o-ring.
- B. Ball valves for 3 inch and larger shall be gate design and shall be iron body, brass or bronze mounted AWWA gate valves, and shall have a clear waterway equal to the full nominal diameter of the valve, and shall be rubber gasket, flanged or mechanical joint only, and shall be able to withstand a continuous working pressure of 150 PSI. Valve shall be equipped with a square-operating nut.
- C. All ball valves located in a valve manifold shall be the same size as the main line (1-1/2 inch size minimum). Provide pipe-reducing adapters down stream of valves, as required. All ball valves in line shall be the same size as the pipe.
- D. Ball valves shall be as indicated on the drawings.

#### 2.12 CHECK VALVES

- A. Swing check valves 2 inch and smaller shall be 200 lbs., W.O.G., bronze construction with replaceable composition, neoprene or rubber disc and shall meet or exceed federal specification WW-V- 5ld, class a, type iv.
- B. Anti-drain valves shall be of heavy-duty virgin PVC construction with female iron pipe thread inlet and outlet. Internal parts shall be stainless steel and neoprene. Anti-drain valves shall be field adjustable against draw out from 5 to 40 feet of head.
- C. Check valves shall be as indicated on the drawings.

#### 2.13 REMOTE CONTROL VALVES

- A. Remote control valves shall be electrically operated, single seat, normally closed configuration, equipped with flow control adjustment and capability for manual operation.
- B. Valves shall be actuated by a normally closed low wattage solenoid using 24 volts, 50/60 cycle solenoid power requirement. Solenoid shall be epoxy encased. A union shall be installed on the discharge end.
- C. Remote control valves shall be wired to controller in same numerical sequence as indicated on drawings.
- D. Remote control valves shall be as indicated on the drawings.

#### 2.14 MASTER CONTROL VALVES

- A. Master Control Valve shall be compatible with the irrigation controller.
- B. Master control valves shall be as indicated on the drawings.

#### 2.15 FLOW SENSOR

- A. Flow sensor shall be compatible with the irrigation controller.
- B. Flow sensor shall be as indicated on the drawings.

#### 2.16 HYDROMETER

- A. Hydrometer shall be compatible with the irrigation controller.
- B. Hydrometer shall be as indicated on the drawings.

#### 2.17 QUICK COUPLER VALVES

- A. Quick coupler valves shall be a one or two piece, heavy-duty brass construction with a working pressure of 150 PSI with a built in flow control and a self-closing valve.
- B. Quick coupler shall be equipped with locking red brass cap covered with durable yellow thermo-plastic rubber cover. Key size shall be compatible with quick coupler and of same manufacturer.
- C. Quick coupler valves shall be as indicated on the drawings.

#### 2.18 SPRINKLER HEADS

- A. All sprinkler heads shall have check valves installed.

- B. All sprinkler heads shall be as indicated on the drawings.
- C. Riser nipples for all sprinkler heads shall be the same size as the riser opening in the sprinkler body and fabricated as shown on the drawings.

#### 2.19 AUTOMATIC CONTROLLER

- A. Controller shall be housed in a sturdy, locking, weather-resistant case, furnished for maximum exterior protection.
- B. Controller shall be equipped with evapo-transpiration (ET) sensor, which adjusts the controller programming based on local climatic conditions. The sensor shall also have a rain sensing shut-off switch, wind sensing shut off switch, and freeze sensing shut-off of switch.
  - 1. If a moisture sensor is used in lieu of an evapo-transpiration sensor an additional sensor, which has a rain-sensing shut-off switch, wind sensing shut-off switch, and freeze sensing shut-off switch shall be provided.
- C. Automatic controller shall be as indicated on the drawings.

#### 2.20 CONTROLLER DECODERS

- A. All decoders shall be per the controller manufacturer's specifications.
- B. Decoder model number shall be as shown on the drawings.

#### 2.21 ELECTRICAL CONTROL WIRING

- A. Low voltage
  - 1. The electrical control wire shall be direct burial type UF, no. 14 AWG, solid, single conductor, copper wire UL approved or larger, if required to operate system as designed.
  - 2. For 2-Wire controllers all irrigation wire for the controller, flow sensor, master valve, hydrometer, remote control valves and moisture sensors shall be per the controller manufacturer's specifications and recommendations.
  - 3. Color code wires to each valve. Common wire shall be white.
  - 4. If multiple controllers are being utilized, and wire paths of different controllers cross each other, both common and control wires from each controller to be of different colors.
  - 5. Control wire splices: Splices are when required shall be placed in splice boxes.
  - 6. Wire connections shall be per the controller manufacturer's specifications and recommendations.
- B. High voltage
  - 1. Shall be of type as required by local codes and ordinances.
  - 2. Shall be of proper size to accommodate needs of equipment it is to serve.

#### 2.22 VALVE BOXES AND MATERIALS

- A. Valve boxes: valve boxes shall be constructed of ABS (acrylonitrile butadiene styrene) plastic, green in color, with rigid base and sides and shall be supplied with bolt lock cover secured with stainless steel bolts. Cover shall be identified as shown on drawings. Provide box extensions as required.

1. Master valves, flow sensors, remote control irrigation valves, gate valves, and ball valves 3 inch or less in size shall use a 14 inch x 19 inch x 12 inch rectangular box.
2. Quick coupler valves, wire splices, and grounding rods shall use a 10 inch circular box.

#### 2.23 CONCRETE THRUST BLOCKS

- A. Concrete thrust blocks shall be sized per the pipe manufactures requirement or as indicated on the drawings.

#### 2.24 VALVE IDENTIFICATION TAGS

- A. Valve Identification Tags shall be 2.25 inch x 2.65 inch polyurethane. Color: potable water; yellow / Non-potable water; purple. Tags shall be permanently attached to each remote control valve with tamper proof seals as indicated on the drawings.

#### 2.25 EQUIPMENT TO BE FURNISHED TO OWNER

- A. Two (2) sets of keys for each automatic controller.
- B. Two (2) 48 inch tee wrenches for operating the gate valves.
- C. Three (3) sets of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.
- D. Five (5) Extra sprinkler heads, nozzles, shrub adapters, nozzle filter screens, for each type used on the project.
- E. Two (2) quick coupler keys to match manufacturer type of quick coupler.

#### 2.26 INCIDENTAL MATERIALS AND EQUIPMENT

- A. Furnish all materials and equipment not specified above, but which are necessary for completion of the work as intended.

#### 2.27 MAIN LINE LOCATOR TAPE

- A. 3 - inch wide plastic detectable locator tape.

#### 2.28 MAIN LINE AND LATERAL LINE BEDDING SAND

- A. Sand shall consist of natural or manufactured granular material, free of organic material, mica, loam, clay or other substances not suitable for the intended purpose.
- B. Sand shall be masonry sand ASTM C 144 or coarse concrete sand, ASTM C 33.

### PART 3 - EXECUTION

#### 3.1 GENERAL REQUIREMENTS

- A. Code requirements shall be those of state and municipal codes and regulations locally governing this work, providing that any requirements of the drawings and specifications, not conflicting therewith, but exceeding the code requirements, shall govern unless written permission to the contrary is granted by the Owner's Representative.

- B. Extreme care shall be exercised at all times by the Contractor in excavating and working in the project area due to existing utilities and irrigation systems to remain. Contractor shall be fully responsible for expenses incurred in the repair of damages caused by their operation.
    - 1. The Contractor is responsible for identifying and maintaining existing irrigation main lines that supply water to areas on the site as noted on the drawings and outside of the proposed limit of work. The Contractor shall relocate or replace existing irrigation main line piping as required to provide a continuous supply of water to all areas of existing irrigation on site.
      - a. Providing continuous water supply shall include hand watering and or the use of watering trucks to provide adequate water.
  - C. Plan locations of backflow preventers, valves, controllers, irrigation lines, sleeves, spray heads and other equipment are diagrammatic and indicate the spacing and relative locations of all installations. Final site conditions and existing and proposed plantings shall determine final locations and adjusted as necessary and as directed to meet existing and proposed conditions and obtain complete water coverage. Minor changes in locations of the above from locations shown shall be made as necessary to avoid existing and proposed trees, piping, utilities, structures, etc. at the Contractor's expense or when directed by the Owner's Representative.
    - 1. The Contractor shall be held responsible for relocation of any items without first obtaining the Owner's Representative's approval. The Contractor shall remove and relocate such items at their expense if so directed by the Owner's Representative.
  - D. Prior to any work the Contractor shall stake out locations of all pipe, valves, equipment and irrigation heads and emitters using an approved staking method and maintain the staking of the approved layout in accordance with the drawings and any required modifications. Verify all horizontal and vertical site dimensions prior to staking of heads. Do not exceed spacing shown on drawings for any given area. If such modified spacing demand additional or less material than shown on the drawings, notify the Owner's Representative before beginning any work in the adjacent area.
  - E. Stub out main line at all end runs and as shown on drawings. Stub out wires for future connection where indicated on plan and as directed.
  - F. Point of connection shall be approximately as shown on drawings. Connect new underground piping and valves and provide all flanges, adapters or other necessary fittings for connection.
  - G. Permission to shut off any existing in-use water line must be obtained 48 hours in advance, in writing from the Owner. The Contractor shall receive instructions from the Owner's Representative as to the exact length of time of each shut-off.
  - H. No fittings shall be installed on pipe underneath pavement or walls.
  - I. Prior to starting any work, Contractor shall obtain a reading of existing static water pressure (no flow condition) at the designated point of connection and immediately submit written verification of pressure with date and time of recording to Owner's Representative.
- 3.2 TRENCHING, DIRECTIONAL BORING AND SLEEVING
- A. Perform all trenching, directional boring, sleeving and excavations as required for the installation of the work included under this section, including shoring of earth banks to prevent cave-ins.

- B. The Contractor may directional bore lines where it is practical or where required on the plans.
  - 1. Extend the bore 1' past the edge of pavement unless noted differently on the plans
  - 2. Cap ends of each bore and locate ends at finished grade using metal stakes.
  - 3. All boring and sleeving shall have detectable locator tape placed at the ends of the pipe.
- C. Make trenches for mains, laterals and control wiring straight and true to grade and free of protruding stones, roots or other material that would prevent proper bedding of pipe or wire.
- D. Excavate trenches wide enough to allow a minimum of 4 - inch between parallel pipelines and 8 inch from lines of other trades. Maintain 3 - inch vertical clearance between irrigation lines. Minimum transverse angle is 45 degrees. All pipes shall be able to be serviced or replaced without disturbing the other pipes.
- E. Trenches for pipelines shall be made of sufficient depth to provide the minimum cover from finished grade as follows:
  - 1. Pressure main line: 18 inches below finish grade and 24-30 inches below paved areas in Schedule 40 PVC sleeves.
  - 2. Reclaimed water constant pressure main lines shall cross at least twelve (12) inches below potable water lines.
    - a. If a constant pressure reclaimed water main line must be installed above a potable water line or less than twelve (12) inches below a potable water line, then reclaimed water line shall be installed within an approved protective sleeve. The sleeve shall extend ten (10) feet from each side of the center of the potable line, for a total of twenty (20) feet. The sleeve shall be color-coded (purple) for use with reclaimed water.
  - 3. Lateral lines: 12 inches below finish grade and 18 inches below paved areas in Schedule 40 PVC sleeves.
  - 4. Control wiring: to the side of pressure main line and 24 inches below paved areas in Schedule 40 PVC sleeves.
- F. On new on-site systems (post-meter), the required horizontal separation between potable water lines, reclaimed water constant pressure main lines and sewer lines shall be a minimum of four (4) feet apart as directed by the project engineer and/ or regulatory agency. Measurements shall be between facing surfaces, not pipe centerlines.
- G. When trenching through areas of imported or modified soil, deposit imported or modified soils on one side of trench and subsoil on opposite side.
- H. Backfill the trench per the requirements in paragraphs "Backfilling and Compacting" below.

### 3.3 PIPE INSTALLATION

- A. General Pipe Installation
  - 1. Exercise caution in handling, loading and storing, of plastic pipe and fittings to avoid damage.
    - a. The pipe and fittings shall be stored under cover until using, and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat so as not to be subjected to undue bending or concentrated external load at any point.

- b. All pipe that has been dented or damaged shall be discarded unless such dent or damaged section is cut out and pipe rejoined with a coupling.
2. Trench depth shall be as specified above from the finish grade to the top of the pipe.
3. Install a detectable pipe locator tape 6 to 8 inches above all main line pipes.

B. Polyvinyl Chloride Pipe (PVC) Installation

1. Under no circumstance is pipe to rest on concrete, rock, wood blocks, construction debris or similar items.
2. No water shall be permitted in the pipe until a period of at least 24 hours has elapsed for solvent weld setting and curing.
3. Install assemblies and pipe to conform to respective details and where shown diagrammatically on drawings, using first class workmanship and best standard practices as approved. All fittings that are necessary for proper connections such as swing joints, offsets, and reducing bushings that are not shown on details shall be installed as necessary and directed as part of the work.
4. Dielectric bushings shall be used in any connections of dissimilar metals.
5. Gasketed plastic pipe: pipe-to-pipe joints or pipe to fittings shall be made in accordance with manufacturer's specifications.
6. Solvent weld or threaded plastic pipe:
  - a. Installation of all pipe and fittings shall be in strict accordance with manufacturer's specifications.
  - b. Pipe shall be cut using approved PVC pipe cutters only. Sawed joints are disallowed. All field cuts shall be beveled to remove burrs and excess before gluing.
  - c. Welded joints shall be given a minimum of 15 minutes to set before moving or handling. Excess solvent on the exterior of the joint shall be wiped clean immediately after assembly.
  - d. Plastic to metal connections shall be made with plastic adapters and if necessary, short (not close) brass threaded-nipples. Connection shall be made with two (2) wraps of Teflon tape and hand tightened plus one turn with a strap wrench.
  - e. Snake pipe horizontally in trench to allow one (1) foot of expansion and contraction per 100 feet of straight run.
  - f. Threaded pipe joints shall be made using Teflon tape. Solvent shall not be used with threaded joints. Pipe shall be protected from tool damage during assembly. All damaged pipe shall be removed and replaced. Take up threaded joints with light wrench pressure.
  - g. No close nipples or risers are allowed. Cross connections in piping is disallowed.
  - h. Center load pipe at 10 feet on center intervals with small amount of backfill to prevent arching and slipping under pressure. Other than this preliminary backfill all pipe joints, fittings and connections are to remain uncovered until successful completion of hydrostatic testing and written approval of the testing report.
  - i. Concrete thrust blocks shall be constructed behind all pipe fittings 1-1/2 inch diameter and larger at all changes of direction of 45 degrees or more.

C. Galvanized Pipe Installation

1. All joints shall be threaded with pipe joint compound used on all threads.
2. Dielectric bushings shall be used in any connections of dissimilar metals.

3.4 TRENCHING, DIRECTIONAL BORING, AND SLEEVING REVIEW:

- A. Upon completion and installation of all trenching, directional boring, and sleeving, all installed irrigation control wiring, lines and fittings shall be visually observed by the Owner's

Representative unless otherwise authorized. Do not cover any wires, lines or fittings until they have been tested and observed by the Owner's Representative.

### 3.5 FLUSHING

- A. Openings in piping system during installation are to be capped or plugged to prevent dirt and debris from entering pipe and equipment. Remove plugs when necessary to flush or complete system.
- B. After completion and prior to the installation of any terminal fittings, the entire pipeline system shall be thoroughly flushed to remove dirt, debris or other material.

### 3.6 HYDROSTATIC PRESSURE TESTING

- A. After flushing, and the installation of valves the following tests shall be conducted in the sequence listed below. The Contractor shall furnish all equipment; materials and labor necessary to perform the tests and all tests shall be conducted in the presence of the Owner's Representative.
- B. Water pressure tests shall be performed on all pressure main lines before any couplings, fittings, valves and the like are concealed.
- C. Immediately prior to testing, all irrigation lines shall be purged of all entrapped air or debris by adjusting control valves and installing temporary caps forcing water and debris to be discharged from a single outlet.
- D. Test all pressure main line at 150 PSI. For a minimum of four (4) hours with an allowable loss of 5 PSI. Pressure and gauges shall be read in PSI, and calibrated such that accurate determination of potential pressure loss can be ascertained.
- E. Re-test as required until the system meets the requirements. Any leaks, which occur during test period, will be repaired immediately following the test. All pipe shall be re-tested until final written acceptance.
- F. The Contractor is responsible for proving documentation stating the weather conditions, date, the start time and initial water pressure readings, the finish time and final water pressure readings and the type of equipment used to perform the test. The documentation must be signed by a witness acceptable to the Owner, verifying all of the above-mentioned conditions.
- G. Submit a written report of the pressure testing results with the other above required information to the Owner's Representative for approval.

### 3.7 BACKFLOW PREVENTER TESTING

- A. The backflow preventer shall be tested according to procedures and results per the requirements of the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California or American Water Works Association whichever is more stringent.
- B. Testing shall be performed by a Backflow Prevention Assembly Tester with a current certification from the American Backflow Preventer Association.

### 3.8 BACKFILLING AND COMPACTING

- A. Irrigation trenches shall be carefully backfilled with material approved for backfilling and free of rocks and debris one (1) inch in diameter and larger. When back filling trenches in areas of imported or modified planting soil, replace any excavated subsoil at the bottom and the imported soil or modified planting soil at the top of the trench.
- B. Backfill shall be compacted with approved equipment to the following densities
  - 1. Backfill under pavement and within 2 feet of the edge of pavement: Compact to 95% or greater of maximum dry density standard proctor.
  - 2. Backfill of subsoil under imported planting mixes or modified existing planting soil: Between 85 and 90% of maximum dry density standard proctor.
  - 3. Backfill of imported planting mixes or modified existing planting soil: Compact to the requirements of the adjacent planting mix or planting soil as specified in section "Planting Soil".
- C. Finish grade of all trenches shall conform to adjacent grades without dips or other irregularities. Dispose of excess soil or debris off site at Contractor's expense.
- D. Any settling of backfill material during the maintenance or warranty period shall be repaired at the Contractor's expense, including any replacement or repair of soil, lawn, and plant material or paving surface.

### 3.9 RESURFACING PAVING OVER TRENCHES

- A. Restore all surfaces and repair existing underground installations damaged or cut as a result of the excavation to their original condition, satisfactory to the Owner's Representative.
- B. Trenches through paved areas shall be resurfaced with same materials quality and thickness as existing material. Paving restoration shall be performed by the project paving Sub-contractor or an approved Contractor skilled in paving work.
- C. The cost of all paving restoration work shall be the responsibility of the irrigation Contractor unless the trenching thru the paving was, by previous agreement, part of the general project related construction.

### 3.10 INSTALLATION OF EQUIPMENT

- A. General:
  - 1. All equipment shall be installed to meet all installation requirements of the product manufacturer. In the event that the manufactures requirements cannot be implemented due to particular condition at the site or with other parts of the design, obtain the Owner's Representative's written authorization and approval for any modifications.
  - 2. Install all equipment at the approximately at the location(s) and as designated and detailed on the drawings. Verify all locations with the Owner's Representative.
  - 3. Install all valves within a valve box of sufficient size to accommodate the installation and servicing of the equipment. Group valves together where practical and locate in shrub planting areas.
  - 4. All sprinkler irrigation systems that are using water from potable water systems shall require backflow prevention. All backflow prevention devices shall meet and be installed in accordance with requirements set forth by local codes and the health department.
- B. Pressure regulator:
  - 1. Set regulator for required PSI per manufacturer's specifications.

- C. Check Valve:
  - 1. Install check valves approximately at the locations necessary to prevent low head run off.
- D. Remote control valves:
  - 1. Install one remote control valve per valve box.
  - 2. Remote control valve manifolds and quick coupler valves shall be separate allowing use of a quick coupler with all remote control valves shut off.
  - 3. Install boxes no farther than 12 inches from edge of paving and perpendicular to edge of paving and parallel to each other. Allow 12 inches clearance between adjacent valve boxes.
- E. Quick coupler valve:
  - 1. Install each quick coupler valve in its own valve box.
  - 2. Install thrust blocks on quick couplers.
  - 3. Place no closer than 12 inches to adjacent paving.
  - 4. Install 18 inches off set from main line.
- F. Sprinkler heads:
  - 1. All main lines and lateral lines, including risers, shall be flushed and pressure tested before installing sprinkler heads.
  - 2. Install specified sprinkler heads as shown in details at locations shown on the drawings. Adjust layout for full coverage, spacing of heads shall not exceed the maximum spacing recommended by the manufacturer.
  - 3. All sprinkler heads shall be set perpendicular to finish grade unless otherwise designated on the drawings or details.
- G. Irrigation controllers:
  - 1. Remote control valves shall be connected to controller in numerical sequence as shown on the drawings.
  - 2. Controller shall be tested with complete electrical connections. The Contractor shall be responsible for temporary power to the controller for operation and testing purposes.
  - 3. Connections to control wiring shall be made within the pedestal of the controller. All wire shall follow the pressure main insofar as possible.
  - 4. Electrical wiring shall be in a rigid gray PVC plastic conduit from controller to electrical outlet. The electrical Contractor shall be responsible for installing all wiring to the controller, in order to complete this installation. A disconnect switch shall be included.
- H. Wiring:
  - 1. Low Voltage
    - a. Control wiring between controller and electrical valves shall be installed in the same trench as the main line where practical. The wire shall be bundled and secured to the lower quadrant of the trench at 10 foot intervals with plastic electrical tape.
    - b. When the control wiring cannot be installed in the same main line trench it shall be installed a minimum of 18 inches below finish grade and a bright colored plastic ribbon with suitable markings shall be installed in the trench 6 inches below grade directly over the wire.

- c. An expansion loop shall be provided every 500 feet in a box and inside each valve box. Expansion loop shall be formed by wrapping wire at least eight (8) times around a  $\frac{3}{4}$  inch pipe and withdrawing pipe.
  - d. Provide one control wire to service each valve in system.
  - e. Provide common wire(s) per controller requirements.
  - f. Run two (2) spare #14-1 wires from controller along entire main line to last electric remote control valve on each and every leg of main line. Label spare wires at controller and wire stub to be located in a box.
  - g. All control wire splices not occurring at control valve shall be installed in a separate splice valve box.
  - h. Wire markers (sealed, 1 inch to 3 inch square) are to identify control wires at valves and at terminal strips of controller. At the terminal strip mark each wire clearly indicating valve circuit number.
2. High Voltage
- a. All electrical work shall conform to local codes, ordinances and any authorities having jurisdiction. All high voltage electrical work to be performed by licensed electrician.
  - b. The Contractor shall provide 120-volt power connection to the automatic controller unless noted otherwise on drawings.
- I. Valve boxes:
1. Install one valve box for each type of valve installed as per the details.
  2. Gravel sump shall be installed after compaction of all trenches. Final portion of gravel shall be placed inside valve box after valve is backfilled and compacted.
  3. Permanently label valve number and or controller letter on top of valve box lid using a method approved by the Owners Representative.
- J. Tracer wire:
1. Tracer wire shall be installed with non-metallic plastic irrigation main lines where controller wires are not buried in the same trench as the main line.
  2. The tracer wire shall be placed on the bottom of the trench under the vertical projection of the pipe with spliced joints soldered and covered with insulation type tape.
  3. Tracer wire shall be of a color not used for valve wiring. Terminate wire in a valve box. Provide enough length of wire to make a loop and attach wire marker with the designation "tracer wire".
- K. Drip Installation:
1. Clamp fittings with Oetiker clamps or approved equal when operating pressure exceeds specific drip tubing fitting requirements.
  2. When installing drip tubing, install soil staples as listed below:
    - a. Sandy Soil - One staple every three (3') feet and two (2) staples on each change of direction (tee, elbow, or cross).
    - b. Loam Soil - One staple every four (4') feet and two (2) staples on each change of direction (tee, elbow, or cross).
    - c. Clay Soil - One staple every five (5') feet and two (2) staples on each change of direction (tee, elbow, or cross).

3. Cap or plug all openings as soon as lines have been installed to prevent the intrusion of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.
4. Thoroughly flush all water lines before installing valves and other hydrants.

### 3.11 ADJUSTMENT AND COVERAGE TEST

#### A. Adjustment:

1. The Contractor shall flush and adjust all sprinkler heads, valves and all other equipment to ascertain that they function according to the manufacturer's data.
2. Adjust all sprinkler heads not to overspray onto walks, roadways and buildings when under maximum operating pressure and during times of normal prevailing winds.

#### B. Coverage test:

1. The Contractor shall perform the coverage test in the presence of the Owner's Representative after all sprinkler heads have been installed, flushed and adjusted. Each section is tested to demonstrate uniform and adequate coverage of the planting areas serviced.
2. Any systems that require adjustments for full and even coverage shall be done by the Contractor prior to final acceptance at the direction of the Owner's Representative at no additional cost. Adjustments may also include realignment of pipes, addition of extra heads, and changes in nozzle type or size.
3. The Contractor at no additional cost shall immediately correct all unauthorized changes or improper installation practices.
4. The entire irrigation system shall be operating properly with written approval of the installation by the Owner's representative prior to beginning any planting operations.

### 3.12 REPAIR OF PLANTING SOIL

- #### A.
- Any areas of planting soil including imported or existing soils or modified planting soil which become compacted or disturbed or degraded as a result of the installation of the irrigation system shall be restored to the specified quality and compaction prior to beginning planting operations at no additional expense to the Owner. Restoration methods and depth of compaction remediation shall be approved by the Owner's Representative.

### 3.13 CLEAN-UP

- #### A.
- During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.

1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.

- #### B.
- Once installation is complete, wash all soil from pavements and other structures.

1. Make all repairs to grades ruts, and damage to the work or other work at the site.
2. Remove and dispose of all excess soil, packaging, and other material brought to the site by the Contractor.

### 3.14 PROTECTION

- A. The Contractor shall protect installed irrigation work from damage due to operations by other Contractors or trespassers.
  - 1. Maintain protection during installation until Acceptance. Treat, repair or replace damaged work immediately. The Owner's Representative shall determine when such treatment, replacement or repair is satisfactory.

### 3.15 PRE-MAINTENANCE OBSERVATION:

- A. Once the entire system shall be completely installed and operational and all planting is installed, the Owner's Representative shall observe the system and prepare a written punch list indicating all items to be corrected and the beginning date of the maintenance period.
- B. This is not final acceptance and does not relieve the Contractor from any of the responsibilities in the contract documents.

### 3.16 GENERAL MAINTENANCE AND THE MAINTENANCE PERIOD

- A. General maintenance shall begin immediately after installation of irrigation system. The general maintenance and the maintenance period shall include the following:
  - 1. On a weekly basis the Contractor shall keep the irrigation system in good running order and make observations on the entire system for proper operation and coverage. Repair and cleaning shall be done to keep the system in full operation.
  - 2. Records of all timing changes to control valves from initial installation to time of final acceptance shall be kept and turned over to the Owner's Representative at the time of final acceptance.
  - 3. During the last week of the maintenance period, provide equipment familiarization and instruction on the total operations of the system to the personnel who will assume responsibility for running the irrigation system.
  - 4. At the end of the maintenance period, turn over all operations logs, manuals, instructions, schedules, keys and any other equipment necessary for operation of the irrigation system to the Owner's Representative who will assume responsibility for the operations and maintenance of the irrigation system.
- B. The maintenance period for the irrigation system shall coincide with the maintenance period for the Planting. (See specification section "Planting").

### 3.17 SUBSTANTIAL COMPLETION ACCEPTANCE

- A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
- B. The date of substantial completion of the irrigation shall be the date when the Owner's Representative accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.

### 3.18 FINAL ACCEPTANCE / SYSTEM MALFUNCTION CORRECTIONS

- A. At the end of the Plant Warrantee and Maintenance period, (See specification section "Planting") the Owner's Representative shall inspect the irrigation work and establish that all provisions of the irrigation system are complete and the system is working correctly.
  - 1. Restore any soil settlement over trenches and other parts of the irrigation system.
  - 2. Replace, repair or reset any malfunctioning parts of the irrigation system.

- B. The Contractor shall show all corrections made from punch list. Any items deemed not acceptable shall be reworked and the maintenance period will be extended.
- C. The Contractor shall show evidence that the Owner's Representative has received all charts, records, drawings, and extra equipment as required before final acceptance.
- D. Failure to pass review: If the work fails to pass final review, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the reviewer.

END OF SECTION

## SECTION 329115 - SOIL PREPARATION (PERFORMANCE SPECIFICATION)

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

1.2 Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.3 SUMMARY

- A. Section includes preconstruction soil testing and planting soils specified according to performance requirements of the mixes.
- B. Related Requirements:
  - 1. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
  - 2. Section 329300 "Plants" for placing planting soil for plantings.

#### 1.4 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- M. SSSA: Soil Science Society of America.
- N. 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.
- O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- Q. USCC: U.S. Composting Council.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include recommendations for application and use.
  - 2. Include test data substantiating that products comply with requirements.
  - 3. Include sieve analyses for aggregate materials.
  - 4. Material Certificates: For each type of imported soil, soil amendment, and fertilizer before delivery to the site, according to the following:
    - a. Manufacturer's qualified testing agency's certified analysis of standard products.
    - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

#### 1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.
  - 1. Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

#### 1.7 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Landscape Architect, soil scientist (CPSS) certified by SSSA, or state-certified, -licensed, or -registered soil scientist under the direction of the testing agency.
  1. Number and Location of Samples: Minimum of five representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
  2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
  3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
  4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

#### 1.8 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
  1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
    - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
    - b. Hydrometer Method: Report percentages of sand, silt, and clay.
  2. Bulk Density: Analysis according to core method and clod method of SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  3. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  4. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  5. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85 percent compaction according to ASTM D698 (Standard Proctor).
- C. Chemical Testing:
  1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
  2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.

4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
- D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol of SSSA NAPT SERA-6, including the following:
1. Percentage of organic matter.
  2. CEC, calcium percent of CEC, and magnesium percent of CEC.
  3. Soil reaction (acidity/alkalinity pH value).
  4. Buffered acidity or alkalinity.
  5. Nitrogen ppm.
  6. Phosphorous ppm.
  7. Potassium ppm.
  8. Manganese ppm.
  9. Manganese-availability ppm.
  10. Zinc ppm.
  11. Zinc availability ppm.
  12. Copper ppm.
  13. Sodium ppm and sodium absorption ratio.
  14. Soluble-salts ppm.
  15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
  16. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inchdepth of soil.
  2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inchdepth of soil.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  3. Do not move or handle materials when they are wet or frozen.

4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Regional Materials: soil amendments and fertilizers shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

### 2.2 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

- A. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained; and/or stockpiled on-site; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:

1. Particle Size Distribution by USDA Textures: Classified as sandy loam soil according to USDA textures.
2. Percentage of Organic Matter: Minimum 5 percent by volume.
3. Soil Reaction: pH of 6 to 7.

- B. Planting-Soil Type: Imported. Where existing soil has been removed, settled or compacted to more than 85% Standard Proctor: Manufactured soil consisting of manufacturer's basic topsoil, blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials as specified in other articles of this Section to produce viable planting soil.

1. Basic Properties: Manufactured soil shall not contain the following:
  - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
  - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the imported soil.
  - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches in any dimension.
2. Soil Reaction: pH of 6 to 7.

### 2.3 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

- D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- E. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

#### 2.4 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
  - 1. Feedstock: Limited to leaves.
  - 2. Reaction: pH of 5.5 to 7.
  - 3. Soluble-Salt Concentration: Less than 4 dS/m.
  - 4. Moisture Content: 35 to 55 percent by weight.
  - 5. Organic-Matter Content: 30 to 40 percent of dry weight.
  - 6. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.
- B. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

#### 2.5 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. 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 planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

### 3.2 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 8 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth of 4 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
- D. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.3 PROTECTION

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Landscape Architect and replace contaminated planting soil with new planting soil.

### 3.4 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
  - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION

## SECTION 329300 - PLANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

1.2 Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section

#### 1.3 SUMMARY

A. Scope: Provide labor, materials, appliances, tools, equipment, facilities, transportation, and related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for planting as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

B. Section Includes:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.

C. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 320190 "Operation and Maintenance of Planting" for detailed maintenance requirements and warranty.
3. Section 328400 "Irrigation" for complete irrigation systems.
4. Section 329115 "Soil Preparation (Performance Specification)" for soil preparation of planting, lawn, and seeding areas.

#### 1.4 REFERENCES

A. The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail or as determined by the Owners' Representative. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

C. American Association of Nurserymen, Inc. (AAN):

1. ANSI/AAN Z60.1, "American Standard for Nursery Stock" (copyrighted by AAN, ANSI approved).
  - D. American National Standards Institute:
    1. ANSI A300, "Standard Practices for Tree, Shrub, and Other Wood Plant Maintenance."
  - E. American Wood Preservers Bureau (AWPB):
    1. AWPB LP 22, "Standard for Softwood Lumber and Plywood, Pressure Treated with Water Borne Preservatives for Ground Contact Use."
  - F. American Society for Testing and Materials (ASTM):
    1. ASTM C 33, "Standard Specification for Concrete Aggregates."
    2. ASTM D 3385-09 "Infiltration Testing."
    3. ASTM D 5268, "Standard Specification for Topsoil Used for Landscaping Purposes."
  - G. Florida Department of Agriculture, Tallahassee, Florida:
    1. "Florida Grades and Standards for Nursery Stock."
  - H. Texas Nursery & Landscape Association:
    1. "Grades and Standards."
  - I. Interpretation of plant names and descriptions shall reference the following documents. Where the names or plant descriptions disagree between the several documents, the most current document shall prevail.
    1. USDA - The Germplasm Resources Information Network (GRIN)
    2. Manual of Woody Landscape Plants; Michael Dirr; Stipes Publishing, Champaign, Illinois.
    3. The New Sunset Western Garden Book, Oxmoor House.
  - J. Pruning practices shall conform to recommendations "Structural Pruning: A Guide For The Green Industry"; published by Urban Tree Foundation, Visalia, California.
  - K. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign, IL.
- 1.5 COORDINATION
- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
    1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.
- 1.6 VERIFICATION
- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner's Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner's Representative.

- B. In the case of a discrepancy in the plant quantities between the plan drawings and the plant call outs, list or plant schedule, the number of plants or square footage of the planting bed actually drawn on the plan drawings shall be deemed correct and prevail.

#### 1.7 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

#### 1.8 PROTECTION OF WORK, PROPERTY, AND PERSON

- A. The Contractor, at their own cost, shall remove and replace any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest as possible time that can be coordinated with other work and seasonal weather demands.

#### 1.9 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. 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.
- D. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

- G. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
  - H. Planting Area: Areas to be planted.
  - I. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.
  - J. 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.
  - K. 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.
  - L. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
  - M. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
  - N. Weeds: Any plant life not specified, scheduled, or identified to be protected in place.
- 1.10 PREINSTALLATION MEETINGS
- A. Preinstallation Conference: Conduct conference at Project site.
- 1.11 ACTION SUBMITTALS
- A. General: See Division 01 – General Requirements for Submittal Procedures.
  - B. Product Data: Submit product data for each product showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Product data shall include, but shall not be limited to, manufacturer's specifications for:
    - 1. Plant materials.
    - 2. Fertilizers.
    - 3. Weed-control barriers.
    - 4. Mulches.
    - 5. Herbicides and pesticides.
    - 6. Tree-stabilization materials.
    - 7. Landscape edgings.
  - C. Samples for Verification: Actual sample of finished products for each of the following:
    - 1. Planting Soil Mix: 1-quart volume of planting soils required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of soils. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
    - 2. Organic Mulch: 1-quart volume of each organic mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.

3. Nutshell Mulch: 1-quart volume of mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.
  4. Mineral Mulch: 2 lb of each mineral mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with source of mulch. Provide accurate indication of color, texture, and makeup.
  5. Weed-Control Barrier: 12 by 12 inches.
  6. Proprietary Root-Ball-Stabilization Device: One unit.
  7. Slow-Release, Tree-Watering Device: One unit of each size required.
  8. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
  9. Root Barrier: Width of panel by 12 inches.
- D. Plant Material Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 10 plants are required, include a minimum of five photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, quantity, and name of the growing nursery.

#### 1.12 INFORMATIONAL SUBMITTALS

- A. Field Quality Control Reports: Percolation drainage tests for tree pits. Excavate and fill holes with water as directed in Drainage Testing Paragraph in Part 3 – Execution. Fill holes with soil immediately after testing. Do not leave open pits. Include the following:
1. Tree identification number matching the plans.
  2. Date of test.
  3. Time when water was added to tree pit to start percolation test.
  4. Time with photo documentation showing increments of testing with water level in tree pit.
  5. Identification of tester.
- B. Qualification Statements: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- C. Project Schedule: Submit chart identifying proposed Project schedule and Project progress.
- D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with manufacturer's certified analysis of standard products.
- E. Pesticides and Herbicides: Product label and manufacturer's written application instructions specific to Project.
- F. Project Record Documents: Maintain Project Record Drawings and Specifications in good order and marked to record changes in the Work.
- G. Warranty period site visit record: Contractor is required to visit the site periodically, minimum one (1) visit per month, and submit a written record of the visit, including any problems, potential problems, and recommendations for corrective action to the Owner's Representative.

1.13 SELECTION OF PLANT MATERIALS AND OBSERVATION OF THE WORK

- A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Landscape Architect shall be informed of the progress of the Work so the Work may be observed at the following key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visit to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification. Notifications shall include, but shall not be limited to the following:
  - 1. Site conditions prior to the start of planting: review the soil and drainage conditions.
  - 2. Completion of the plant layout staking: Review of the plant layout.
  - 3. Plant quality: Review of plant quality at the time of delivery and prior to installation. Review tree quality prior to unloading where possible, but in all cases prior to planting.
  - 4. Completion of the planting: Review the completed planting.
- C. The Landscape Architect shall review all plants subject to approval of size, health, quality, character, etc. Review or approval of any plant during the process of selection, delivery, installation, and establishment period shall not prevent that plant from later rejection in the event that the plant quality changes or previously existing defects become apparent that were not observed.
- D. Plant Selection: The Landscape Architect reserves the right to and shall select and observe all trees and representative plants at the nursery prior to delivery and to reject plants that do not meet specifications as set forth in this specification.
  - 1. The Landscape Architect may make invasive observation of the plant's root system in the area of the root collar and the top of the root ball in general in order to determine that the plant meets the quality requirements for depth of the root collar and presence of roots above the root collar. Such observations will not harm the plant.
  - 2. The Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of Work. Remove rejected trees or shrubs immediately from Project site.
- E. The Contractor shall bear all cost related to plant corrections.
- F. All plants that are rejected shall be immediately removed from the site and acceptable replacement plants provided at no cost to the Owner. Rejected plant material shall be removed and replaced within fifteen (15) days.
- G. Submit to the Owner's Representative, for approval, plant sources including the names and locations of nurseries proposed as sources of acceptable plants, and a list of the plants they will provide. The plant list shall include the botanical and common name and the size at the time of selection. Observe all nursery materials to determine that the materials meet the requirements of this section.
- H. Trees shall be purchased from the growing nursery. Re-wholesale plant suppliers shall not be used as sources unless the Contractor can certify that the required trees are not directly available from a growing nursery. When Re-wholesale suppliers are utilized, the Contractor shall submit the name and location of the growing nursery from where the trees were obtained

by the re-wholesale seller. The re-wholesale nursery shall be responsible for any required plant quality certifications.

- I. The Contractor shall require the grower or re-wholesale supplier to permit the Owner's Representative to observe the root system of all plants at the nursery or job site prior to planting including random removal of soil or substrate around the base of the plant. Observation may be as frequent and as extensive as needed to verify that the plants meet the requirements of the specifications and conform to requirements.
- J. Each tree shall have a numbered seal applied by the Contractor. The seal shall be placed on a lateral branch on the north side of the tree. The seal shall be a tamper proof plastic seal bearing the Contractor's name and a unique seven-digit number embossed on the seal.
  - 1. Do not place seals on branches that are so large that there is not sufficient room for the branch growth over the period of the warranty.
- K. The Landscape Architect may choose to attach their seal to each plant, or a representative sample. Viewing and/or sealing of plants by the Owner's Representative at the nursery does not preclude the Landscape Architect's right to reject material while on site. The Contractor is responsible for paying any up charge for the Owner's Representative to attach their seal to specific plants.

#### 1.14 PLANT SUBSTITUTIONS

- A. Submit all requests for substitutions of plant species or sizes not available, to the Landscape Architect for approval, prior to purchasing the proposed substitution. Request for substitution shall be accompanied with a list of nurseries contacted in the search for the required plant and a record of other attempts to locate the required material. Requests shall also include sources of plants found that may be of a smaller or larger size, or a different shape or habit than specified, or plants of the same genus and species but different cultivar origin, or which may otherwise not meet the requirements of the specifications, but which may be available for substitution.

#### 1.15 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

#### 1.16 MEASUREMENT, GRADING, & QUANTITIES

- A. Time: The specified sizes and grades shall be at the time of delivery to site. Any assessment or measurement before this time can only be based on the plant characteristics at that time and not any future or predicted growth potential of the plant.
- B. Size: The measurements specified or referenced shall be the minimum sizes acceptable after any necessary pruning and with branches, trunks or canes in their normal position. Plants that meet measurements specified but do not possess a normal balance between height and spread shall be rejected. Plants larger than specified may be used if approved by the Landscape Architect. Use of such plants shall not increase the Contract price. If larger plants are approved, increase the root ball size in proportion to the size of the plant.
- C. Quantity: If there is a discrepancy between the number of plants drawn and the number of plants listed or noted, then the number of plants drawn, or square footage of the planting bed drawn shall take precedence. Verification of all quantities is the sole responsibility of the Contractor. For planting areas shown as filled areas, Contractor shall fill areas with specified plants per spacing provided.

#### 1.17 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
  - 1. Professional Membership: Member in good standing of either the National Association of Landscape Professionals or AmericanHort.
  - 2. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
  - 3. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Personnel Certification: Installer's field supervisor certified in one of the following categories from the National Association of Landscape Professionals:
    - a. Landscape Industry Certified Technician - Exterior.
    - b. Landscape Industry Certified Horticultural Technician.
  - 5. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure in accordance with ANSI Z60.1. Do not prune to obtain required sizes.
  - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
  - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

#### 1.18 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, or walkways and pavements; or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Packing and Shipping: Transport plant materials covered or in closed vehicles to protect them from exposure to heat, cold, and wind. Spray evergreens and trees in full leaf with anti-desiccant as recommended by the manufacturer, before shipping. Take precautions to protect

plant materials from desiccation and from damage to bark and branches. Do not allow root balls to crack. Lift balled and burlapped plants from the ball with straps, do not lift trees by the trunks. Schedule shipments to coincide with planting seasons. Thoroughly remove anti desiccant from plant materials after installations. Cracked, soft, or "mushroomed" rootballs will be unacceptable and rejected.

- E. Handle planting stock by root ball.
- F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  - 2. Do not remove container-grown stock from containers before time of planting.
  - 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

#### 1.19 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
  - 1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Owner's Representative in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Owner's Representative of such conditions, he/she shall remain responsible for plant material under the warranty clause of the specifications.
- C. It is the responsibility of the Contractor to be familiar with the local growing conditions, and if any specified plants will be in conflict with these conditions. Report any potential conflicts, in writing, to the Owner's Representative.
- D. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.
  - 1. Planting operations shall not begin until such time that the irrigation system is completely operational for the area(s) to be planted, and the irrigation system for that area has been preliminarily observed and approved by the Owner's Representative.
- E. Actual planting shall be performed during those periods when weather and soil conditions are suitable in accordance with locally accepted horticultural practices.

1. Do not install plants into saturated or frozen soils. Do not install plants during inclement weather, such as rain or snow or during extremely hot, cold, or windy conditions.

- F. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

#### 1.20 PLANTING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of Local Utility Locator Service is required for all planting areas: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the Local Utility Locator Service.

#### 1.21 MAINTENANCE

- A. Maintenance Service: Maintain the work of this Section until the date of Substantial Completion. In addition, the contractor shall provide maintenance starting at the date Substantial Completion through Project Closeout for the scope of work and perform the following operations at least once a week:
  1. Remove and replace dead plant material. Prune plants to remove dead wood.
  2. Maintain mulch areas at a 3-inch depth. Remove weeds and grass from shrub and groundcover areas and from tree watering saucers.
  3. Maintain tree staking and reset if required to maintain proper grade or vertical position.
  4. Provide insect and disease control to maintain health of plants.
  5. Provide irrigation at the minimum rate of 1 inch per week.
    - a. If the irrigation system is operating, program and monitor the system to provide adequate water for plants.
    - b. If the irrigation system is not operating, hand water plants. Deep water trees each week.
  6. See Section 320190 "Operation and Maintenance of Planting" for detailed maintenance requirements.
  7. If continuing maintenance is not included in this contract, periodically inspect the site during warranty period (not less than once per month) and notify the Owner in writing if proper maintenance is not being performed.

#### 1.22 WARRANTY

- A. Special Warranty: Installer agrees to remove and replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period. The Owner's Representative shall make the final determination if plantings and accessories are defective.
  1. Failures include, but are not limited to, the following:

- a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
  - b. Structural failures, including plantings falling or blowing over.
  - c. Faulty performance of tree stabilization, edgings, and tree grates.
  - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Periods: From date of Substantial Completion.
- a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
  - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
  - c. Annuals: Three months.
3. When the Work is accepted in parts, the warranty shall extend from Substantial Completion of the terminal date of all Work. This will ensure warranty period for all plantings shall terminate at one time.
4. All plants shall be warranted to meet all the requirements for plant quality at installation in this specification. Defective plants shall be defined as plants not meeting these requirements. The Owner's representative shall make the final determination that plants are defective.
5. Include the following remedial actions as a minimum:
- a. Immediately remove dead or dying plants and replace unless required to plant in the succeeding planting season. Remove and replace dead or dying plants within fifteen (15) days.
  - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
  - c. Provide extended warranty for period equal to original warranty period, for replaced plant material.
- B. End of Warranty Final Acceptance:
1. At the end of the warranty period, the Owner's Representative shall observe all warranted Work. The Contractor shall schedule and notify the Owner at least ten (10) days prior to the anticipated date for final inspection.
  2. End of Warranty Final Acceptance will be given only when all the requirements of the Work under this specification and in specification sections related to Planting and Irrigation have been met.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All plants and raw materials shall be grown, manufactured, extracted, and harvested within 250 miles of Project site.

### 2.2 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the manufacturers listed within this Section under each individual product description, as specified, or as indicated on Material Schedule.
- B. Acceptable Products: Subject to compliance with requirements, provide one of the products listed within this Section under each individual product description, as specified, or as indicated on Material Schedule.

## 2.3 PLANT MATERIALS

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of die-back, disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
  - 1. Trees with damaged, crooked, or multiple leaders; with tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); with crossing trunks; with cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
  - 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare in accordance with ANSI Z60.1.
- D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for plant.
- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to ensure symmetry in planting.
- F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but are not yet in bloom.
- G. Trees in tree grates: To ensure accessibility requirements are met, any trees to be planted in tree grates shall have a clear trunk of eighty-inches (80") above the finish grade of the pedestrian surface. Select trees with approximate ninety-two-inch (92") clear trunk. Pruning trees after installation to accommodate the height of the clear trunk requirement is not acceptable.

## 2.4 PLANT QUALITY

- A. Plant quality above the soil line:
  - 1. Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves normal to the plant type specified. Tree quality above the soil line shall comply with the project Crown Acceptance details (or Florida Grades and Standards, tree grade Florida Fancy or Florida #1) and the following:
    - a. Crown: The form and density of the crown shall be typical for a young specimen of the species or cultivar pruned to a central and dominant leader.
    - b. Leaves: The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of

prolonged moisture stress or over watering as indicated by wilted, shriveled, or dead leaves.

- c. Branches: Shoot growth (length and diameter) throughout the crown should be appropriate for the age and size of the species or cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.
    - 1) Main branches shall be distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.
    - 2) Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch union.
    - 3) The attachment of the largest branches (scaffold branches) shall be free of included bark.
  - d. Trunk: The tree trunk shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks (fungal fruiting bodies), wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, or lesions (mechanical injury).
  - e. Temporary branches, unless otherwise specified, can be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper. These branches should be no greater than 3/8-inch diameter. Clear trunk should be no more than 40% of the total height of the tree.
2. Trees shall have one central leader. If the leader was headed, a new leader (with a live terminal bud) at least one-half the diameter of the pruning cut shall be present.
    - a. All trees are assumed to have one central leader trees unless a different form is specified in the plant list or drawings.
  3. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.
  4. Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. Auxiliary stake may be used to maintain a straight leader in the upper half of the tree.
- B. Plant quality at or below the soil line:
1. Plant roots shall be normal to the plant type specified. Root observations shall take place without impacting tree health. Root quality at or below the soil line shall comply with the project Root Acceptance details and the following:
    - a. The roots shall be reasonably free of scrapes, broken or split wood.
    - b. The root system shall be reasonably free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Wounds resulting from root pruning used to produce a high-quality root system are not considered injuries.
    - c. A minimum of three structural roots reasonably distributed around the trunk (not clustered on one side) shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species.
      - 1) Plants with structural roots on only one side of the trunk (J roots) shall be rejected.

- d. The root collar shall be within the upper 2 inches of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all stem girdling roots above the structural roots across the top of the root ball.
- e. The root system shall be reasonably free of stem girdling roots over the root collar or kinked roots from nursery production practices.
  - 1) Plant Grower Certification: The final plant grower shall be responsible to have determined that the plants have been root pruned at each step in the plant production process to remove stem girdling roots and kinked roots, or that the previous production system used practices that produce a root system throughout the root ball that meets these specifications. Regardless of the work of previous growers, the plant's root system shall be modified at the final production stage, if needed, to produce the required plant root quality. The final grower shall certify in writing that all plants are reasonably free of stem girdling and kinked roots as defined in this specification, and that the tree has been grown and harvested to produce a plant that meets these specifications.
2. At time of observations and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.

## 2.5 ROOT BALL TYPES

- A. General: The following root ball types are permitted. Specific root ball types shall be required where indicated on the plant list or in this specification. Any type of root ball that is not specifically defined in this specification shall not be permitted.
- B. Balled And Burlapped Plants
  1. All Balled and Burlapped Plants shall be field grown, and the root ball packaged in a burlap and twine and/or burlap and wire basket package.
  2. Plants shall be harvested with the following modifications to standard nursery practices.
    - a. Prior to digging any tree that fails to meet the requirement for maximum soil and roots above the root collar, carefully removed the soil from the top of the root ball of each plant, using hand tools, water or an air spade, to locate the root collar and attain the soil depth over the structural roots requirements. Remove all stem girdling roots above the root collar. Care must be exercised not to damage the surface of the root collar and the top of the structural roots.
    - b. Trees shall be dug for a minimum of 4 weeks and a maximum of 52 weeks prior to shipping. Trees dug 4 to 52 weeks prior to shipping are defined as hardened-off. Digging is defined as cutting all roots and lifting the tree out of the ground and either moving it to a new location in the nursery or placing it back into the same hole. Trees that are stored out of the ground shall be placed in a holding area protected from extremes of wind and sun with the root ball protected by covering with mulch or straw and irrigated sufficiently to keep moisture in the root ball above wilt point and below saturation
    - c. If wire baskets are used to support the root ball, a "low profile" basket shall be used. A low profile basket is defined as having the top of the highest loops on the basket no less than 4 inches and no greater than 8 inches below the shoulder of the root ball package.

- 1) At nurseries where sandy soils prevent the use of “low profile baskets”, baskets that support the entire root ball, including the top, are allowable. Remove wire basket for planting if possible. If not possible due to loose root ball soils, remove a minimum of the top 1/2 of the wire basket.
- d. Twine and burlap used for wrapping the root ball package shall be natural, biodegradable material. If the burlap decomposes after digging the tree then the root ball shall be re-wrapped prior to shipping if roots have not yet grown to keep root ball intact during shipping.

C. Spade Harvested and Transplanted:

1. Spade Harvested and Transplanted Plants shall meet all the requirements for field grown trees. Root ball diameters shall be of similar size as the ANSI Z60.1 requirements for Balled and Burlapped plants.
2. Trees shall be harvested prior to leafing out (bud break) in the spring or during the fall planting period except for plants know to be considered as fall planting hazards. Plants that are fall planting hazards shall only be harvested prior to leafing out in the spring.
3. Trees shall be moved and planted within 48 hours of the initial harvesting and shall remain in the spade machine until planted.

D. Container (Including Above-Ground Fabric Containers and Boxes) Plants

1. Container plants may be permitted only when indicated on the drawing, in this specification, or approved by the Owner’s Representative.
2. Provide plants shall be established and well rooted in removable containers.
3. Container class size shall conform to ANSI Z60.1 for container plants for each size and type of plant.

2.6 SOURCE QUALITY CONTROL

A. Tree Procurement:

1. Within 60 days of award of Contract, notify Landscape Architect in writing of the availability or lack thereof of the specified plant material.
2. Procure trees and arrange for contract growing as required to ensure that plant material is available in the quantities and sizes specified, and of the quality specified, at time of installation.
3. Verify plant branching requirements with Landscape Architect prior to contract growing.
4. Landscape Architect will review advanced procured trees prior to initial purchase and at end of the first growing season.
5. Prior to delivery of advanced procured plant material to site, coordinate and schedule a final review of the plant material at the place of growth.
6. Review and acceptance of the advance-procured plant material at the place of growth does not cancel the right of the Landscape Architect to reject plant material at the site, if damage or unacceptable conditions are found that were not detected at the place of growth.

B. Plant Material Review and Tagging:

1. All Trees will be reviewed, photographed, and tagged using irremovable tags by the Landscape Architect at the nursery, or other place of growth prior to delivery of trees to site.
2. At the Landscape Architect’s discretion, shrubs may or may not be reviewed, photographed, and tagged by the Landscape Architect at the nursery or other place of

growth. If shrubs are not reviewed at the nursery, Contractor shall provide photographs of shrubs as a Submittal as outlined herein.

3. Tagging of plant material at the nursery or place of growth does not affect the right of the Landscape Architect to reject plant material at the site, if damage or unacceptable conditions are found that were not detected at the nursery, place of growth, or in the submitted photographs.

## 2.7 SOILS

- A. General: Reference Section 329113 "Soil Preparation" for details related to soils including agronomic soil testing, amendments, and compaction.
  1. Required depth of acceptable planting soils shall be as follows:
    - a. Turf Areas: 6 inches.
    - b. Shrub, Groundcover, and Flower Beds: 12 inches.
    - c. Hardscape Enclosed Planter Areas: 4 feet.
    - d. Tree Wells/Grates: 4 feet.
- B. Existing Site Soils:
  1. Existing site soils shall be uncompacted, fertile, friable, natural loam free of subsoil, clay lumps, brush, weeds, litter, roots, stumps, stones larger than 2 inches in any dimension, and any other extraneous or toxic matter harmful to humans or plant life.
  2. Soils limed and compacted for soil stabilization purposes are unacceptable and shall be removed from planting areas.
  3. Acceptable pH range shall be 6.0 to 7.0.
  4. Amend soils, as recommended by Soil Testing Laboratory after soil test analysis, to maintain proper soil pH and nutrient levels. The Contractor shall provide soil test analysis to the Landscape Architect prior to beginning work. Minimum acceptable organic matter content shall be 5 percent.
- C. Planting Soils:
  1. Planting soil as used in this specification means the amended soil at the planting site or imported and modified as defined in specification Section "Soil Preparation." If there is no Planting Soil specification, the term Planting Soil shall mean the soil at the planting site within the planting hole.
- D. Imported Topsoil: Comply with ASTM D 5268. Provide fertile, friable, natural loam surface soil free of subsoil, clay lumps, brush, weeds, litter, roots, stumps, stones larger than 2 inches in any dimension, and any other extraneous or toxic matter harmful to humans or plant life. Provide pH range of 6.0 to 7.0. The Contractor shall provide sample and soil test analysis to the Landscape Architect prior to delivery of topsoil to site. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at the Project site. Minimum acceptable organic matter content shall be 5 percent.

## 2.8 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 10percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- E. Manufacturer:
  - 1. Grace Sierra Co.
  - 2. Vigoro Industries, Inc.
  - 3. Woodace
  - 4. Approved Equal.
- F. Types:
  - 1. Trees: Davey Arbor Green Pro. Apply at manufacturer's maximum recommended rates.
  - 2. Shrub, groundcover, annuals, and perennials: MicroLife all organic fertilizer as supplied by San Jacinto Environmental (713) 957-0909. Apply at manufacturer's maximum recommended rates.
  - 3. Tree Planting: Agriform 21 gram fertilizer tablets, 20 10 5 N P K analysis.
  - 4. Tree Planting: Woodace 17 gram tablets; 14-3-3 N-P-K analysis.
  - 5. Shrub Planting: Agriform 16 7 12 (+iron) slow release fertilizer.
  - 6. Shrub Planting: Woodace 17 gram tablets; 14-3-3 N-P-K analysis.
  - 7. Palm Planting: Woodace Palm Supreme; 12-4-12 N-P-K analysis.
  - 8. Groundcover and Flowers: Woodace 17 gram tablets; 9-9-4 N-P-K analysis.

## 2.9 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers inert to biological degradation and naturally resistant to chemicals, alkalis, and acids, formed into a stable network so that fibers retain their relative position.
- B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd..

## 2.10 MULCHES

- A. Mulch shall be "Walk on" grade, coarse, ground, from tree and woody brush sources. The size range shall be a minimum (less than 25% or less of volume) fine particles 3/8 inch or less in size, and a maximum size of individual pieces (largest 20% or less of volume) shall be approximately 1 to 1-1/2 inch in diameter and maximum length approximately 3 to 6". Pieces larger than 8 inch long that are visible on the surface of the mulch after installation shall be removed.
  - 1. It is understood that mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the Owner's Representative.

- B. Submit supplier's product specification data sheet and a 1-quart sample for approval.
- C. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:
  - 1. Type: Native Shredded hardwood; double-ground.
  - 2. Size Range: Three inch minus.
  - 3. Color: Natural.
- D. Nutshell Mulch: Free from deleterious materials and suitable as a soil cover in rooftop planter areas, consisting of:
  - 1. Type: Ground Pecan Shell.
  - 2. Size Range: 1-inch maximum, 1/4-inch minimum.
  - 3. Color: Natural.
- E. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay and other foreign substances, of the following:
  - 1. Type: Per plans and material schedule.
  - 2. Size Range: Per plans and material schedule.
  - 3. Color: Per plans and material schedule.

#### 2.11 HERBICIDES AND PESTICIDES

- A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.
- C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing 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.

#### 2.12 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
  - 1. Staking-and-Guying Devices: Stake or anchor and adjustable tie systems to secure each new planting by plant stems; size and detail as indicated on construction documents.
  - 2. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
  - 3. Wood Deadmen: Timbers measuring 8 inches in diameter and 48 inches long, treated with specified wood pressure-preservative treatment.
  - 4. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.
  - 5. Guys and Tie Wires: ASTM A641/A641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
  - 6. Tree-Tie Webbing: flat woven polypropylene material, 3/4 inch wide, and 900 lb. break strength. Color to be Green.
  - 7. Guy Cables: Five-strand, 3/16-inch-diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
  - 8. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

9. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and according to manufacturer's written recommendations.
  - a. Deep Root Partners, L.P. – Arbor Tie.
  - b. Berkshire Products, Inc. – “Earthwings Cable Kit.”
  - c. Platipus Tree Anchoring System, Raleigh, NC; (866) 792-8478.
  - d. Duckbill – “Anchors.”
  - e. Arborbrace – “Tree Guying System.”
  - f. Or approved equal.

B. Root-Ball Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated; stakes pointed at one end.
2. Wood Screws: ASME B18.6.1.
3. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball and that do not encircle the trunk; sized in accordance with manufacturer's written instructions unless otherwise indicated.
  - a. GreenBlue Urban – “ArborGuy.”
  - b. Berkshire Products, Inc. – “Earthwings Root Ball Anchors.”
  - c. Platipus Deadman System RF3RDMP.
  - d. Or approved equal.

2.13 EROSION CONTROL MATERIALS

- A. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Log: Fully biodegradable jute or fiber-packed erosion control log between 6 inches and 10 inches in diameter. Include 2 inch square by 18 inch long untreated pine stakes at 48 inches on-center to secure in place. Drive stakes through log and into grade.

2.14 LANDSCAPE EDGINGS

- A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
  1. Edging Size: 1/8 inch thick by 6 inches deep.
  2. Stakes: Tapered steel, a minimum of 15 inches long.
  3. Accessories: Standard tapered ends, corners, and splicers.
  4. Finish: Manufacturer's standard paint.
    - a. Paint Color: Black, or as indicated.

2.15 MISCELLANEOUS PRODUCTS

- A. Root Barrier: Black, molded, modular panels 24 inches high (deep), or as indicated or required, 85 mils thick, and with vertical root deflecting ribs protruding 3/4 inch out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. DeepRoot Green Infrastructure, LLC.
  - b. GreenBlue Urban.
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix in accordance with manufacturer's written instructions.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Owner and the Landscape Architect in writing, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
  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. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
  3. Suspend planting operations during periods of excessive soil moisture until moisture content reaches acceptable levels to attain required results.
  4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove soil and contamination as directed by Architect and replace with new planting soil.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
  1. Beginning of the Work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

#### 3.2 SOIL PROTECTION DURING PLANT DELIVERY AND INSTALLATION

- A. Protect soil from compaction during the delivery of plants to the planting locations, digging of planting holes and installing plants.
  1. Where possible deliver and plant trees that require the use of heavy mechanized equipment prior to final soil preparation and tilling. Where possible, restrict the driving lanes to one area instead of driving over and compacting a large area of soil.
- B. Till to a depth of 6 inches, all soil that has been driven over prior and during the installation of plants.

3.3 SOIL MOISTURE

- A. Volumetric soil moisture level, in both the planting soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilting point and below field capacity for each type of soil texture within the following ranges.

B.

Soil Type	Permanent Wilting Point	Field Capacity
Sand, Loamy Sand, Sandy Loam	5% – 8%	12% - 18%
Loam, Sandy Clay, Sandy Clay Loam	14% - 25%	27% - 36%
Clay Loam, Silt Loam	11% - 22%	31% - 36%
Silty Clay, Silty Clay Loam	22% - 27%	38% - 41%

- 1. Volumetric soil moisture shall be measured with a digital moisture meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equal.

- C. The Contractor shall confirm the soil moisture levels with a moisture meter. If the soil moisture is too high, suspend planting operations until the soil moisture drops below field capacity.

3.4 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations. Determine location of utilities and flag locations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect’s acceptance of layout before excavating or planting. Make minor adjustments as required.

3.5 EXCAVATION AND PERCOLATION TESTING

- A. Excavation: See Section 312000 “Earth Moving”. Remove unacceptable existing site soils and dispose of off site. Amend existing site soils, as necessary, to achieve specified qualities prior to beginning of planting operations and retest to ensure proper soil analysis. Scarify the bottoms and sides of plant pits dug by auger, mechanical spade, or backhoe. In hardpan soils drill 6 inch diameter holes into free draining strata or to a depth of 10 feet, whichever is less, and backfill with drainage gravel. Provide specified drain pipe as required to provide positive drainage in planting beds and pits. See Drainage Testing Paragraph below.
- B. Percolation Testing:

1. Wait a minimum of 24 hours after rain and dig test pit 12 inches square or 12-1/2 inches in diameter to a depth of bottom of tree pit in representative locations on site. Remove loose soil. If standing water is visible, notify the Landscape Architect.
2. Quickly fill the bottom with 6 inches of water (approximately 3 1/4 gallons of water).
3. Record length of time from filling until disappearance of water. Divide number of minutes by six to give average time of 1 inch fall.
4. Compare 1 inch percolation time with table below:
  - a. 1 Inch in 0 to 3 Minutes: Rapid percolation.
  - b. 1 Inch in 3 to 5 Minutes: Medium percolation.
  - c. 1 Inch in 5 to 30 Minutes: Slow percolation (semi impervious soil).
  - d. 1 Inch in Over 30 Minutes: Impervious soil.
5. If the tests indicate semi impervious soil or impervious soil or if standing water is initially found in the pit, notify the Landscape Architect before beginning work.
6. If the Contractor does not make proper tests and does not file complete reports of semi impervious and impervious soils or plants in areas shown to have poor drainage, without written release from the Owner, he shall be responsible for any warranted replacements due to substrate water damage.

### 3.6 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil in accordance with Section 329113 "Soil Preparation."
- B. Loosen subgrade of planting areas to a minimum of eight-inches (8"). Remove stones larger than 1-inch in any dimension and sticks, roots, construction debris, trash, and other extraneous matter and legally dispose of them off Owner's property.
  1. Apply fertilizer directly to subgrade before loosening.
  2. Thoroughly blend planting soil before spreading.
  3. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
  4. Mix lime with dry soil before mixing fertilizer.
- C. Placing Planting Soil: Place and mix one-half the thickness of planting soil in-place over exposed loosened subgrade. Mix into top two (2) inches of subgrade. Spread remainder of planting soil.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.7 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
  1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. 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. Scarify sides of planting pit smeared or smoothed during excavation.
  2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.

3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
  4. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of root ball.
  5. If area under the plant was initially dug too deep, add soil to raise it to correct level and thoroughly tamp the added soil to prevent settling.
  6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  7. Maintain supervision of excavations during working hours.
  8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
  9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated. Amend excavated soil per recommendations of agronomic soil testing prior to use.
- C. Obstructions: Notify Owner's Representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to depth of 10 ft., whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

### 3.8 PLANTING, GENERAL

- A. Inspection: At time of 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. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. The root system of each plant, regardless of root ball package type, shall be observed by the Contractor, at the time of planting to confirm that the roots meet the requirements for plant root quality described herein. The Contractor shall undertake at the time of planting, all modifications to the root system required by the Owner's Representative to meet these quality standards.
1. Modifications, at the time of planting, to meet the specifications for the depth of the root collar and removal of stem girdling roots and circling roots may make the plant unstable or stress the plant to the point that the Owner's Representative may choose to reject the plant rather than permitting the modification.
  2. Any modifications required by the Owner's Representative to make the root system conform to the plant quality standards outlined herein, or other requirements related to the permitted root ball package, shall not be considered as grounds to modify or void the plant warranty.
  3. The resulting root ball may need additional staking and water after planting. The Owner's Representative may reject the plant if the root modification process makes the tree

unstable or if the tree is not healthy at the end of the warranty period. Such plants shall still be covered under the warranty.

- D. **Container and Boxed Root Ball Shaving:** The outer surfaces of all plants in containers and boxes, including the top, sides and bottom of the root ball shall be shaved to remove all circling, descending, and matted roots. Shaving shall be performed using saws, knives, sharp shovels or other suitable equipment that is capable of making clean cuts on the roots. Shaving shall remove a minimum of one inch of root mat or up to 2 inches as required to remove all root segments that are not growing reasonably radial to the trunk.
- E. **Exposed Stem Tissue after Modification:** The required root ball modifications may result in stem tissue that has not formed trunk bark being exposed above the soil line. If such condition occurs, wrap the exposed portion of the stem in a protective wrapping with a white filter fabric. Secure the fabric with biodegradable masking tape. Do not use string, twine, green nursery ties or any other material that may girdle the trunk if not removed.
- F. **Excavation of the Planting Space:** Using hand tools or tracked mini-excavator, excavate the planting hole into the Planting Soil to the depth of the root ball measured after any root ball modification to correct root problems, and wide enough for working room around the root ball or to the size indicated on the drawing or as noted below.
1. For trees and shrubs planted in soil areas that are not tilled or otherwise modified to a depth of at least 12 inches over a distance of more than 10 feet radius from each tree, or 5 feet radius from each shrub, the soil around the root ball shall be loosened as defined below or as indicated on the drawings.
    - a. The area of loosening shall be a minimum of 3 times the diameter of the root ball at the surface sloping to 2 times the diameter of the root ball at the depth of the root ball.
    - b. Loosening is defined as digging into the soil and turning the soil to reduce the compaction. The soil does not have to be removed from the hole, just dug, lifted and turned. Lifting and turning may be accomplished with a tracked mini excavator, or hand shovels.
  2. If an auger is used to dig the initial planting hole, the soil around the auger hole shall be loosened as defined above for trees and shrubs planted in soil areas that are not tilled or otherwise modified.
  3. The measuring point for root ball depth shall be the average height of the outer edge of the root ball after any required root ball modification.
  4. If motorized equipment is used to deliver plants to the planting area over exposed planting beds, or used to loosen the soil or dig the planting holes, all soil that has been driven over shall be tilled to a depth of 6 inches.
- G. For trees to be planted in prepared Planting Soil that is deeper than the root ball depth, compact the soil under the root ball using a mechanical tamper to assure a firm bedding for the root ball. If there is more than 12 inches of planting soil under the root ball excavate and tamp the planting soil in lifts not to exceed 12 inches.
- H. Set top outer edge of the root ball four inches (4") above the average elevation of the proposed finish per details. Set the plant plumb and upright in the center of the planting hole. The tree graft, if applicable, shall be visible above the grade. Do not place soil on top of the root ball.
- I. The Owner's Representative may request that plants orientation be rotated when planted based on the form of the plant.

- J. Backfill the space around the root ball with the same planting soil or existing soil that was excavated for the planting space. See Specification Section Planting Soil, for requirements to modify the soil within the planting bed.
  - K. Brace root ball by tamping Planting Soil around the lower portion of the root ball. Place additional Planting Soil around base and sides of ball in six-inch (6") lifts. Lightly tamp each lift using foot pressure or hand tools to settle backfill, support the tree and eliminate voids. Do not over compact the backfill or use mechanical or pneumatic tamping equipment. Over compaction shall be defined as greater than 85% of maximum dry density, standard proctor or greater than 250 psi as measured by a cone penetrometer when the volumetric soil moisture is lower than field capacity.
    - 1. When the planting hole has been backfilled to three quarters of its depth, water shall be poured around the root ball and allowed to soak into the soil to settle the soil. Do not flood the planting space. If the soil is above field capacity, allow the soil to drain to below field capacity before finishing the planting. Air pockets shall be eliminated and backfill continued until the planting soil is brought to grade level.
  - L. Build a 5 inch high, level berm of Planting Soil around the outside of the root ball to retain water. Tamp the berm to reduce leaking and erosion of the saucer.
  - M. Thoroughly water the Planting Soil and root ball immediately after planting.
  - N. Remove all nursery plant identification tags and ribbons as per Owner's Representative instructions. The Owner's Representative's seals are to remain on plants until the end of the warranty period.
  - O. Remove corrugated cardboard trunk protection after planting.
  - P. Follow additional requirements for the permitted root ball packages.
- 3.9 BALLED AND BURLAPPED STOCK
- A. Set each plant plumb and in center of planting pit or trench with root flare 4 inches above adjacent finish grades.
  - B. Backfill: Planting soil. For trees, use excavated soil mixed with Planting soil for backfill.
  - C. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Do not fold burlap or wire baskets down onto the Planting Soil. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  - D. If the plant is shipped with a wire basket that does not meet the requirements of a "Low Rise" basket, remove the top 6 - 8 inches of the basket wires just before the final backfilling of the tree.
  - E. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - F. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

1. Quantity: As indicated per manufacturer's latest printed instruction.

G. Continue backfilling process. Water again after placing and tamping final layer of soil.

### 3.10 CONTAINER GROWN STOCK

A. Set each plant plumb and in center of planting pit or trench with root flare 4 inches for trees above adjacent finish grades.

B. This specification assumes that most container plants have significant stem girdling and circling roots, and that the root collar is too low in the root ball.

C. Carefully remove root ball from container without damaging root ball or plant.

D. Perform root ball shaving as defined in Installation of Plants above.

E. Remove all roots and substrate above the root collar and the main structural roots according to root correction details so root system conforms to root observations detail.

F. Remove all substrate at the bottom of the root ball that does not contain roots.

G. Using a hose, power washer or air excavation device, wash out the substrate from around the trunk and top of the remaining root ball and find and remove all stem girdling roots within the root ball above the top of the structural roots.

H. Backfill: Planting soil. For trees, use excavated soil mixed with Planting Soil for backfill.

I. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

J. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.

1. Quantity: As indicated per manufacturer's latest printed instruction.

K. Continue backfilling process. Water again after placing and tamping final layer of soil.

L. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball. Also refer to planting details.

### 3.11 SPADE HARVETED AND TRANSPLANTED PLANTS

A. Trees shall be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.

- C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- D. Cut exposed roots cleanly during transplanting operations.
- E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.
- F. Where possible, orient the tree in the same direction as in its original location.
- G. After installing the tree, loosen the soil along the seam between the root ball and the surrounding soil out to a radius from the root ball edge equal to the diameter of the root ball to a depth of 8 - 10 inches by hand digging to disturb the soil interface.
- H. Fill any gaps below this level with loose soil.

### 3.12 GROUND COVER, PERENNIAL, AND ANNUAL PLANTS

- A. Assure that soil moisture is within the required levels prior to planting. Irrigation, if required, shall be applied at least 12 hours prior to planting to avoid planting in muddy soils.
- B. Assure that soil grades in the beds are smooth and as shown on the plans.
- C. Plants shall be planted in even, triangularly spaced rows, at the intervals called out for on the drawings, unless otherwise noted. The first row of Annual flower plants shall be 6 inches from the bed edge unless otherwise directed.
- D. Schedule the planting to occur prior to application of the mulch. If the bed is already mulched, pull the mulch from around the hole and plant into the soil. Do not plant the root system in the mulch. Pull mulch back so it is not on the root ball surface.
- E. Dig planting holes sufficiently large enough to insert the root system without deforming the roots. Set the top of the root system at the grade of the soil.
- F. Use Planting Soil for backfill. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water. Press soil to bring the root system in contact with the soil.
- G. Spread any excess soil around in the spaces between plants.
- H. Apply mulch to the bed being sure not to cover the tops of the plants with or the tops of the root ball with mulch.
- I. Water each planting area thoroughly as soon as the planting is completed. Apply additional water to keep the soil moisture at the required levels. Do not over water.
- J. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

### 3.13 TREE, SHRUB, AND VINE PRUNING

- A. Prune plants as directed by the Owner's Representative. Pruning trees shall be limited to addressing structural defects. Follow recommendations in "Structural Pruning: A Guide For The Green Industry" published by Urban Tree Foundation, Visalia CA.
- B. Remove only dead, dying, or broken branches. Do not prune for shape.

- C. Do not cut central leaders.
- D. Pruning shall be done with clean, sharp tools.
- E. Do not apply pruning paint or sealants to wounds, unless noted otherwise.

### 3.14 INSTALLATION OF TREE-STABILIZATION MATERIALS

- A. Do not stake or guy trees unless specifically required by the Contract Documents, or in the event that the Contractor feels that staking is the only alternative way to keep particular trees plumb.
  - 1. The Owner's Representative shall have the authority to require that trees are staked or to reject staking as an alternative way to stabilize the tree.
  - 2. Trees that required heavily modified root balls to meet the root quality standards may become unstable. The Owner's Representative may choose to reject these trees rather than utilize staking to temporarily support the tree.
- B. Trees that are guyed shall have their guys and stakes removed after one full growing season or at other times as required by the Owner's Representative.
- C. Tree guying shall utilize the tree staking and guying materials specified. Guying to be tied in such a manner as to create a minimum 12-inch loop to prevent girdling. Refer to manufacturer's recommendations and the planting details for installation.
  - 1. Plants shall stand plumb after staking or guying.
  - 2. Stakes shall be driven to sufficient depth to hold the tree rigid.
- D. For trees planted in planting mix over waterproofed membrane, use dead men buried 24 inches to the top of the dead man, in the soil. Tie the guy to the dead man with a double wrap of line around the dead man followed by a double half hitch. When guys are removed, leave the dead men in place and cut the guy tape 12 inches above the ground, leaving the tape end covered in mulch.
- E. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
  - 1. Upright Staking and Tying: Stake trees per plans and details. Set vertical stakes and space to avoid penetrating root balls or root masses.
  - 2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
  - 3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
- F. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings. Stake and guy trees more than 14 feet in height and more than 3 inches in caliper unless otherwise indicated.
  - 1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.
    - a. Securely attach guys to stakes 30 inches long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle for each guy wire and tighten securely.

- b. For trees more than 6 inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle for each guy wire and tighten securely.
    - c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
    - d. Support trees with guy cable, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
    - e. Attach flags to each guy wire, 30 inches above finish grade.
    - f. Paint turnbuckles with luminescent white paint.
  2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
- G. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
  1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.
    - a. Install stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation. Saw stakes off at horizontal stake.
    - b. Install screws through horizontal hold-down and penetrating at least 1 inch into stakes. Predrill holes if necessary to prevent splitting wood.
    - c. Install second set of stakes on other side of root trunk for larger trees.
  2. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

### 3.15 STRAIGHTENING PLANTS

- A. Maintain all plants in a plumb position throughout the warranty period. Straighten all trees that move out of plumb including those not staked. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled.
- B. Do not straighten plants by pulling the trunk with guys.

### 3.16 INSTALLATION OF FERTILIZER AND OTHER CHEMICAL ADDITIVES

- A. Do not apply any soluble fertilizer to plantings during the first year after transplanting unless soil test determines that fertilizer or other chemical additives is required. Apply chemical additives only upon the approval of the Owner's Representative.
- B. Controlled release fertilizers shall be applied according to the manufacturer's instructions and standard horticultural practices.

### 3.17 MULCHING OF PLANTS

- A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 12 inches and secure seams with galvanized pins.

- B. Mulch backfilled surfaces of planting areas and other areas indicated.
- C. Apply 4 inches of mulch before settlement, covering the entire planting bed area. Install no more than 1 inch of mulch over the top of the root balls of all plants. Taper to 2 inches when abutting pavement.
  - 1. Trees in Turf Areas: Apply organic mulch ring of 4-inch average thickness, with 60-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
  - 2. Organic Mulch in Planting Areas: Apply 4-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
  - 3. Mineral Mulch in Planting Areas: Apply 3-inch average thickness of mineral mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
- D. Lift all leaves, low hanging stems and other green portions of small plants out of the mulch if covered.

### 3.18 PLANTING BED FINISHING

- A. After planting, smooth out all grades between plants before mulching.
- B. Separate the edges of planting beds and lawn areas with a smooth, formed edge cut into the turf with the bed mulch level slightly lower, 1 and 2 inches, than the adjacent turf sod or as directed by the Owner's Representative. Bed edge lines shall be as depicted on the drawings.

### 3.19 WATERING

- A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the date of Substantial Completion Acceptance. The Contractor shall adjust the automatic irrigation system, if available, and apply additional or adjust for less water using hoses as required.
- B. Hand water root balls of all plants to assure that the root balls have moisture above wilt point and below field capacity. Test the moisture content in each root ball and the soil outside the root ball to determine the water content.
- C. The Contractor shall install 25 gallon watering bag for each tree to be maintained and used for tree watering during the warranty period if not watered by automatic irrigation system.
  - 1. The watering bags shall remain the property of the Owner at the completion of the work.

### 3.20 INSTALLATION OF ROOT BARRIER

- A. Install root barrier where trees are planted within 60 inches of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.
- B. Align root barrier with bottom edge angled at 20 degrees away from the paving or other hardscape element, and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.

- C. Install root barrier continuously for a distance of 60 inches in each direction from the tree trunk, for a total distance of 10 feet per tree. If trees are spaced closer, use a single continuous piece of root barrier.
  - 1. Position top of root barrier 1-inch below finished grade.
  - 2. Overlap root barrier a minimum of 12 inches at joints.
  - 3. Do not distort or bend root barrier during construction activities.
  - 4. Do not install root barrier surrounding the root ball of tree.

### 3.21 INSTALLATION OF EDGING

- A. Wood Edging: Install edging where indicated. Mitre cut joints and connections at a 45-degree angle. Fasten each cut joint or connection with two galvanized nails. Anchor with wood stakes spaced up to 36 inches apart, driven at least 1 inch below top elevation of edging. Use two galvanized nails per stake to fasten edging, of length as needed to penetrate both edging and stake and provide 1/2-inch clinch at point. Pre-drill stakes if needed to avoid splitting. Replace stakes that crack or split during installation process.
- B. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.
- C. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch-deep, shovel-cut edge as indicated on Drawings.

### 3.22 INSTALLATION OF SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

### 3.23 PLANT MAINTENANCE

- 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.
- 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.
- 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 when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

### 3.24 PESTICIDE APPLICATION

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

- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

### 3.25 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
  - 1. Submit details of proposed pruning and repairs.
  - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
  - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.
  - 1. Provide new trees of same specie, size, shape, caliper, and character as those being replaced.

### 3.26 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
  - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property. Remove trash and debris from the site no less than once a week.
- C. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers. Maintain protection during installation until Substantial Completion Acceptance. Treat, repair or replace damaged work immediately.
- D. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including roots, trunk or branches of large existing trees, soil, paving, utilities, lighting, irrigation, other finished work, and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Owner's Representative shall determine when such cleaning, replacement or repair is satisfactory.
- E. Make all repairs to grades, ruts, and damage to the Work.
- F. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site.

The Owner's Representative's seals are to remain on the trees and removed at the end of the warranty period.

- G. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, wire, burlap, and other debris from plant material, planting areas, and Project site.
- H. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

### 3.27 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

### 3.28 PLANT MAINTENANCE PRIOR TO SUBSTANTIAL COMPLETION ACCEPTANCE

- A. During the project work period and prior to Substantial Completion Acceptance, the Contractor shall maintain all plants.
- B. Maintenance during the period prior to Substantial Completion Acceptance shall consist of pruning, watering, cultivating, weeding, mulching, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, repairing and replacing of damaged tree wrap material, resetting plants to proper grades and upright position, and furnishing and applying such sprays as are necessary to keep plantings reasonably free of damaging insects and disease, and in healthy condition. The threshold for applying insecticides and herbicide shall follow established Integrated Pest Management (IPM) procedures. Mulch areas shall be kept reasonably free of weeds, grass.

### 3.29 MAINTENANCE DURING THE WARRANTY PERIOD BY OTHERS

- A. After Substantial Completion Acceptance, the Contractor shall make sufficient site visits to observe the Owner's maintenance and become aware of problems with the maintenance in time to request changes, until the date of End of Warranty Final Acceptance.
  - 1. Notify the Owner's Representative in writing if maintenance, including watering, is not sufficient to maintain plants in a healthy condition. Such notification must be made in a timely period so that the Owner's Representative may take corrective action.
    - a. Notification must define the maintenance needs and describe any corrective action required.
  - 2. In the event that the Contractor fails to visit the site and or notify, in writing, the Owner's Representative of maintenance needs, lack of maintenance shall not be used as grounds for voiding or modifying the provisions of the warranty.

### 3.30 END OF WARRANTY FINAL ACCEPTANCE / MAINTENANCE OBSERVATION

- A. At the end of the Warranty and Maintenance period the Owner's Representative shall observe the work and establish that all provisions of the contract are complete and the work is satisfactory.
  - 1. If the work is satisfactory, the maintenance period will end on the date of the final observation.

2. If the work is deemed unsatisfactory, the maintenance period will continue at no additional expense to the Owner until the work has been completed, observed, and approved by the Owner's Representative.

B. Failure To Pass Observation: If the work fails to pass final observation, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Owners Representative.

END OF SECTION

SECTION 329600 - TRANSPLANTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Planting materials.
  - 2. Tree-stabilization materials.
  - 3. Tree-watering devices.

Retain "Owner-Furnished Material" Paragraph below if Owner furnishes material for installation in the completed Work.

- B. Owner-Furnished Material: **<Insert product or material>**.
- C. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

- 1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
- 2. Section 329300 "Plants" for new trees from nursery-grown sources.

1.3 UNIT PRICES

Retain this article if products and Work specified in this Section are measured and paid for under the provisions of unit prices.

- A. See Section 012200 "Unit Prices" for description of unit prices affecting items specified in this Section.
- B. Unit prices apply to additions to and deletions from the Work as authorized by Change Orders.

## 1.4 DEFINITIONS

Retain terms that remain after this Section has been edited for a project. Include only essential not well understood by the affected industry or trade.

- A. General: See definitions in ANSI A300 (Part 6) and in ANSI Z60.1 pertaining to field-grown trees, except as otherwise defined in this Section.

Generally, retain "Caliper" or "Caliper (DBH)" Paragraph below. First paragraph corresponds to diameter measurement used in the landscaping industry; second, to diameter measurement in the timber industry and for trees measuring more than 8 inches (200 mm) in diameter in accordance with ANSI A300 (Part 6). Revise either paragraph if required for clump and multi-stemmed tree forms and to suit Project. The method of measuring tree caliper for landscape purposes varies. See the Evaluations.

- B. Caliper: Diameter of a trunk as measured by diameter tape or average of the smallest and largest diameters at height 6 inches above the root flare for trees up to, and including, 4-inch size at this height; and as measured at height of 12 inches above the root flare for trees larger than 4-inch size.

Retain last option in "Caliper (DBH)" Paragraph below if using this measurement only for larger trees.

- C. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by diameter tape or average of the smallest and largest diameters at height 54 inches above the groundline for trees with caliper of 8 inches or greater as measured at height of 12 inches above the root flare.
- D. Root-Ball Depth: Measured from bottom of trunk flare to bottom of root ball.
- E. Root-Ball Width: Measured horizontally across the root ball with an approximately circular form or the least dimension for non-round root balls, not necessarily centered on the tree trunk, but within tolerance in accordance with ANSI Z60.1.
- F. Root Flare: Also called "trunk flare." Area at the base of tree's stem or trunk where stem or trunk broadens to form roots; area of transition between root system and stem or trunk.

## 1.5 PREINSTALLATION MEETINGS

Retain "Preinstallation Conference" Paragraph below if Work of this Section is extensive or complex enough to justify a conference.

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

Retain subparagraph below if additional requirements are necessary; include information about conference.

1. Methods and procedures related to transplanting work include, but are not limited to, the following:
  - a. Construction schedule. Verify availability of materials, personnel, equipment, and unimpeded access needed to make progress and avoid delays.
  - b. Tree and plant protection.
  - c. Tree maintenance.

- d. Arborist's responsibilities.

If needed, insert list of conference participants not mentioned in Section 013100 "Project Management and Coordination."

## 1.6 ACTION SUBMITTALS

Action submittals are submittals requiring responsive action and return of reviewed documents to Contractor.

- A. Product Data:
  - 1. Planting materials.
  - 2. Tree-stabilization materials.
  - 3. Tree-watering devices.
- B. Samples for Verification: Actual sample of finished products for each of the following:
  - 1. Weed-control barriers.
  - 2. Proprietary Root-Ball-Stabilization Device: One unit.
  - 3. Slow-Release Watering Device: One unit of each size required.
- C. Pruning Schedule: Written schedule prepared by arborist detailing scope and extent of pruning each tree in preparation for and subsequent to transplanting.

Revise subparagraphs below to suit Project.

- 1. Species and size of plant.
- 2. Location on site plan. Include unique identifier for each.
- 3. Reason for pruning.
- 4. Seasonal limitations on pruning.
- 5. Preparatory Pruning: Time schedule and description of preparatory pruning to be performed.
  - a. Indicate time in months preceding extraction of tree.
  - b. Indicate diameter of root ball and depth of root pruning for each tree.
- 6. Description of root and crown pruning during and subsequent to transplanting.
- 7. Description of maintenance after pruning.

## 1.7 INFORMATIONAL SUBMITTALS

Informational submittals are submittals that require review by Landscape Architect, but they do not require Landscape Architect's responsive action and return of reviewed documents to Contractor, provided submittals comply with requirements. If rejected, submittals with responsive action must be returned to Contractor.

Coordinate "Qualification Statements" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article. If inserting additional entities or specialist, add qualifications to "Quality Assurance" Article.

- A. Qualification Statements: For tree-service firm and arborist.
- B. Certification: From arborist, certifying that transplanted trees have been protected during construction and that trees were promptly and properly treated and repaired when damaged.

Retain "Maintenance Recommendations" Paragraph below if Owner's personnel will provide maintenance after trees are established.

- C. Maintenance Recommendations: From arborist, recommended procedures to be established by Owner for care and protection of trees after completing the Work.
  - 1. Submit before completing the Work.
- D. Existing Conditions: Documentation of existing trees indicated to be transplanted, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

Revise subparagraphs below and insert additional requirements to suit Project.

- 1. Use sufficiently detailed color photographs or video recordings. Color must accurately depict hue condition of foliage and bark.
  - 2. Include drawings and notations to indicate specific wounds and damage conditions of each tree designated to be transplanted.
- E. Tree-Transplanting Program: Submit before work begins.
- F. Sample Warranties: For special warranties.
- G. Tree-maintenance reports.

## 1.8 QUALITY ASSURANCE

Revise "Tree-Service Firm Qualifications" Paragraph below to suit Project.

- A. Tree-Service Firm Qualifications: An experienced landscaping contractor or tree-moving firm that has successfully completed transplanting work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

Retain one or more qualifications in "Arborist Qualifications" Subparagraph below to suit Project; revise for other qualified professional. Retain only one of first two options. See the Evaluations.

- 1. Arborist Qualifications: ISA Certified Arborist and licensed arborist in jurisdiction where Project is located.

Retain "Tree-Transplanting Program" Paragraph below for difficult sites or access conditions encumbered by utilities, structures, or other permanent plantings.

- B. Tree-Transplanting Program: Prepare a written plan by arborist for transplanting trees for whole Project, including each phase or process, tree maintenance, and protection of surrounding materials during operations. Describe in detail the materials, methods, and equipment to be used for each phase of transplanting work.

1. Include transplanting times appropriate for each species at Project location unless otherwise indicated on Drawings or directed by arborist.

Generally, retain first subparagraph below if transplanting work is extensive or complex.

2. Include transplanting schedule for each species to be transplanted, coordinated with Project schedule.
3. Include site plans clearly marked to show tree-moving routes from extraction to planting locations. Indicate proposed equipment, weight, and turning radii.
4. Show details of temporary protective barriers where needed.
5. Include diagrams showing clearances to utility lines and other encumbrances along route.
6. Include care and maintenance provisions[ **and eventual removal of tree stabilization**].

#### 1.9 DELIVERY, STORAGE, AND HANDLING

Retain one or more paragraphs in this article to suit Project. Limit inserts to detailed requirements that apply to Work of this Section and that supplement general provisions in Section 016000 "Product Requirements."

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  1. Do not dump or store bulk materials near structures, utilities, or walkways and pavements; or on existing turf areas or trees.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  3. Accompany each delivery with appropriate certificates.
- C. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy their natural shape.
- D. Completely cover foliage when transporting trees while they are in foliage.
- E. Handle trees by root ball. Do not drop trees.
- F. Move trees after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after moving, set trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

#### 1.10 FIELD CONDITIONS

- A. Field Measurements: Verify final grade elevations and final locations of trees and construction contiguous with trees by field measurements before proceeding with transplanting work. Perform transplanting only after finish grades are established.

Retain "Seasonal Restrictions" Paragraph below for limited transplanting times.

- B. Seasonal Restrictions: Transplant trees during the following in-season periods:

Insert specific dates for transplanting in subparagraphs below. For clarity, insert tree species and sizes or tree designations on Drawings if known.

1. Spring: <Insert dates>.
2. Summer: <Insert dates>.
3. Fall: <Insert dates>.
4. Winter: <Insert dates>.

- C. Weather Limitations: Proceed with transplanting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Do not transplant during excessively wet or frozen conditions. Apply products during favorable weather conditions in accordance with manufacturer's written instructions and warranty requirements.

Retain "Coordination with Turf Areas (Lawns)" Paragraph below if there are turf areas (lawns) or revise if contrary to planting schedule.

- D. Coordination with Turf Areas (Lawns): Perform transplanting before planting turf areas unless otherwise indicated.
1. When transplanting after planting turf areas, protect turf areas, and promptly repair damage caused by transplanting operations.

Retain "Coordination with Planting Beds" Paragraph below if there are planted beds or revise if contrary to planting schedule.

- E. Coordination with Planting Beds: Perform transplanting before planting bedded areas unless otherwise indicated.
1. When transplanting after planting bedded areas, protect bedding plants, and promptly repair damage caused by transplanting operations.

#### 1.11 WARRANTY

Retain this article if required; revise to suit Project. Transplanted trees generally have no warranty; however, some warranty may be available if tied to a continuing maintenance agreement.

When warranties are required and available, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

- A. Installer's Special Warranty: Tree-service firm agrees to repair or replace trees and related materials that fail within specified warranty period.
1. Failures include, but are not limited to, the following:

- a. Death and unsatisfactory growth except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner; or incidents that are beyond Contractor's control.

Revise first subparagraph below to suit Project. Exceptions may be necessary for significant trees.

- b. Death and unsatisfactory growth is defined as more than 25 percent dead or in an unhealthy condition or failure to meet general performance requirements at end of warranty period.
- c. Structural failures, including trees falling or blowing over.
- d. Faulty performance of materials and devices related to tree plantings including [tree stabilization] [and] [watering devices] <Insert item>.

Revise start date in first subparagraph below in accordance with local practice and the types of transplanting required and coordinate with the maintenance period. It is not usually equitable to require the tree-service firm to warrant living tree material beyond the maintenance period. See the Evaluations.

2. Warranty Periods from Date of [Transplanting Completion] [Substantial Completion] <Insert starting time>:

Warranty period in "Trees" Subparagraph below is an example only; revise to suit Project. Trees may not show evidence of improper work for years, long after final payment for Project is issued. For clarity, insert tree species and sizes or tree designations on Drawings if known.

- a. Trees: 12 months.

3. Include the following remedial actions as a minimum:

Revise first subparagraph below to suit Project. Exceptions may be necessary for significant trees.

- a. Remove dead trees and trees with unsatisfactory growth at end of warranty period; replace when directed.
- b. Limit of one replacement of each tree will be required except for losses or replacements due to failure to comply with requirements.
- c. Replace materials and devices related to tree plantings.

Retain subparagraph below if required; revise to suit Project.

- d. Provide extended warranty for period equal to original warranty period, for replaced trees.

## 1.12 MAINTENANCE SERVICE

Generally, retain this article; consider deleting it only for projects where Owner will provide maintenance. A maintenance period should be long enough to ascertain the initial establishment of healthy trees. Coordinate maintenance period with warranty requirements.

- A. Initial Maintenance Service: Provide tree maintenance by skilled employees of tree-service firm and as required in Part 3. Begin maintenance immediately after [preparatory pruning] [trees are installed] and continue until plantings are healthy and well established, but for not less than maintenance period below:

Revise "Maintenance Period" Subparagraph below to suit Project.

1. Maintenance Period: [12] [18] <Insert number> months from date of [transplanting completion] [Substantial Completion] <Insert starting time>.

Retain "Continuing Maintenance Proposal" Paragraph below if needed. Revise starting date if required. See "Maintenance and Warranties" Article in the Evaluations.

- B. Continuing Maintenance Proposal: From tree-service firm to Owner, in the form of standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

## PART 2 - PRODUCTS

Manufacturers and products listed in this Section are neither recommended nor endorsed by the AIA or Deltek. Before selecting manufacturers and products, verify availability, suitability for intended applications, and compliance with minimum performance requirements. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

Product options commonly available from manufacturers are included in square brackets throughout the Section Text. Not every manufacturer listed can provide every option offered; verify availability with manufacturers. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

### 2.1 PERFORMANCE REQUIREMENTS

If retaining period longer than one year in "General Performance" Paragraph below, verify that Contractor has contractual obligation or maintenance contract with Owner for that period. See "Maintenance and Warranties" Article in the Evaluations.

- A. General Performance: Transplanted trees are to be healthy and resume vigorous growth within one year of transplanting without dieback due to defective extracting, handling, planting, maintenance, or other defects in the Work.

### 2.2 PLANTING MATERIALS

Revise "Backfill Soil" Paragraph below to suit Project.

- A. Backfill Soil: [Excavated soil] [Excavated soil mixed with planting soil] [Planting soil] of suitable moisture content and granular texture for placing and compacting in planting pit around tree, and free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

Retain "Mixture" Subparagraph below if retaining second option in "Backfill Soil" Paragraph above; delete below if retaining first or third option. Insert additional requirements for inorganic or organic soil amendments and fertilizer if required.

1. Mixture: Well-blended mix of [two parts excavated soil to one part planting soil] <Insert requirement>.

Retain "Planting Soil" Subparagraph below if retaining second or third option in "Backfill Soil" Paragraph above; delete below if retaining first option.

2. Planting Soil: <Insert drawing designation> as specified in [Section 329113 "Soil Preparation."] [Section 329115 "Soil Preparation (Performance Specification)."]

## 2.3 TREE-STABILIZATION MATERIALS

Retain this article if tree stabilization is required; coordinate with details on Drawings.

### A. Trunk-Stabilization Materials:

Retain "Upright and Guy Stakes," "Wood Deadmen," "Flexible Ties," "Guys and Tie Wires," "Tree-Tie Webbing," "Guy Cables," and "Flags" subparagraphs below for nonproprietary devices. Insert provisions for painting the stakes if required.

1. Upright and Guy Stakes: Rough-sawn, sound, new [hardwood] [softwood with specified wood preservative treatment by pressure process], free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring 8 inches in diameter and 48 inches long, treated with specified wood preservative treatment by pressure process.

Retain "Flexible Ties" or "Guys and Tie Wires" Subparagraph below.

3. Flexible Ties: Wide rubber or elastic bands or straps.

Revise wire measurement in "Guys and Tie Wires" Subparagraph below to 0.080 inch (2 mm) in diameter for small trees.

4. Guys and Tie Wires: ASTM A641/A641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.

Retain "Guy Cable" Subparagraph below for tall and large-caliper trees.

6. Guy Cable: Five-strand, 3/16-inch-diameter, galvanized-steel cable, fitted with zinc-coated 3/8-inch galvanized eyebolts at ends.
7. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

Retain "Proprietary Staking-and-Guying Devices" Subparagraph below for proprietary devices.

8. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by tree stem; sized as indicated and in accordance with manufacturer's written instructions.

Retain "Root-Ball-Stabilization Materials" Paragraph below for root-ball stabilization.

### B. Root-Ball-Stabilization Materials:

Retain "Upright Stakes and Horizontal Hold-Down" and "Wood Screws" subparagraphs below for nonproprietary devices.

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated; stakes pointed at one end.
2. Wood Screws: Hot-dip galvanized or stainless steel.

Retain "Proprietary Root-Ball-Stabilization Devices" Subparagraph below for proprietary devices.

3. Proprietary Root-Ball-Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball; sized in accordance with manufacturer's written instructions unless otherwise indicated.

Retain "Palm Bracing" Paragraph below for palm trees; revise to suit Project.

- C. Palm Bracing: Battens or blocks, struts, straps, and protective padding as indicated.

Retain "Battens or Blocks and Struts," "Straps," and "Padding" subparagraphs below for nonproprietary devices.

1. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-4-inch nominal by lengths indicated.
2. Straps: Adjustable steel or plastic package banding straps.
3. Padding: Burlap.

Retain "Proprietary Palm-Bracing Devices" Subparagraph below for proprietary devices.

4. Proprietary Palm-Bracing Devices: Proprietary systems to secure each new planting by trunk; sized in accordance with manufacturer's written instructions unless otherwise indicated.

## 2.4 TREE-WATERING DEVICES

Generally, retain "Watering Pipe" or "Slow-Release Watering Device" Paragraph below. If retaining both, indicate where each is used either on Drawings or by inserts. Watering pipes are installed during planting; slow-release watering devices are installed after planting is complete.

- A. Watering Pipe: PVC pipe 4 inches in diameter, site-cut to length as required, and with snug-fitting removable cap.

Retain "Slow-Release Watering Device" Paragraph below if required; revise to suit Project. Option is broad enough to include all listed products.

- B. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over a period of [2 to 9] <Insert number or range> hours; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
  1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

## 2.5 MISCELLANEOUS PRODUCTS

Retain applicable paragraphs in this article; revise to suit Project. Insert other miscellaneous products such as tree-protection devices (tree guards) if not included elsewhere. Coordinate with other Sections to avoid duplication.

Retain "Organic Mulch" or "Mineral Mulch" Paragraph below if required and mulch type is not indicated on Drawings; revise to suit Project.

- A. Organic Mulch: [**Shredded hardwood**] [**Ground or shredded bark**] [**Wood and bark chips**] [**Compost mulch**] <Insert mulch type> as specified in Section 329300 "Plants."
- B. Mineral Mulch: [**Rounded riverbed gravel or smooth-faced stone**] [**Crushed stone or gravel**] [**Marble chips**] [**Granite chips**] <Insert mulch type> as specified in Section 329300 "Plants."
- C. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix in accordance with manufacturer's written instructions.
- D. Burlap: Non-synthetic, biodegradable.
- E. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing 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.
  - 1. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling germination or growth of weeds within planted areas at soil level directly below the mulch layer.
  - 2. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.
- F. Weed-Control Barriers:

Generally, retain "Nonwoven Geotextile Filter Fabric" or "Composite Fabric" Subparagraph below; revise to suit Project. If retaining both, indicate where each is used either on Drawings or by inserts.

- 1. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric is to be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.
  - 2. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd..
- G. Wood Preservative Treatment by Pressure Process: AWWA U1; Use Category UC4a, using preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium.

## PART 3 - EXECUTION

### 3.1 TREE-TRANSPLANTING SPECIALIST

Retain this article if list of preapproved firms is used as quality-control procedure.

- A. Tree-Transplanting Specialist Firms: Subject to compliance with requirements, have tree transplanting performed by one of the following firms:
  - 1. **<Insert, in separate subparagraphs, names of tree-transplanting specialist firms>.**

### 3.2 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross transplanting areas.
- B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to transplanting work and tree protection and health.
- C. Proceed with transplanting only after unsatisfactory conditions have been corrected.

### 3.3 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, other facilities, turf areas, and other plants and planting areas from damage caused by transplanting operations.

Retain "Utility Locator Service" Paragraph below if required and not specified in Section 311000 "Site Clearing"; revise to suit Project. First option is a generic term that is known in various states by different names listed in the other options.

- B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning excavation.
- C. Locate and clearly identify trees for transplanting. Tie a 1-inch blue-vinyl tape around each tree at 54 inches above the ground.

Retain first paragraph below if locations of plantings are not indicated on Drawings or if final adjustment is required.

- D. Lay out individual transplant locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before transplanting. Make minor adjustments as required.

Retain one of two paragraphs below; revise to suit Project.

- E. Apply antidesiccant to trees uniformly, using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during extracting, handling, and transportation.

1. If deciduous trees are moved in full leaf, spray with antidesiccant before extracting and again two weeks after transplanting.
- F. Wrap trees with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during extracting, handling, and transporting.

### 3.4 PREPARATORY PRUNING

Generally, retain this article if preparatory pruning is required. Preparatory pruning may also be performed under separate contract.

- A. Root Pruning: Perform preparatory root pruning under direction of arborist as far in advance of extracting each tree as Project schedule allows.

Retain first subparagraph below if size or shape of tree suggests existence of major roots extending beyond root ball. Indicate specific trees here or on Drawings if not required for all trees.

1. Dig exploratory pits or trench [**by hand**] [**or**] [**with air spade**] around perimeter of tree at indicated root-ball width to determine locations of main lateral roots.
2. Dig trench [**by hand**] [**or**] [**with tree spade**] around perimeter of tree at indicated root-ball width to the depth of the root system. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
3. Root-Ball Width: Minimum [**9 inches**] <Insert dimension> of root-ball diameter, or least dimension for non-round root balls, for each 1 inch of tree caliper being transplanted.
4. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking.
5. Use narrow-tine spading forks to comb soil to expose roots with minimal damage to root system.
6. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
7. Do not paint or apply sealants on cut root ends.
8. Backfill trench with excavated soil.

- B. Crown Pruning (Tip Pruning):

Retain one of two subparagraphs below.

1. Do not perform preparatory crown pruning (tip pruning).
2. Perform preparatory crown pruning as directed by arborist. Follow procedures as specified in "Crown Pruning" Article.

### 3.5 EXCAVATION AND PLANTING EQUIPMENT

Retain this article if using a tree spade is permitted; revise to suit Project. Delete article if only hand digging or boxing is anticipated.

Insert other specialized excavating and planting equipment in this article to suit Project.

- A. Tree Spade: Track-mounted mechanized tree mover; sized in accordance with manufacturer's size recommendation for each tree being transplanted.

### 3.6 EXCAVATION OF PLANTING PITS

Revise size and cross section of planting pits in "General" Paragraph below to suit Project, office standards, and local practice. Revise descriptions if required and supplement with Drawing details.

- A. General: Excavate under supervision of arborist.
  - 1. Excavate planting pits or trenches with sides sloping. 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. Scarify sides of planting pit smeared or smoothed during excavation.
  - 2. Excavate approximately three times as wide as root ball.
  - 3. Keep excavations covered or otherwise protected until replanting trees.

Retain first paragraph below to suit Project. Planting practices often allow use of unamended native subsoil or topsoil as backfill planting soil. Coordinate with "Planting Materials" Article.

- B. Subsoil and topsoil removed from excavations may[ **not**] be used as planting soil.
- C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees are encountered in excavations.

Retain "Hardpan Layer" Subparagraph below if hardpan or caliche is expected. Revise treatment to suit Project. Revise hole size and depth if required.

- 1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 ft., whichever is less, and backfill with free-draining material.

Retain "Seepage" and "Drainage" paragraphs below if no subsoil drainage systems are indicated.

- D. Seepage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage into tree-planting pits.

Generally, retain "Drainage" Paragraph below to assure that roots will not become waterlogged after planting.

- E. Drainage: Fill planting pit or trench with [**6 inches**] <Insert dimension> of water and time the infiltration rate of soil. If drainage rate is less than [**0.25 inch**] <Insert dimension> per hour, notify Landscape Architect to determine need for subsurface drainage.

The practice in "Saline or Sodic Soils" Paragraph below is used in dry climates, particularly in mountain zones and southwestern United States, to leach saline or sodic soils. Retain if applicable.

- F. Saline or Sodic Soils: Completely fill excavations with water and allow to percolate away before positioning trees.

### 3.7 EXTRACTION OF TREES

- A. General: Extract trees under supervision of arborist.
- B. Orientation Marking: Mark the north side of each tree with non-permanent paint before extracting.

Coordinate "Root-Ball Width" Paragraph below with "Preparatory Pruning" Article if retained. Diameter of root ball when extracted is generally larger than diameter of pruned root ball. Revise paragraph or insert additional requirements for different proportions for root-ball width.

- C. Root-Ball Width: Minimum [**10 inches**] <Insert dimension> of root-ball diameter, or least dimension for non-round root balls, for each 1 inch of tree caliper being transplanted.

Retain "Out-of-Season Planting" Subparagraph below if permitted.

- 1. Out-of-Season Planting: If planting before or after the in-season period for tree, provide minimum root-ball diameter of [**12 inches**] <Insert dimension> for each 1 inch of tree caliper being transplanted.
- D. Root-Ball Depth: As determined by arborist for each species and size of tree and for site conditions at original and planting locations.
- E. Digging:
  - 1. Dig and clear a pit [**by hand**] [**or**] [**with tree spade**] to depth of root system. Do not use backhoe or other equipment that rips, tears, or pulls roots.
  - 2. Use narrow-tine spading forks to comb soil to expose roots with minimal damage to root system.
  - 3. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking.

Revise first subparagraph below if required. Most tree authorities do not consider it beneficial to paint or seal cut root ends.

- 4. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not paint or apply sealants on cut root ends.

Retain first subparagraph below if digging and boxing are anticipated.

- 5. Construct box tight against root system sides and bottom as pit is dug. Brace and support box to prevent breaking of root ball.
- 6. Temporarily support and protect exposed roots from damage until they are permanently redirected and covered with soil. Cover roots with burlap and keep them moist until planted.

Retain "Extracting with Tree Spade" Paragraph below if using a tree spade is permitted; revise to suit Project. Delete paragraph if only hand digging or boxing is anticipated.

- F. Extracting with Tree Spade: Use same tree spade to extract the tree as will be used to transport and plant the tree.

1. Do not use tree spade to move trees larger than manufacturer's maximum size recommendation for tree spade being used.
2. When extracting the tree, center the trunk within tree spade and move tree with solid ball of earth.

### 3.8 PLANTING

- A. Planting Standard: Perform planting in accordance with ANSI A300 (Part 6) unless otherwise indicated.

Retain first paragraph below if visual control of root-ball depth during planting is required.

- B. Before planting, verify that root flare is visible at top of root ball. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.
- C. Ensure that root flare is visible after planting.

Revise first paragraph below if required. Most tree authorities do not consider it beneficial to paint or seal cut root ends.

- D. Remove injured roots by cutting cleanly; do not break. Do not paint or apply sealants on cut root ends.
- E. Orientation: Position the tree so that its north side, marked before extracting, is facing north in its new location.

First option in first paragraph below corresponds to ANSI A300 (Part 6) practice; second option corresponds to ANSI Z60.1 practice.

- F. Set tree plumb and in center of planting pit with **[bottom]** **[top]** of root flare **[1 inch]** **[2 inches]** <Insert dimension> above adjacent finish grades.
1. Use specified backfill soil for backfill.
  2. If area under the tree was initially dug too deep, add backfill to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  3. After placing some backfill around root ball to stabilize plant, begin backfilling.
  4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  5. Redirect exposed root ends downward in backfill areas where possible. Hand-expose roots as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is impractical, cut roots approximately 3 inches back from new construction and as required for root pruning.
  6. Continue backfilling process. Water again after placing and tamping final layer of soil.

Retain "Watering Pipe" Paragraph below if required; coordinate with Drawing details. Generally, delete paragraph if slow-release watering device is required in "Installation of Tree-Watering Devices" Article.

- G. Watering Pipe: During backfilling, install watering pipe 4 ft. deep into the planting pit outside the root ball **[as indicated on Drawings]** **[and]** **[with top of pipe 1 inch above the mulched surface]**.

Retain "Planting with Tree Spade" Paragraph below if using a tree spade is permitted; revise to suit Project. Delete paragraph if only hand digging or boxing is anticipated.

- H. Planting with Tree Spade: Use same tree spade for planting as was used to extract and transport the tree. Do not use tree spade for trees larger than manufacturer's maximum size recommendation for tree spade being used.
- I. Slopes: When planting on slopes, set the tree so root flare on the uphill side is flush with surrounding soil on the slope; edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

### 3.9 CROWN PRUNING

- A. Prune branches **[as indicated on Drawings, under direction of arborist]** **[as directed by arborist]**.
  - 1. Prune to remove only **[injured,]** broken, dying, or dead branches. Do not prune for shape.
  - 2. Do not remove or reduce living branches to compensate for root loss caused by cutting root system or to improve natural tree form.
  - 3. Pruning Standards: Perform pruning in accordance with ANSI A300 (Part 1).
- B. Unless otherwise directed by arborist and acceptable to Landscape Architect, do not cut tree leaders.
- C. Cut branches with sharp pruning instruments; do not break or chop.
- D. Do not paint or apply sealants to wounds.
- E. Provide subsequent maintenance during Contract period as recommended by arborist.
- F. Chip removed branches and **[spread over areas identified by Landscape Architect]** **[stockpile in areas approved by Landscape Architect]** **[dispose of off-site]** **<Insert requirement>**.

### 3.10 INSTALLATION OF TREE-STABILIZATION MATERIALS

Retain this article if tree stabilization is required; coordinate with details on Drawings. See the Evaluations for discussion of advantages and disadvantages of stabilization methods.

Retain one or more paragraphs in this article; if retaining more than one, indicate where each is used either on Drawings or by inserts. Retain "Trunk Stabilization by Upright Staking and Tying" Paragraph below for tree-trunk stabilization by upright staking with horizontal tie wires.

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated on Drawings **[or directed by arborist]**.

1. Upright Staking and Tying: Stake only as required to prevent wind tip out. Use a minimum of **[two]** **[three]** stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend **[to dimension indicated on Drawings]** **[one-third of trunk height]** **<Insert dimension or requirement>** above grade. Set stakes vertical and space to avoid penetrating root balls or root masses.

Retain one of two subparagraphs below.

2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with two strands of tie wire, connected to brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

Retain "Trunk Stabilization by Staking and Guying" Paragraph below for tree-trunk stabilization with diagonal guy wires secured to stakes driven at an angle into the ground.

- B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings **[ or directed by arborist]**.

Retain "Site-Fabricated Staking-and-Guying Method" or "Proprietary Staking-and-Guying Device" Subparagraph below for stabilization method or revise to suit Project.

1. Site-Fabricated Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

Retain options for compression springs in subparagraphs below to provide more line flexibility than turnbuckles.

- a. Securely attach guys to stakes 30 inches long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide **[turnbuckle]** **[compression spring]** for each guy wire and tighten securely.
- b. For trees more than **[6 inches in caliper]** **<Insert size>**, anchor guys to wood deadmen buried at least 36 inches below grade. Provide **[turnbuckle]** **[compression spring]** for each guy wire and tighten securely.

Retain one of first two subparagraphs below.

- c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to a **[turnbuckle]** **[compression spring]**. Allow enough slack to avoid rigid restraint of tree.
- d. Support trees with **[guy cable]** **[or]** **[multiple strands of tie wire]**, connected to brass grommets of tree-tie webbing at contact points with tree trunk and reaching to **[turnbuckle]** **[compression spring]**. Allow enough slack to avoid rigid restraint of tree.

Retain one of first two subparagraphs below.

- e. Attach flags to each guy wire, 30 inches above finish grade.
  - f. Paint **[turnbuckles]** **[compression springs]** with luminescent white paint.
2. Proprietary Staking-and-Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

Retain "Root-Ball Stabilization" Paragraph below for tree root-ball stabilization.

- C. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by root ball unless otherwise indicated on Drawings[ **or directed by arborist**].

Retain "Wood Hold-Down Method" or "Proprietary Root-Ball-Stabilization Device" Subparagraph below for stabilization method or revise to suit Project.

1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of vertical stakes.
  - a. Install stakes of length required to penetrate at least [**to dimension indicated on Drawings**] [**18 inches**] <Insert dimension> below bottom of backfilled excavation. Saw stakes off at horizontal stake.
  - b. Install screws through horizontal hold-down and penetrating at least 1 inch into stakes. Pre-drill holes if necessary to prevent splitting wood.
  - c. Install second set of stakes on other side of root trunk for larger trees as indicated.
2. Proprietary Root-Ball-Stabilization Device: Install root-ball-stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

Retain "Palm Bracing" Paragraph below for palm trees; revise to suit Project.

- D. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.

Retain "Site-Fabricated Palm-Bracing Method" or "Proprietary Palm-Bracing Device" Subparagraph below for stabilization method or revise to suit Project.

1. Site-Fabricated Palm-Bracing Method:
  - a. Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact trunk.
  - b. Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.
2. Proprietary Palm-Bracing Device: Install palm-bracing system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

### 3.11 INSTALLATION OF MULCHES

Retain first paragraph below if required.

- A. Install weed-control barriers before mulching in accordance with manufacturer's written instructions. Completely cover area to be mulched, overlapping edges minimum of [6 inches] [12 inches] and secure seams with galvanized pins.

Retain required mulch applications in "Organic Mulch" and "Mineral Mulch in Planting Areas" paragraphs below; revise to suit Project.

- B. Organic Mulch: Apply [2-inch] [3-inch] <Insert dimension> average thickness of organic mulch [extending 12 inches beyond edge of individual planting pit] [and] [over whole surface of planting area], and finish level with adjacent finish grades. Do not place mulch within [3 inches] [6 inches] <Insert distance> of trunks or stems.
- C. Mineral Mulch in Planting Areas: Apply [2-inch] [3-inch] <Insert dimension> average thickness of mineral mulch [extending 12 inches beyond edge of individual planting pit] [and] [over whole surface of planting area], and finish level with adjacent finish grades. Do not place mulch within [3 inches] [6 inches] <Insert distance> of trunks or stems.

### 3.12 INSTALLATION OF TREE-WATERING DEVICES

Retain this article if required; revise to suit Project. Generally, delete if watering pipe is required in "Planting" Article.

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree and fill with water in accordance with manufacturer's written instructions.

### 3.13 TREE MAINTENANCE

- A. Perform tree maintenance as recommended by arborist. Maintain arborist observation of transplanting work.
- B. Maintain trees 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. Treat as required to keep trees free of insects and disease.
- C. From time of [preparatory root pruning] [or] [tree extraction], measure soil moisture adjacent to edge of each root ball [weekly] <Insert period>. Record findings and weather conditions.
- D. Fill areas of soil subsidence with backfill soil. Replenish mulch materials damaged or lost in areas of subsidence.
- E. Apply treatments as required to keep tree materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

- F. Pesticide Application: Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
  - 1. Pre-Emergent Herbicides (Selective and Non-Selective): Apply in accordance with manufacturer's written instructions. Do not apply to seeded areas.
  - 2. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.
- G. Reports: Have arborist prepare [monthly] <Insert period> inspection reports.

### 3.14 REPAIR AND REPLACEMENT

- A. Repair or replace transplanted trees and other plants indicated to remain or be relocated that are damaged by construction operations, in a manner recommended by arborist and approved by Landscape Architect.
  - 1. Submit details of proposed pruning and repairs.
  - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours in accordance with arborist's written instructions.
  - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.

Retain paragraph below to quantify tree-survival evaluation and replacement; revise to suit Project. See "Maintenance and Warranties" Article in the Evaluations.

- B. Remove and replace trees that are more than [25] <Insert number> percent dead or in unhealthy condition[ before end of corrections period] or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.

Retain one of first two subparagraphs below, or both; revise to suit Project.

- 1. Provide new trees of same size as those being replaced for each tree of [6 inches] [4 inches] <Insert dimension> or smaller in caliper size.

Revise first subparagraph below to suit Project. Replacing larger than 6-inch (150-mm) caliper-size trees with trees of equal size is difficult and not always successful; some jurisdictions have established formulas for large-tree replacements.

- 2. Provide [one] [two] <Insert number> new tree(s) of [6-inch] [4-inch] <Insert dimension> caliper size for each tree being replaced that measures more than [6 inches] [4 inches] in caliper size.
- 3. Species of Replacement Trees: [Same species being replaced] [Species selected by Landscape Architect] <Insert species>.

3.15 CLEANING AND PROTECTION

- A. During transplanting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect trees from damage due to transplanting operations and operations of other contractors and trades. Maintain protection during transplanting and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After planting and before [**Substantial Completion**] <Insert time>, remove tags, markings, tie tape, labels, wire, burlap, and other debris from transplanted trees, planting areas, and Project site.

END OF SECTION 329600

## SECTION 334600 - SUBDRAINAGE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

#### 1.2 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for surface drainage and subdrainage as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. Section Includes:
  - 1. Delegated Design/Engineering and shop drawings of drainage shown that is not covered by civil engineering drawings.
  - 2. Landscape surface drains, grates, and catch basins.
  - 3. Perforated-wall pipe and fittings.
  - 4. Drainage conduits.
  - 5. Drainage panels.
  - 6. Geotextile filter fabrics.
- C. Related Requirements:
  - 1. Reference civil engineering plans and specifications for general requirements for excavation, piping, fittings, backfill, and compaction of underground utilities.
  - 2. Meet all requirements by authorities having jurisdiction.

#### 1.3 ACTION SUBMITTALS

- A. Product Data:
  - 1. Drainage piping and conduits, including rated capacities.
  - 2. Drainage panels, including rated capacities.
  - 3. Geotextile filter fabrics.
- B. Shop Drawings:
  - 1. Catch basins and subdrainage. Include plans, inverts, elevations, sections, details, frames, covers, and grates. Include connection details to storm conveyance systems and/or stormwater detention structures.

### PART 2 - PRODUCTS

#### 2.1 LANDSCAPE SURFACE DRAINS, GRATES, AND CATCH BASINS

- A. Catch Basins: NDS Square catch basin, size for grate indicated.

- B. Grates for Lawn Areas: NDS Square Flat HDPE ADA compliant grate, color green, or as indicated.
- C. Grates for Planting Areas: NDS Square Atrium HDPE grate, color black, or as indicated.

## 2.2 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:
  - 1. NPS 6 and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
  - 2. Couplings: Manufacturer's standard, band type.
- B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

## 2.3 DRAINAGE CONDUITS

- A. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
  - 1. Nominal Size: 6 inches high by approximately 0.9 inch thick.
    - a. Minimum In-Plane Flow: 2.4 gpm at hydraulic gradient of 1.0 when tested in accordance with ASTM D4716.
  - 2. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. when tested in accordance with ASTM D4491.

## 2.4 DRAINAGE PANELS

- A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, 36 to 60 inches wide with drainage core faced with geotextile filter fabric.
  - 1. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
    - a. Minimum Compressive Strength: 10,000 lbf/sq. ft. when tested in accordance with ASTM D1621.
    - b. Minimum In-Plane Flow Rate: 2.8 gpm/ft. of unit width at hydraulic gradient of 1.0 and compressive stress of 25 psig when tested in accordance with ASTM D4716.
  - 2. Filter Fabric, Nonwoven: Needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:
    - a. Survivability: Class 2.
    - b. Apparent Opening Size: No. 40 sieve, maximum.
    - c. Permittivity: 0.2 per second, minimum.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EARTHWORK

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

### 3.3 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- J. Install drainage panels on foundation walls as follows:
  - 1. Coordinate placement with other drainage materials.
  - 2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
  - 3. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
  - 4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.
- K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

### 3.4 UNDERSLAB DRAINAGE INSTALLATION

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.
- F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Install horizontal drainage panels as follows:
  - 1. Coordinate placement with other drainage materials.
  - 2. Lay perforated drainage pipe at inside edge of footing.
  - 3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
  - 4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

### 3.5 RETAINING-WALL DRAINAGE INSTALLATION

- A. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches.
- B. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- C. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- D. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- E. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- F. Place drainage course in layers not exceeding 3 inches in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- G. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

- H. Install drainage panels on wall as follows:
1. Coordinate placement with other drainage materials.
  2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
  3. If weep holes are used instead of drainage pipe, cut 1/2-inch-diameter holes on core side at weep-hole locations. Do not cut fabric.
  4. Mark horizontal calk line on wall at a point 6 inches less than panel width above footing bottom. Before marking wall, subtract footing width.
  5. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
  6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
  7. If another panel is required on same row, cut away 4 inches of installed panel core and wrap fabric over new panel.
  8. If additional rows of panel are required, overlap lower panel with 4 inches of fabric.
  9. Cut panel as necessary to keep top 12 inches below finish grade.
  10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.
- I. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

### 3.6 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

### 3.7 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 in accordance with manufacturer's written instructions and other requirements indicated.
  - 1. Foundation Subdrainage: Install piping level and with a minimum cover of 36 inches unless otherwise indicated.
  - 2. Underslab Subdrainage: Install piping level.
  - 3. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches unless otherwise indicated.
  - 4. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches unless otherwise indicated.
  - 5. Lay perforated pipe with perforations down.
  - 6. 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 in accordance with ASTM D2321.

### 3.8 PIPE JOINT CONSTRUCTION

- A. Join perforated PE pipe and fittings with couplings in accordance with ASTM D3212 with loose banded, coupled, or push-on joints.
- B. Join perforated PVC sewer pipe and fittings in accordance with ASTM D3212 with loose bell-and-spigot, push-on joints.
- C. 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.

### 3.9 BACKWATER VALVE INSTALLATION

- A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."
- B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.
- C. Install horizontal backwater valves in piping where indicated.

### 3.10 CLEANOUT INSTALLATION

- A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."
- B. Cleanouts for Landscaping 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 1 inch above grade.
3. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

- A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.
- C. Where required, connect low elevations of subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."
  1. Install PE warning tape or detectable warning tape over ferrous piping.
  2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 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.

3.14 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.

END OF SECTION

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dimensional characters.
  - a. Cutout dimensional characters.
  - b. Fabricated channel dimensional characters.
  - c. Illuminated, fabricated channel dimensional characters.

1.2 DEFINITIONS

- A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

- A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

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

- B. Shop Drawings: For signs.

1. Provide a full set of shop drawings, graphic submittal drawings, and signed and sealed structural drawings with calculations by licensed engineer within the jurisdiction of the Project location.
  - a. Shop Drawings to include the following components: Appropriate orthographic view of the signage exterior components, necessary details orthographic views, sections and section details of signage interior components (i.e. framing, anchoring, component locations, etc.), electrical layouts, etc. All materials, material thicknesses, material finishes, anchoring systems, electrical components, electrical loads, wiring diagrams, etc. are clearly called out.
  - b. Graphic Submittals to include the following components: Graphical layouts for each sign in the package showing copy, copy size, copy font, copy locations, braille layouts & locations, etc. Graphic submittals may be scaled unless otherwise noted, but must depict exact appearance (kerning, letter spacing, actual fonts, etc.).
  - c. Structural Drawings & Calculations include the following: Any exterior sign that is subject to wind loads and the elements must have signed and sealed structural shop drawings and supporting calculations to affirm structural design adheres to or

surpasses local building codes for signage wind loading, maximum allowable stresses, allowable deflections, etc. Signing and Sealing must be performed by a Professional Engineer, licensed and registered to perform work in the location and jurisdiction of signage installation.

2. Include fabrication and installation details and attachments to other work.
  3. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
  4. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
  5. Show locations of electrical service connections.
  6. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Sample Warranty: For special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Upon completion of Project, provide as-built drawings and maintenance manual. As-builts drawings shall include redlines, revisions, and actual sign construction. Maintenance Manuals to include the following:
  1. Cleaning procedures demonstrating how to clean the sign and/or individual components of the sign without damaging any finishes or materials.
  2. All mechanical maintenance such as hardware which should be checked and tightened on an interval basis.
  3. All electrical maintenance such as location of the main shut off switch, location and access to any and all transformers, power supplies, and ballasts, location and access to any and all lamps, LED's, neon tubes, and each electrical component that would need regular replacement. Reference the following:
    - a. Item number, manufacturer of item, manufacturer's part number, and relevant specifications. Example:
      - 1) I.E. Light Source: Brand: Sloan
      - 2) Description: V-Series
      - 3) Manufacturer's Part Number: 701269-WLPY-MB
      - 4) Specifications: 12 VDC @ .6 watts per module
  4. Procedures to perform all cosmetic maintenance issues. List paint formulas, sheens, manufacturers, etc. State locations of those formulas.
  5. Procedures to perform all vinyl replacement. Provide vinyl manufacturers, part number, color spec, and location.

## 1.7 FIELD CONDITIONS

### A. Field Measurements:

1. Verify in field all measurements required for the fabrication and installation of signage and signage components. Include site context, existing conditions, adjacent elements, and dimensions.
2. Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings. Notify signage of service voltage or amperage requirements beyond the presumed circuit availability. Circuit loading must be in accordance with the NEC, UL, and all applicable building codes.
3. Markings and Labels: Do not place visible markings or labels of any kind. Labels required by code, such as ETL serial labels, UL serial labels, Manufacturer labels w/ electrical requirements shall be placed in the most inconspicuous areas possible, while still adhering to the applicable code and/or regulations.
4. Regulations and Ordinances: Ensure signs comply with Federal, State, and local laws, codes, ordinances, and regulations.

## 1.8 QUALITY ASSURANCE

- A. Owner's representative may make scheduled or unscheduled viewings at the Sign Contractor's shop to ensure quality control. This will be initiated on an "as needed" basis. Make any necessary adjustments required during fabrication. Unsatisfactory items are to be corrected by the fabricator and contractor as directed.
- B. Fabrication may not proceed without written approvals of the shop drawings, graphic submittals, samples, prototypes, and/or any other related documents.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Separation or delamination of sheet materials and components.
  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, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of dimensional character sign type(s) according to structural performance requirements.

- B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads.
- C. 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.

## 2.2 DIMENSIONAL CHARACTERS

- A. Cutout Characters: Characters with uniform faces; square-cut, smooth, eased edges; precisely formed lines and profiles.
- B. Fabricated Channel Characters: Metal face and side returns, Open face with metal side returns, or Translucent face with metal side returns, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.

## 2.3 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B26, B209, or B221 as applicable, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.
- B. All structural components of the sign must be made of 6061-T6 alloy aluminum. All architectural extrusions such as architectural angle or channel may be made of 6063-T5 or 6061-T6 alloys of aluminum. Any sheet material used for non-structural panels such as skins for sign cabinets or sign faces may be made from 5052 H32 alloy aluminum at the fabricator's discretion for ease of that alloy's processing and fabrication.
- C. Mounting plates, match plates, or base plates may not utilize 5052-H32 or lesser alloy of aluminum. Those mounting surfaces must be made of the before mentioned 6061-T6 alloy aluminum.
- D. Structural aluminum to aluminum connections must be physically welded together. Do not use chemical bonding or adhesive for structural connections. Non-structural bonding of aluminum to aluminum may be performed with the following methods, provided the object in question is not overhead, with 3M DP805, 3M 4930 or 4950 VHB, and Lord 7610 if welding is not desired by the Sign Contractor.
- E. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 316, stretcher-leveled standard of flatness.
- F. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- G. All acrylic sheeting must come from the same manufacturer to ensure consistent color. Acrylic to acrylic connections may be a chemical welded with methylene chloride or chemically bonded with a high bond adhesive such as Weld-On No. 16, 3M DP805, or Lord 7610. Acrylic may also be bonded to high bond adhesives such as 3M DP805 or Lord 7610 may NOT be used to

bond acrylic to acrylic if the joint is for bare acrylic or exposed joints. If the joint is exposed or the acrylic left bare, methylene chloride or Weld-On No.16 may only be used.

- H. Polycarbonate Sheet: All polycarbonate sheets shall only be “sign grade” polycarbonate sheet material. All polycarbonate sheeting must come from the same manufacturer to ensure consistent color. It is preferred not to chemically bond polycarbonate to polycarbonate connections and polycarbonate to acrylic connections, however, should such a chemical bond be the only conceivable option such a chemical bond may only occur with Weld-On No.16.
- I. PVC Sheet: All PVC (Polyvinyl Chloride) shall be only Type I, rigid PVC sheeting. PVC to PVC connections may be a chemical bond with a high bond adhesive specifically made for PVC bonding (i.e. Gorilla PVC Cement or Weld-On PVC 700) or any of the following: 3M DP190, 3M DP805, or Lord 7610.
- J. PVC Pipe: All PVC (polyvinyl Chloride) piping must be of a scheduled proportional sizing appropriate to the purpose of the pipe. PVC pipe should not be used as a structural component to a sign. PVC to PVC connections may be a chemical bond with a high bond adhesive specifically made for PVC bonding (i.e. Gorilla PVC Cement or Weld-On PVC 700) or any of the following: 3M DP190, 3M DP805, or Lord 7610.
- K. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

## 2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
  - 1. Use concealed fasteners and anchors unless indicated to be exposed.
  - 2. Fasteners: All mechanical fasteners (machine screws, bolts, washers, nuts, etc.) shall be stainless steel of 316 alloys. The only exceptions to this are in the case of high strength steel fasteners as required per Professional Engineer's calculations for mounting, such as Grade 8 or ASTM A307 alloys as an example. All fasteners are to be concealed or in some way hidden from public view.
  - 3. Exposed Metal-Fastener Components, General:
    - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
  - 4. Sign Mounting Fasteners:
    - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

- B. Adhesive: As recommended by sign manufacturer.
- C. Silicone Adhesive: When the use of silicone adhesive is required, the fabricator shall use a silicone adhesive that is one part component, acetoxy-cure, and high tensile strength, Dow Corning 999A Silicone Adhesive, GE SCS1200 Silicone Adhesive or approved equal.
- D. Vinyl for Graphics & Copy: If a specific vinyl is called out in the design intent, fabricator must use that vinyl or approved equal by TBG Partners. If no such call out is made, vinyl must have pressure sensitive adhesive, resistance to moisture and outdoor elements, be 2mil in thickness, and carry at least a 7 year outdoor warranty on all opaque colors (including reflective) and at least a 5 year outdoor warranty on translucent colors. Defects within the warranty period shall be repaired by the Sign Contractor at the client's convenience.
- E. Cable Connections: Only 7 x 7 stranded, stainless steel cable with a clear vinyl coating will be accepted for cable connections or suspensions. Any cable loops that go through an eye bolt, eye hook, any piece of hardware or through a sign cabinet or panel must have the appropriate sized stainless steel thimble to prevent fraying of the cable. All cable connections must be either double crimped with a crimping tool or has swaged hardware.
- F. Foam Tapes: The Sign Contractor may use the following foam tapes in substitution of the epoxies listed above in the instances listed above:
  1. 3M 4930 VHB: To be used for high strength bonding of aluminum to aluminum, metal, acrylic, or polycarbonate. Appropriate for painted or unpainted aluminum.
  2. 3M 4945, 6381, 6380 VHB: To be used for high strength bonding of most materials except powder coated and electrostatically painted surfaces. Particularly good for vinyl materials and plastic to painted surfaces. This is the installation tape of choice (when combined with silicone adhesive) for exterior applications as well as interior applications onto vinyl wall covering, EPVC (i.e. Sintra), or where a critical high strength bonding is required.
  3. 3M 9473PC (Commonly referred to as Isotac): To be used for critical bonding of materials where minimal thickness is required or where minimum of surface is available.
  4. Perma-stick CW2522: To be used for critical bonding of materials where minimal thickness is required.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
  1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
  2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
  3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.

4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
  5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
  6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
  7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match sign-background color unless otherwise indicated.
  2. Stainless Steel Brackets: Factory finish brackets to match sign background with No. 4 finish unless otherwise indicated.

## 2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

## 2.7 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.
- B. Color Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

## 2.8 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - 1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
  - 2. Directional Satin Finish: No. 4.
  - 3. Dull Satin Finish: No. 6.
  - 4. Reflective, Directional Polish: No. 7.
  - 5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

## 2.9 LACQUER COATING FOR COPPER-ALLOY FINISHES

- A. Lacquer Coating: Clear, organic, waterborne, air-drying, acrylic lacquer called "Incralac"; specially developed for coating copper-alloy products; consisting of a solution of acrylic resin, methyl methacrylate copolymer, leveling agent, and corrosion inhibitor benzotriazole.

## 2.10 MISCELLANEOUS

- A. UV Protection: All exterior signs will have an applied UV protectant clear coat of the approved sheen to prevent color fading and white "filming" due to exposure to the sun. Sign contractor to provide a 5 year written warranty stating the clear coat will not crack, pit, peel, craze, corrode, or otherwise deemed as coating failure. Defects within the warranty period shall be repaired by the Sign Contractor at the client's convenience.
- B. Paint Quality: All required painting shall be performed with catalyzed acrylic polyurethane paints to achieve an "Automotive Finish". Sign Contractor to use Matthews Paint System paints, Akzo Nobel paints or equal to be approved by TBG Partners. Painted surfaces must be free of debris, cracks, crazing, pitting, "orange peel", etc. upon time of installation. Sign Contractor to provide a 5 year written warranty stating the finished product will not excessively fade, develop excessive non uniform colorations, crack, pit, peel, craze, corrode, or otherwise deemed as paint failure. Defects within the warranty period shall be repaired by the Sign Contractor at the client's convenience.
- C. Eased Corners & Edges: All corners will be eased to prevent any sharp edges or corners in which someone may injure themselves. This means the corners are lightly sanded or treated but NOT rounded over.
- D. Welds: All structural welds shall be performed by a certified welder in the applicable material. Certification ensures the welder knows how to achieve the maximum amount of penetration with no porosity. The welding wire and/or stick should be an appropriate alloy to provide the greatest strength and workability.
- E. Weld Treatments:
  - 1. Welds, first surface of a plane (plug welds): Shall be ground smooth and flush with the planar surface Polished and sanded as needed to not see any evidence of welding after paint.
  - 2. Welds, second surface of a plane (weld worms from inside sign): All welds from the interior of a sign cabinet that are visible from the exterior of a sign cabinet must be polished to not see any evidence of welding after paint.

3. Structural Welds: All exposed structural welds shall be filled with Bondo or similar filling material to give the appearance of a smooth fillet and not show exposed weld worms after paint.
  4. Non-Structural Welds: All non-structural welds shall be ground smooth.
- F. Fasteners: There is to be no exposed fasteners. All fasteners should be concealed. Mounting hardware must be located inside the sign or covered with an escutcheon. Hardware that is exposed, I.E. escutcheon set screws, must be painted to match the items they are fastening and have an appropriate head type (flat head or pan head - NO exposed hex head fasteners)
  - G. Exposed Edges: Any sheet material with exposed edges must be sanded or in some way treated so that it is to be free of saw marks, CNC chatter, water-jet chatter, etc. Any material that requires extraordinary finishing (I.E. - flame polishing of acrylic edges) will be called out specifically on the design intents.
  - H. Galvanic Reaction: any connections between ferrous metals and non-ferrous metals must be in some way separated from direct contact with one another to prevent galvanic reaction (electrolysis). Examples of acceptable gasketing materials are .063" or greater polycarbonate sheeting, 1/8" or greater type I PVC sheeting, 1/8" or greater hard, solid neoprene sheeting.
  - I. Overhead Connections: All overhead connections must be redundant in nature to ensure against catastrophic failure. This may be achieved with any two of the following: physical locking hardware (split rings, nylock hex nuts, etc.), concealed safety cables, or chemical permanent thread lockers ("red" Loctite 263)
  - J. Interior of Sign Cabinets: Interior of sign cabinets and wireways/raceways to be cleared of all debris, chips, and trash upon completion.
  - K. Vinyl for Graphics and Copy: All vinyl must be electronically cut with the appropriate equipment. All vinyl must be cut using the fonts and graphical artwork provided. Vinyl is to be laid out on signage free of debris and air bubbles.
  - L. Digital Output Graphics: All digital output graphics must be laid out on signage free of debris and air bubbles. All edges must be treated or sealed to prevent deterioration from water or other elements. All digital output graphics must have the appropriate over-laminates. Exterior, exposed graphics must have anti-graffiti and UV protectant over-laminates. Interior, exposed graphics must have anti-graffiti over-laminate.

## 2.11 ELECTRICAL CRITERIA

- A. Wiring and Equipment: All wiring and electrical equipment such as ballasts, transformers, power supplies, lamps, neon components, LED modules, conduit, connectors, junction boxes, and all other electrical equipment must be UL listed per UL48 and the UL Sign Components Manual (SAM). The assembly of this equipment must be in accordance with article 600 of the NEC, UL48, and any local ordinances. This includes proper grounding and bonding of the sign. All wiring and equipment must be concealed within the sign with the only exception being the need for remotely located power supplies or transformers.
- B. Wires (under 1000 volts): Wires must be rated for the highest voltage in the sign. The gage of wiring should be based upon the amperage as indicated on Table 19.2 Sign Circuits of UL 48.

I.E. If the secondary voltage of a fluorescent ballast is 600 volts, all the wiring in the sign must be rated for 600 volts.

- C. Wires (1000 volts or more): must be sleeved GTO insulated wiring must be used for any voltages above 1000 and must be rated for the maximum secondary voltage of the transformer it is wired to. No GTO insulated wire shall be in runs of longer than 20 feet in metallic conduit of any kind.
- D. Neon Transformers: All neon transformers shall comply with UL2161 (secondary ground fault protection). Neon transformers should be wired to neon tubing so that each leg is of equal length. Neon and neon transformers should be mid-point grounded.
- E. Remotely Located Power Supplies & Transformers: All remotely located transformers and power supplies must have their own enclosures (fabricated or off the shelf) to conceal all wiring, wiring connections, and connectors related to those power supplies and/or transformers.
- F. Disconnect Switch: All electrical signs must have a discretely located, appropriately rated, toggle switch. If the sign is exterior, the toggle switch must have a matching weather proof rubber boot.
- G. Weather Exposure: The Sign Contractor is to presume all exterior signage should be wet location rated (full exposure to the elements) as defined by article 600 of the NEC and UL 48. All signage to be designed and constructed accordingly.
- H. Ventilation: adequate ventilation must be provided if it is warranted by the enclosed electrical equipment to prevent overheating, premature component failure, and/or fire. Examples of acceptable ventilation techniques are, but not limited to, mini-louvers, vents, discretely located perforated panels, and if needed cooling fans.
- I. Serviceability: All electrical components, lamps, electrical connections, etc. must be serviceable or in some way provisions for access to these components must be made.

## 2.12 ILLUMINATION CRITERIA

- A. Light Leaks: The Sign Contractor shall ensure the finished product is free of light leaks from hinges, seams, vents, or weep holes. Vents shall be placed either in an inconspicuous place as to be out of public view or baffled. Weep holes shall be baffled to prevent light leaks.
- B. Quality of Light: A light shall shine through the appropriate illuminated surfaces evenly and uniformly. The illuminated surfaces shall be free of “hot spots” and “cold spots”. “Hot Spots” where one can see the light source (i.e. LED module, fluorescent lamp, neon tubing, etc.) will not be accepted unless previously specified by the TBG Partners. This may be achieved with either proper amount of lighting devices and/or adequate light diffusers and film. Shadows or “cold spots” caused by the internal wiring or electrical components (i.e. j-boxes, ballasts, etc.) will not be accepted. Illuminated surfaces should appear bright when turned on and visible from the viewing distance set forth by the TBG Partners.
- C. Light Source: Whenever possible, lighting sources will be specified in the design intents with no substitutions allowed without previous written consent from the designer. ONLY if no such

specifications have been set forth in the design intent, the Sign Contractor is to adhere to the following guidelines:

1. LED's: All LED's must be UL listed for damp locations OR listed in the UL Sign Components Manual (SAM). All LED's must be 12 volts, direct current (12 VDC). All LED's shall be "sign white" or cool white (about 6500K) unless specified. LED's must also have at least a 120 degree viewing angle. All LED modules to be rated for AT LEAST 50,000 hours of life and carry at least a five year warranty.
2. Fluorescent Lamps: All fluorescent lamps shall be recessed, double contact, high output (HO) with at least 9,000 hours of life. All signs with fluorescent lamps must be uniform color, cool white or daylight white, but mixing and matching will not be permitted. All fluorescent lamps are assumed to be T12 in diameter; however, some electrical vendors are phasing out T12's in preference to T8's due to lower power consumption. It is the Sign Contractor's discretion to use T12 or T8 lamps, but all signs with fluorescent lamps shall use the same diameter bulbs. No mixing and matching will be permitted.
3. Neon: All neon tubing to be 6500 white, 13mm tubing. Neon tubing to be mounted to glass stand-offs, with a silicone cushion, and tied with copper wire ties.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that electrical service is correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
  3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
  1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

- a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
  - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
    - b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
  3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
  4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.
  5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
  6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

### 3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

**2022 COSA Bond – Hays St. Bridge Connection &  
East Side Streets  
Construction Contract Special  
Specifications - Irrigation**

This guide specification was prepared utilizing 3-part format recommended by the Construction Specifications Institute (CSI), and generally incorporates recommendations from their SectionFormat™/Page Format™, and MasterFormat®, latest Editions, insofar as practicable.

Carefully review and edit the text to meet the Project requirements and coordinate this Section with the remainder of the Specifications and the Drawings.

Where bracketed text is indicated, e.g. [text], make appropriate selection and delete the remainder of text within additional brackets, highlighting, and bold face type, if any.

This specification defines material and performance requirements for the "Silva Cell System". The Specifier should adapt these specifications to reflect specific project requirements.

Consult the manufacturer for assistance in editing this guide specification for specific Project applications where necessary, including conventional applications, and for assistance evaluating and sizing design elements for Silva Cell stormwater applications.

This Specification was current at the time of publication but is subject to change. Please confirm the accuracy of these specifications with the manufacturer prior to use.

Some elements in these specifications require coordination with Project drawings; these items are noted "as indicated on plans or drawings" or similar phrases.

Refer to the DeepRoot website, [www.deeproot.com](http://www.deeproot.com) for additional information.



**SECTION 32 94 51  
SOIL CELLS  
("SILVA CELL SYSTEM")**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
1. Silva Cell system for planting and paving, including Silva Cell assemblies and related accessories.
  2. Other materials including, but not limited to, geotextile, geogrid, aggregate, subbase material, backfill, root barrier, Water + Air System, and planting soil.

*SPECIFIER: Delete paragraph below if planting soils will be installed under a separate contract.*

- B. Materials Installed But Not Furnished Under This Section:
1. Planting soils are furnished in Section 32 94 56 - Planting Soil for Silva Cells.
- C. Related Requirements:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

*SPECIFIER: Revise Section numbers and titles in subparagraphs below per CSI MasterFormat and Project requirements.*

2. Section 01 33 00 - Submittal Procedures: For administrative and procedural requirements for processing of submittals during the construction phase.
3. Section 01 77 00 - Closeout Procedures: For administrative and procedural requirements for completion of the Work.

*SPECIFIER: Sections listed below are examples only; revise Section numbers and titles in subparagraphs below to suit Project requirements.*

4. Section 32 12 16 - Asphalt Paving
5. Section 32 13 13 - Concrete Paving
6. Section 32 14 00 - Unit Paving
7. Section 32 84 00 - Planting Irrigation
8. Section 32 93 00 - Plants

## 1.02 REFERENCES

### A. Definitions:

1. AGGREGATE BASE COURSE: Aggregate material between the paving and the top of the Silva Cell deck below, designed to distribute loads across the top of the deck.

*SPECIFIER: Delete subparagraph below if pavers are not a part of the Project.*

2. AGGREGATE SETTING BED FOR PAVERS: Aggregate material between the aggregate base course and unit surface pavers, designed to act as a setting bed for the pavers.
3. AGGREGATE SUBBASE: Aggregate material between the bottom of the Silva Cell base and the compacted subgrade below, designed to distribute loads from the Silva Cell bases to the subgrade.
4. BACKFILL: The earth used to replace or the act of replacing earth in an excavation beside the Silva Cell system to the excavation extents.
5. FINISH GRADE: Elevation of finished surface of planting soil or paving.
6. PLANTING SOIL: Soil as defined in Division 32, Section 32 94 56 - Planting Soil for Silva Cells, intended to fill the Silva Cell system and other planting spaces.
7. SILVA CELL SYSTEM:
  - a. Silva Cell: One assembled unit made up of 1 base, 6 post assemblies, and 1 Silva Cell deck.
  - b. Silva Cell System: Two or more Silva Cells used in combination with each other and with required accessories.
8. SUBGRADE: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill.
9. WALK-THROUGH COMPACTION: A process for light compaction of soils by walking through the soil following placement.
  - a. Walk through compaction shall result in 75-85 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method. Do not exceed root limiting compaction for the given soil type.

### B. Reference Standards:

*SPECIFIER: Use care when indicating the edition date of the referenced standards; these standards are subject to regular review, and updated accordingly.*

1. American Association of State Highway and Transportation Officials (AASHTO):
  - a. AASHTO H-20
2. ASTM International (ASTM):

- a. ASTM D448-12, Standard Classification for Sizes of Aggregate for Road and Bridge Construction
- b. ASTM D698-12e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> [600 kN-m/m<sup>3</sup>])
- c. ASTM D1241-07, Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses
- d. ASTM D3786/D3786M-13, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
- e. ASTM D4491-99a(2014)e1, Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- f. ASTM D4533-D4533M-15, Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- g. ASTM D4632-D4632M-15, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- h. ASTM D4751-12, Standard Test Method for Determining Apparent Opening Size of a Geotextile
- i. ASTM D4833/D4833M-07(2013)e1, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
- j. ASTM D5262-07(2012), Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics
- k. ASTM D6241-14, Standard Test Method for Static Puncture Strength of Geotextile and Geotextile-Related Products Using a 50mm Probe
- l. ASTM D6637-11, Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

*SPECIFIER: Delete reference below if Project is not located in Canada.*

3. Ontario Provincial Standard Specification (OPSS)

### 1.03 ADMINISTRATIVE REQUIREMENTS

*SPECIFIER: Select either "Landscape Architect", "Architect" or "Engineer" in paragraph below as applicable.*

- A. Preinstallation Conference: Prior to installation of the Silva Cell system and associated Work, meet with the Contractor, Silva Cell system installer and their field supervisor, manufacturer's technical representative, the [**Landscape Architect**] [**Architect**] [**Engineer**], the Owner at the Owner's discretion, and other entities concerned with the Silva Cell system performance.
  1. Provide at least 72 hours advance notice to participants prior to convening preinstallation conference.
  2. Introduce and provide a roster of individuals in attendance with contact information.
  3. The preinstallation conference agenda will include, but is not limited to the review of:
    - a. Required submittals both completed and yet to be completed.
    - b. The sequence of installation and the construction schedule.
    - c. Coordination with other trades.
    - d. Details, materials and methods of installation.
      - 1) Review requirements for substrate conditions, special details, if any, installation procedures.
      - 2) Installation layout, procedures, means and methods.
    - e. Mock-up requirements.
- B. Sequencing and Scheduling:
  1. General: Prior to beginning Work of this Section, prepare a detailed schedule of the Work involved for coordination with other trades.
  2. Schedule utility installations prior to beginning Work of this Section.
  3. Where possible, schedule the installation of the Silva Cell system after the area is no longer required for use by other trades and Work. Where necessary to prevent damage, protect installed system if Work must occur over or adjacent to the installed Silva Cell system.

## 1.04 SUBMITTALS

- A. Action Submittals: Submit in accordance with Section **[01 33 00] [other]**:

*SPECIFIER: Select paragraph A above if detailed submittal requirements are specified in Division 01 and revise Section number if necessary to match that used in the Project Manual, or; select paragraph A below if Division 01 is not a part of the Project Manual; keep subparagraphs 1 through 5 with either paragraph A selected.*

*Select either "Landscape Architect", "Architect", or "Engineer" in the paragraph below as applicable.*

- A. Action Submittals: Submit these to the **[Landscape Architect] [Architect] [Engineer]** for review and acceptance not less than 45 days prior to start of installation of materials and products specified in this Section.
1. Product Data: For each type of product, submit manufacturer's product literature with technical data sufficient to demonstrate that the product meets these specifications.
  2. Test and Evaluation Reports:
    - a. Submit results of compaction testing required by the Specifications for approval.
    - b. Include analysis of bulk materials including soils and aggregates, by a recognized laboratory that demonstrates that the materials meet the Specification requirements.
  3. Samples:
    - a. One full size sample of an assembled Silva Cell (copy of manufacturers brochure with images of product may be accepted in lieu of product sample).
    - b. Manufacturer's product data/specification sheet for geogrid.
    - c. Manufacturer's product data/specification sheet for geotextile.
    - d. Manufacturer's product data/specification sheet for Water+Air System components (when specified as part of the system)
  4. Manufacturer's Report: Submit Silva Cell system manufacturer's letter of review and approval of the Project, including Drawings and Specifications, Addenda, Clarifications and Modifications, and for compliance with product installation requirements.
  5. Qualification Statements:
    - a. Manufacturer:
      - 1) Submit list of completed projects demonstrating durability and longevity of in-place systems.
        - a) Include project name, location, and date of completion.

*SPECIFIER: Delete subparagraph below if system is not being designed for stormwater management.*

- 2) Submit list of third party approval for stormwater management projects.

- b. Installer:
  - 1) Submit documentation of the qualifications of the Silva Cell system installer and their field supervisor, sufficient to demonstrate that both meet the requirements specified in Article 1.05 QUALITY ASSURANCE.
  - 2) Submit list of completed projects of similar scope and scale demonstrating capabilities and experience.

- B. Closeout Submittals: Submit in accordance with Section **[01 33 00] [other]**:

*SPECIFIER: Select paragraph B above if detailed submittal requirements are specified in Division 01 and revise Section number if necessary to match that used in the Project Manual, or; select paragraph B below if Division 01 is not a part of the Project Manual.*

*Select either "Landscape Architect", "Architect", or "Engineer" in the paragraph below as applicable.*

- B. Closeout Submittals: Submit these to the [**Landscape Architect**] [**Architect**] [**Engineer**] at completion of installation.
  - 1. Warranty: Submit manufacturer's warranty, fully executed.

#### 1.05 QUALITY ASSURANCE

- A. Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary permits/approvals from these authorities.
- B. Manufacturer Qualifications:
  - 1. A manufacturer whose product is manufactured in an ISO/TS 16949 compliant and ISO 9001 - 2008 registered factory.
  - 2. A manufacturer with not less than 100 Silva Cell systems in-place, each system in use for not less than 7 years, confirming durability and longevity of the system.
  - 3. A manufacturer with documented written approval of their product for use as a stormwater treatment device by a minimum of 3 governmental jurisdictions.
  - 4. A manufacturer with an established and demonstrated utility service and repair process, including written procedure and photographs demonstrating work.
  - 5. A manufacturer with a published operating and maintenance manual
- C. Installer Qualifications: A qualified installer with not less than 5 years of successful experience installing Silva Cell systems or related products and materials, and whose work has resulted in successful installation of underground piping, chambers and vault structures, planting soils, and planter drainage systems of a similar scope and scale in dense urban areas.

*SPECIFIER: Select either "Landscape Architect", "Architect" or "Engineer" in paragraph below as applicable.*

- D. Installer's Field Supervisor: A full-time supervisor employed by the installer with not less than 5 years of successful experience similar to that of the installer and present at the Project site when Work is in progress. Utilize the same field supervisor throughout the Project, unless a substitution is submitted to and approved in writing by the [**Landscape Architect**] [**Architect**] [**Engineer**].
- E. Mock-Up: Prior to the installation of the Silva Cell system, construct a mock-up of the complete installation at the Project site in the presence of the Landscape Architect.
  - 1. Size and Extent: Minimum of 100 sq. ft. (10 sq. m.) in area and including the complete Silva Cell system installation with subbase, aggregate subbase, drainage installation, Silva Cell decks, posts, and bases, base course aggregate, geotextile, geogrid, backfill, planting soil, and necessary accessories.
  - 2. The mock-up area may remain as part of the installed Work at the end of the Project provided that it remains undamaged and meets the requirements of the Drawings and Specifications.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Silva Cell System: Protect Silva Cell system components from damage during delivery, storage and handling.
  - 1. Store components on smooth surfaces, free from dirt, mud and debris. Store under tarp to protect from sunlight when time from delivery to installation exceeds one week.
  - 2. Perform handling with equipment appropriate to the size (height) of Silva Cells and site conditions; equipment may include, hand, handcart, forklifts, extension lifts, or small cranes, with care given to minimize damage to Silva Cell bases, posts, decks and adjacent assembled Silva Cells.
- B. Packaged Materials: Deliver packaged materials in original, unopened containers indicating weight, certified analysis, name and address of manufacturer, and indication of conformance with State and Federal laws, if applicable. Protect materials from deterioration during delivery and while on the Project site.

1. Do not deliver or place backfill, soils, or soil amendments in frozen, wet, or muddy conditions.
  2. Provide protection including tarps, plastic and/or matting between bulk materials and finished surfaces sufficient to protect the finish material.
  3. Bring planting soil to the site using equipment and methods that do not overly mix and further damage soil peds within the soil mix.
- D. Provide erosion-control measures to prevent erosion or displacement of bulk materials and discharge of soil-bearing water runoff or airborne dust to adjacent properties, water conveyance systems, and walkways. Provide additional sediment control to retain excavated material, backfill, soil amendments and planting mix within the Project limits as needed.

#### **1.07 FIELD CONDITIONS**

- A. Existing Conditions: Do not proceed with Work when subgrades, soils and planting soils are in a wet, muddy or frozen condition.

#### **1.08 WARRANTY**

*SPECIFIER: This Warranty gives the Owner specific legal rights, and the Owner may also have other legal rights, which vary from state to state, or in Canada, from province to province. Some states do not allow the exclusion of incidental or consequential damages, so the stated limitations and exclusions may not apply.*

- A. The Contractor shall warrant the Silva Cell system to be free of faults and defects in accordance with the General Conditions, except that the warranty shall be extended by manufacturer's written warranty against defects in materials and workmanship as follows:
1. DeepRoot® warrants to the original purchaser of its Silva Cell™ product that such product will be free from defects in materials and workmanship, and perform to DeepRoot's written specifications for the warranted product, when installed and used as specifically provided in the product's installation guidelines for a period of 20 years from the date of purchase. This warranty does not cover wear from normal use, or damage caused by abuse, mishandling, alterations, improper installation and/or assembly, accident, misuse, or lack of reasonable care of the product. This warranty does not apply to events and conditions beyond DeepRoot's control, such as ground subsidence or settlement, earthquakes and other natural events, acts of third parties, and/or Acts of God. If this warranty is breached, DeepRoot® will provide a replacement product. Incurred costs, such as labor for removal of the original product, installation of replacement product, and the cost of incidental or other materials or expenses are not covered under this warranty.
  2. Deeproot® makes no other warranties, express or implied, and specifically disclaims the warranty of merchantability or fitness for a particular purpose. Deeproot® shall not be liable either in tort or in contract for any direct, incidental or consequential damages, lost profits, lost revenues, loss of use, or any breach of any express or implied warranty.

### **PART 2 - PRODUCTS**

#### **2.01 MANUFACTURER**

- A. Acceptable Manufacturers:

DeepRoot Green Infrastructure, LLC  
101 Montgomery Street, Suite 2850  
San Francisco, CA, 94104

Phone: 415.781.9700  
Toll Free: 800.458.7668  
Fax: 415.781.0191  
[www.deeproot.com](http://www.deeproot.com)

- B. Substitutions: Manufacturers seeking approval of their products are required to comply with the Owner's Instructions to Bidders, generally contained in the Project Manual.

*SPECIFIER: Select paragraph B above or below as applicable, if substitutions will be allowed during the bidding process.*

*If using paragraph B below, select either "Landscape Architect", "Architect", or "Engineer", and adjust the length of time in subparagraph 1 for prior approval according to your practice.*

- B. Substitutions: Manufacturers seeking approval of their products are required to comply with the Owner's Instructions to Bidders, generally contained in the Project Manual. If such instructions are not included in Division 00 or Division 01, submit requests as specified herein.
  - 1. Submit proposed substitutions to the [**Landscape Architect**] [**Architect**] [**Engineer**] not less than [**7**] [**other**] days prior to the date for receipt of Bids.

*SPECIFIER: Select paragraph B below for a specification when substitutions are NOT allowed and delete the 2 paragraphs above.*

- B. No substitutions are allowed.

## **2.02 DESCRIPTION**

*SPECIFIER: The Silva Cell System is designed to support AASHTO H-20 loading (United States) CSA-S6 87.5 (Canada). The entire assembly as described in this specification is necessary in order to meet this loading performance. Alternative assemblies may void Silva Cell warranty.*

*Contact DeepRoot Green Infrastructure, LLC for approval of alternative assemblies.*

- A. The term Silva Cell shall be used to refer to a single Silva Cell.
- B. Silva Cells shall be designed for the purpose of growing healthy trees and providing stormwater management.
- C. Silva Cells shall be modular, structural systems.
- D. Each Silva Cell shall be structurally-independent from all adjacent Silva Cells for incorporating utilities and other site features as well as for future repairs.
- E. Silva Cells shall be capable of supporting loads up to and including AASHTO H-20 (United States) or CSA-S6 87.5 kN (Canada) when used in conjunction with approved pavement profiles.
- F. Silva Cells shall be open on all vertical faces and horizontal planes and shall have no interior walls or diaphragms.
- G. Silva Cells shall be capable of providing a large, contiguous, continuous volume of planting soil that does not inhibit or prevent the following:
  - 1. Placement of planting soil
  - 2. Walk through compaction
  - 3. Compaction testing of planting soil, once in place
  - 4. Movement and growth of roots
  - 5. Movement of water within the provided soil volume, including lateral capillary movement
  - 6. Installation and maintenance of utilities placed within, adjacent to, or below the Silva Cell.
- H. Silva Cells shall be able capable of being filled with a variety of soil types and soils that include peds 2 inches (50 mm) or larger in diameter as is appropriate for the application, location of the installation, and tree species.

## **2.03 SILVA CELL MATERIALS AND ACCESSORIES**

- A. Silva Cell System Components: Each "Silva Cell" soil cell module (hereafter Silva Cell or "cell") is composed of one base, 6 post assemblies, and one deck.

*SPECIFIER: Select one or more of the Silva Cell assemblies specified below as applicable to your Project design.*

- [1. **1x Silva Cell System:**
  - a. **Components: One base, six 1x posts, and one deck.**
  - b. **Assembled Dimensions (Each Cell): 47.2 inches long by 23.6 inches wide by 16.7 inches high (1200 mm long by 600 mm wide by 424 mm high).]**
- [2. **2x Silva Cell System:**
  - a. **Components: One base, six 2x posts, and one deck.**
  - b. **Assembled Dimensions (Each Cell): 47.2 inches long by 23.6 inches wide by 30.9 inches high (1200 mm long by 600 mm wide by 784 mm high).]**
- [3. **3x Silva Cell System:**
  - a. **Components: One base, six 3x posts (a combination of six 1x posts and six 2x posts), and one deck.**
  - b. **Assembled Dimensions (Each Cell): 47.2 inches long by 23.6 inches wide by 43 inches high (1200 mm long by 600 mm wide by 1092.2 mm high).]**
- B. **Silva Cell Materials and Fabrication:**
  - 1. **Bases and Posts: Homopolymer polypropylene.**
  - 2. **Decks: Fiberglass reinforced, chemically-coupled, impact modified polypropylene.**
- C. **Manufacturer's Related Silva Cell Installation Accessories:**
  - 1. **Strongbacks: An accessory designed to stabilize the Silva Cell posts temporarily, during soil placement, and removed for reuse prior to placing decks.**
  - 2. **Anchoring Spikes: 10" landscape spike for securing assembled Silva Cells to subbase.**

## 2.04 RELATED PRODUCTS

- A. **Root Barrier: Recyclable, black, injection molded panels manufactured with a minimum 50 percent post-consumer recycled polypropylene plastic with UV inhibitors, and integrated zipper joining system which allows instant assembly by sliding one panel into another; for redirecting tree roots down and away from hardscapes.**
  - 1. **Panel Sizes:**
    - a. **No. UB12-2: 24 inches long by 12 inches deep by 0.080 inches thick (61 cm long by 30 cm deep by 2.03 mm thick); for use with 1x systems and for pavement profiles less than 12 inches (30 cm) deep.**
    - b. **No. UB18-2: 24 inches long by 18 inches deep by 0.080 inches thick (61 cm long by 46 cm deep by 2.03 mm thick); for use with 2x and 3x systems, and for pavement profiles 12 inches or more in depth.**
  - 2. **Products meeting this specification:**
    - a. **DeepRoot Tree Root Barrier (DeepRoot Green Infrastructure, LLC)**

*SPECIFIER: Select one or more of the Water+Air System assemblies specified below as applicable to your Project design.*

- B. **Water+Air System: Used as a standalone system or in conjunction with the Silva Cell, the Water+Air System enables water and air to be directly added to tree roots and the surrounding soil system.**

- [1. **Water+Air System 01:**
  - a. **Cast aluminum body**
  - b. **Stainless steel grate**
  - c. **Height -3 3/4" (85mm)**
  - d. **Compatible with 3" and 4" (80mm and 100mm) pipe**
- [2. **Water+Air System 02:**
  - a. **Cast aluminum body**
  - b. **Stainless steel gate**
  - c. **Threaded for adjustable height**

- d. **Height- adjustable 3 ½" (89mm) – 10 ½" (267mm)**
- e. **Compatible with 3" and 4" (80mm and 100mm) diameter pipe**

*SPECIFIER: The Following pipe is an optional component of Water+Air System 01 and 02 assemblies specified above.*

- [f. **Pipe**
  - 1. **High density polyethylene corrugated pipe**
  - 2. **Compliant with ASTM F405 and F667, SCS 606 and AASHTO M252**
  - 3. **Knife cut perforations**

**[3. Water+Air System (Root Ball)**

- a. **3" diameter pipe (length per size of tree opening), compatible tee, flexible transition, and heavy-duty plastic grate**
- 5. Products meeting this specification:
  - a. DeepRoot Water+Air System (DeepRoot Green Infrastructure, LLC)

*SPECIFIER: The following products may be provided by DeepRoot Green Infrastructure, LLC, or by other sources.*

B. Geogrid: Net-shaped woven polyester fabric with PVC coating, uniaxial or biaxial geogrid, inert to biological degradation, resistant to naturally occurring chemicals, alkalis, and acids; used to provide a stabilizing force within soil structure as the fill interlocks with the grid.

- 1. Tensile strength at ultimate (ASTM D6637):
  - a. 1850 lbs/ft (27.0 kN/m) minimum
- 2. Creep reduced strength (ASTM D5262):
  - a. 1000 lbs/ft (14.6 kN/m) minimum
- 3. Long term allowable design load (GRI GG-4):
  - a. 950 lbs/ft (13.9 kN/m) minimum
- 4. Grid aperture size (MD):
  - a. 0.8 inch (20 mm) minimum
- 5. Grid aperture size (CD):
  - a. 1.28 inch (32 mm) maximum
- 6. Roll size: 6-foot (1.8-m) width is preferred, up to 18-foot (5.4-m).
- 7. Products meeting this specification:
  - a. Stratagrid SG 150; <http://www.geogrid.com>
  - b. Miragrid 2XT; <http://www.tencate.com>
  - c. Fortrac 35 Geogrid; (<http://www.hueskerinc.com>)
  - d. SF 20 Biaxial Geogrid; <http://www.synteen.com>

C. Geotextile: composed of high tenacity polypropylene yarns which are woven into a network such that the yarns retain their relative position and is inert to biological degradation and resistant to naturally encountered chemicals, alkalis, and acids.

- 1. Tensile strength at ultimate (ASTM D4595):
  - a. 4800 lbs/ft (70.0 KN/m) MD minimum
  - b. 4800 lbs/ft (70.0 KN/m) CD minimum
- 2. Tensile strength at 5% strain (ASTM D4595)
  - a. 2400 lbs/ft (35.0 KN/m) MD minimum
  - b. 3000 lbs/ft (43.8 KN/m) CD minimum
- 3. Flow rate (ASTM D4491):
  - a. 30 gal/min/ft<sup>2</sup> (2648 l/min/m<sup>2</sup>) minimum
- 4. Apparent opening size (ASTM D4751):
  - a. 30 sieve (0.60 mm)
- 5. UV Resistance (at 500 hours):
  - a. 80 percent strength retained
- 6. Products meeting this specification:
  - a. Mirafi HP570; <http://www.tencate.com>

- b. Geolon PP40; <http://www.tencate.com>
- c. Nilex Woven 2044 (Nilex); <http://www.nilex.com>

D. Plastic Cable Ties: A tensioning device or tool used to tie similar or different materials together with a specific degree of tension.

**2.05 OTHER RELATED MATERIALS**

- A. Wood Blocking: Nominal dimensioned untreated lumber used for spacing assembled Silva Cells.
- B. Drain and Distribution Pipes:

*SPECIFIER: Consult with Project Engineer for proper selection and add information below or refer to their Specification Section.*

1. **[Insert applicable drain pipe selection] [Refer to Section 32 84 00] [insert other Section title]**

- C. Aggregate Subbase (Below Silva Cell Base):
  - 1. Aggregate meeting one of the following specifications:

*SPECIFIER: Consult with Project Engineer for proper selection and edit accordingly.*

- a. Complying ASTM D1241, Type I, Gradation B; Type I mixtures shall consist of stone, gravel, or slag with natural or crushed sand and fine mineral particles passing a No. 200 sieve.

<u>Sieve</u>	<u>Percent Passing</u>
1-1/2 inches (37.5 mm)	100
1 inch (25 mm)	75 to 95
3/8 inch (9.5 mm)	40 to 75
No 4 (4.75 mm)	30 to 60
No 10 (2 mm)	20 to 45
No 40 (425 µm)	15 to 30
No 200 (75 µm)	5 to 15

- b. Local Department of Transportation (DOT) virgin aggregate that most closely meets the gradation of ASTM D1241.
- c. Ontario Provincial Standard Specification (OPSS) 1010 Granular A. Dense graded aggregates intended for use as granular base within the pavement structure, granular shouldering, and backfill.

<u>Sieve</u>	<u>Percent Passing</u>
26.5 mm	100
19 mm	85 to 100
13.2 mm	65 to 90
9.5 mm	50 to 73
4.75 mm	35 to 55
1.18 mm	15 to 40
300 µm	5 to 22
75 µm	2 to 8

- D. Aggregate Base Course (Above Silva Cell Deck):
  - 1. Same as aggregate subbase specified above.
- E. Aggregate Base Course for Porous Pavement (Above Silva Cell Deck):
  - 1. Aggregate complying with ASTM D448, No. 57.

<u>Sieve</u>	<u>Percent Passing</u>
1-1/2 inches (37.5 mm)	100
1 inch (25 mm)	95 to 100
1/2 inch (12.5 mm)	25 to 60
No 4 (4.75 mm)	0 to 10
No 8 (2.36 mm)	0 to 5

- F. Setting Bed for Unit Pavers (Above Silva Cell Deck):
1. Aggregate complying with ASTM D448, No. 8.

<u>Sieve</u>	<u>Percent Passing</u>
1/2 inch (12.5 mm)	100
3/8 inch (9.5 mm)	85 to 100
No 4 (4.75 mm)	10 to 30
No 8 (2.36 mm)	0 to 10
No 16 (1.18 mm)	0 to 5

- G. Backfill Material (Adjacent to Silva Cells): Clean, compactable, coarse grained fill soil free of organic material, trash and other debris, and free of toxic material injurious to plant growth.
- H. Planting Soil: Refer to Section 32 94 56 - Planting Soil for Silva Cells.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine the conditions under which the Silva Cells are to be installed.
1. Carefully check and verify dimensions, quantities, and grade elevations.
  2. Carefully examine the Drawings to become familiar with the existing underground conditions before digging. Verify the location of aboveground and underground utility lines, infrastructure, other improvements, and existing trees, shrubs, and plants to remain including their root system.

*SPECIFIER: Select either "Landscape Architect", "Architect", or "Engineer" in the subparagraph below as applicable.*

3. Notify the Contractor and the [**Landscape Architect**] [**Architect**] [**Engineer**] in writing in the event of conflict between existing and new improvements, of discrepancies, and other conditions detrimental to proper and timely completion of the installation.
4. Obtain written approval of changes to the Work prior to proceeding. Proceed with installation only after changes have been made and unsatisfactory conditions have been corrected.

#### **3.02 PREPARATION**

- A. Take proper precautions as necessary to avoid damage to existing improvements and plantings.
- B. Prior to the start of Work, layout and stake the limits of excavation and horizontal and vertical control points sufficient to install the complete Silva Cell system.
- C. Coordinate installation with other trades that may impact the completion of the Work.

#### **3.03 TEMPORARY PROTECTION**

- A. Protect open excavations and Silva Cell system from access and damage both when Work is in progress and following completion, with highly visible construction tape, fencing, or other means until related construction is complete.
- B. Do not drive vehicles or operate equipment over the Silva Cell system until the final surface material has been installed.

#### **3.04 EXCAVATION**

- A. General: Excavate to the depths and shapes indicated on the Drawings. Provide smooth and level excavation base free of lumps and debris.
- B. Confirm that the depth of the excavation is accurate and includes the full section of materials required to place the subbase aggregate, Silva Cell, and pavement profile as indicated on the Drawings.
- C. Over-excavate beyond the perimeter of the Silva Cell to allow for:
  - 1. The extension of aggregate subbase beyond the Silva Cell layout as shown on the Drawings.
  - 2. Adequate space for proper compaction of backfill around the Silva Cell system.
- D. If unsuitable subgrade soils are encountered, consult the Owner's geotechnical consultants for directions on how to proceed.

*SPECIFIER: Select either "Landscape Architect", "Architect", or "Engineer" in the paragraph below as applicable.*

- E. If conflicts arise during excavation, notify the [**Landscape Architect**] [**Architect**] [**Engineer**] in writing and make recommendations for action. Proceed with Work only when action is approved in writing.

### **3.05 SUBGRADE COMPACTION**

- A. Compact subgrade to a minimum of 95 percent of maximum dry density at optimum moisture content in accordance with ASTM D698, Standard Proctor Method, or as approved by the Owner's geotechnical representative.
- B. Do not exceed 10 percent slope for subgrade profile in any one direction. If the 10 percent slope is exceeded, contact manufacturer's representative for directions on how to proceed.

### **3.06 INSTALLATION OF GEOTEXTILE OVER SUBGRADE**

- A. Install geotextile over compacted subgrade.
  - 1. Lay geotextile flat with no folds or creases.
  - 2. Install the geotextile with a minimum joint overlap of 18 inches (450 mm).

### **3.07 INSTALLATION OF AGGREGATE SUBBASE BELOW SILVA CELL BASES**

- A. Install aggregate subbase to the depths indicated on the Drawings.
- B. Extend subbase aggregate a minimum of 6 inches (150 mm) beyond the base of the Silva Cell layout.
- C. Compact aggregate subbase to a minimum of 95 percent of maximum dry density at optimum moisture content in accordance with ASTM D698, Standard Proctor Method.
- D. Do not exceed 10 percent slope on the surface of the subbase. Where proposed grades are greater than 10 percent, step the Silva Cells to maintain proper relation to the finished grade.

### **3.08 INSTALLATION OF SILVA CELL BASE**

- A. Install the Silva Cell system in strict accordance with manufacturer's instructions and as specified herein; where requirements conflict or are contradictory, follow the more stringent requirements.
- B. Layout and Elevation Control:
  - 1. Provide layout and elevation control during installation of the Silva Cell system to ensure that layout and elevations are in accordance with the Drawings.
- C. Establish the location of the tree openings in accordance with the Drawings. Once the trees are located, mark the inside dimensions of the tree openings on the prepared subbase.
- D. Locate and mark other Project features located within the Silva Cell layout (e.g. light pole bases, utility pipes). Apply marking to identify the extent of the Silva Cell layout around these features.

Follow the layout as shown on the Drawings to ensure proper spacing of the Silva Cell bases. Refer to the Drawings for offsets between these features and the Silva Cells.

- E. Check each Silva Cell component for damage prior to placement. Reject cracked or chipped units.

*SPECIFIER: Select either "Landscape Architect", "Architect", or "Engineer" in the paragraph below as applicable.*

- F. Place the Silva Cell bases on the compacted aggregate subbase. Start at the tree opening and place Silva Cell bases around the tree openings as shown on the Drawings.
- G. Working from tree opening to tree opening, place Silva Cell bases to fill in the area between tree openings.
  - 1. Maintain spacing no less than 1 inch (25 mm) and no more than 6 inches (150 mm) apart, assuming geotextile covering the decks meets the specifications in section 2.04 paragraph C.

*SPECIFIER: Select either "Landscape Architect", "Architect", or "Engineer" in the paragraph below as applicable.*

- H. Follow the Silva Cell layout plan as shown on the Drawings.
- I. Install Silva Cell bases around, over, or under existing or proposed utility lines, as indicated on the Drawings.
- J. Level each Silva Cell base as needed to provide full contact with subbase. Adjust subbase material, including larger pieces of aggregate, so each base sits solidly on the surface of the subbase. Silva Cell bases that rock or bend over any stone or other obstruction protruding above the surface of the subbase material are not allowed. Silva Cell bases which bend into dips in the subbase material are not allowed. The maximum tolerance for deviations in the plane of the subbase material under the bottom of the horizontal beams of each Silva Cell base is 1/4 inch in 4 feet (6 mm in 1200 mm).
- K. Anchor Silva Cell base with 2 anchoring spikes per base.
  - 1. For applications where Silva Cells are installed over waterproofed structures, use wood blocking or similar spacing system consistent with requirements of the waterproofing system to maintain required spacing.

### 3.09 INSTALLATION OF SILVA CELL POSTS

*SPECIFIER: Select either "1x", "2x", or "3x" or a combination of "1x", "2x", or "3x" in the paragraphs below as applicable.*

- A. **[1x Silva Cell System:**
  - 1. **Attach 1x posts to the installed Silva Cell base. Each base will receive six 1x posts. Place the end of the post with tabs into the base. Rotate post clockwise to snap in place.]**
- A. **[2x Silva Cell System:**
  - 1. **Attach 2x posts to the installed Silva Cell base. Each base will receive six 2x posts. Place the end of the post with tabs into the base. Rotate post clockwise to snap in place.]**
- A. **[3x Silva Cell System:**
  - 1. **Attach 2x posts to the installed Silva Cell base. Each base will receive six 2x posts. Place the end of the post with tabs into the base. Rotate post clockwise to snap in place.**
  - 2. **Following the placement of backfill and planting soil within the 2x posts, add a 1x post extension as described herein. A 2x post, used in combination with a 1x post is considered a 3x post assembly.]**

### 3.10 INSTALLATION OF STRONGBACKS, GEOGRID, BACKFILL AND PLANTING SOIL

*SPECIFIER: Delete the first paragraph below if there are no drain lines within the system.*

- A. For Silva Cell systems that have a perforated drain line located inside or adjacent to the system, consult Drawings for layout and details for requirements.
- B. Install strongbacks on top of the Silva Cell posts by snapping into place over installed posts prior to installing planting soil and backfill.
  - 1. Strongbacks are required only during the placement and compaction of the planting soil and backfill.
  - 2. Move strongbacks as the Work progresses across the installation.
  - 3. Remove strongbacks prior to the installation of the Silva Cell decks.
- C. Install geogrid around the perimeter of the Silva Cell system where the compacted backfill and planting soil interface.
  - 1. Do not place geogrid between the edge of the Silva Cells and adjacent planting areas.
  - 2. Cut the geogrid to allow for a 6-inch (150-mm) overlap at the Silva Cell base and a 12-inch (300-mm) overlap at the Silva Cell deck.
  - 3. Provide a minimum 12-inch (300-mm) overlap between adjacent sheets of geogrid.
  - 4. Secure geogrid with cable ties below the top of the posts, along the post ridges.
- D. Place the first lift of backfill material loosely around the perimeter of the Silva Cell system, between the geogrid and the sides of the excavation. Place backfill to approximately the midpoint of the Silva Cell post. Do not compact.
- E. Place the first lift of planting soil in the Silva Cell system to approximately the midpoint of the Silva Cell post.
  - 1. Level the planting soil throughout the system.
  - 2. Walk-through the placed planting soil to remove air pockets and settle the soil.
    - a. Lightly compact soils by walking through the soil following placement.
    - b. Walk through compaction shall result in 75-85 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method. Do not exceed root limiting compaction for the given soil type.
- F. Compact the first lift of backfill material, previously spread, to 95 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method or in accordance with Project Specifications for hardscape areas, whichever is greater.
- G. Add and compact additional backfill material so that the final finished elevation is at approximately the same level of the placed planting soil within the Silva Cells.
  - 1. Maintain the geogrid between the Silva Cell system and the backfill material at all times.
- H. Place the second lift of backfill material loosely around the perimeter of the Silva Cell system, between the geogrid and the sides of the excavation so that the material is 2 to 3 inches below the top of the posts. Do not compact.
- I. Place the second lift of planting soil inside of the Silva Cell to the bottom of the strongbacks. Walk through compact.

*SPECIFIER: For 1x or 2x System, skip to Article 3.11 - INSTALLATION OF IRRIGATION AND WATER HARVESTING SYSTEM.*

*SPECIFIER: For 3x System, continue below.*

- J. Remove strongbacks, place one 1x posts into each of the previously-installed 2x posts. Rotate clockwise to snap in place, forming a 3x post assembly.
- K. Immediately reinstall strongbacks on top of the post assembly.
- L. Repeat process of alternately placing backfill and planting soil so that elevation of the compacted backfill and the walked-through compacted planting soil are just below the level of the strongbacks.

### **3.11 INSTALLATION OF IRRIGATION AND WATER HARVESTING SYSTEM (including but not limited to Deeproot Water+Air System components)**

*SPECIFIER: Water is critical to the success of the Silva Cell system; trees planted in the Silva Cell system must receive adequate water to ensure survival of the living system during periods of drier weather. Harvest of natural rainwater or supplemental water must be a part of the system, either through pressurized or non-pressurized systems, within the soil of the Silva Cell system. Coordinate with required irrigation installations. Irrigation should be installed within the entire soil system, not only at the tree openings.*

- A. Install irrigation and water harvesting system in accordance with the Drawings and Specifications. Remove only the minimum number of strongbacks needed to accommodate the Work and reinstall them immediately upon completion to maintain alignment of posts.

### **3.12 INSTALLATION OF SILVA CELL DECK**

*SPECIFIER: Select either "Landscape Architect", "Architect", or "Engineer" in the paragraph below as applicable.*

- A. Obtain final approval by the [Landscape Architect] [Architect] [Engineer] of planting soil installation prior to installation of the Silva Cell decks.
- B. Remove strongbacks, level out the planting soil, and immediately install decks over the posts below. Place deck over the top of the posts. Push decks down until the deck clips lock into the posts, snapping the deck into place.
- C. Fold the 12 inches (300 mm) of geogrid onto the top of the decks.

### **3.13 FINAL BACKFILL PLACEMENT AND COMPACTION**

- A. Place and compact final lift of backfill material to 95 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method, such that the backfill is flush with the top of the installed deck. Do not allow compacting equipment to come in contact with the decks.

### **3.14 INSTALLATION OF GEOTEXTILE AND AGGREGATE BASE COURSE OVER THE DECK**

- A. Ensure geotextile meets the specifications in section 2.04 paragraph C.
- B. Place geotextile over the top of the deck and extend to the edge of the excavation. Overlap joints a minimum of 18 inches (450 mm). Leave enough slack in the geotextile for the aggregate base course to push the geotextile down in the gaps in between the decks.
- C. Install the aggregate base course (including aggregate setting bed if installing unit pavers) over the geotextile immediately after completing the installation of the fabrics. Work the aggregate from one side of the layout to the other so that the fabric and aggregate conform to the Silva Cell deck contours.
- D. Maintain equipment used to place aggregate base course completely outside the limits of the Silva Cell excavation area to prevent damage to the installed system.
- E. For large or confined areas, where aggregate cannot easily be placed from the edges of the excavated area, obtain approval for the installation procedure and types of equipment to be used in the installation from the Silva Cell manufacturer.
- F. Compact aggregate base course(s) to 95 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method. Utilize a vibration or plate compactor with a maximum weight of 800 lbs (362.87 kg).
- G. Do not drive vehicles or operate equipment over the completed aggregate base course.

### **3.15 INSTALLATION OF CONCRETE CURBS AT TREE OPENINGS, AGGREGATE SUBBASE AND PAVEMENT ABOVE THE SILVA CELL SYSTEM**

- A. Place concrete curbs along planting areas and tree openings as shown on the Drawings to retain the aggregate base course from migrating into the planting soil.

- B. When staking concrete forms (e.g. curbs around the tree openings), prevent stakes from penetrating the Silva Cell decks.
- C. Turn down edge of concrete paving to the Silva Cell deck along the edges of tree openings or planting areas to retain the aggregate base course material.
- D. When paving type is a unit paver or other flexible material, provide a concrete curb under the paving at the edge of the Silva Cell deck to retain the aggregate base course material at the tree opening.
- E. Place paving material over Silva Cell system in accordance with the Drawings.
  - 1. The Silva Cell system does not fully meet loading strength until the final paving is installed. Do not operate construction equipment on top of the Silva Cell system until paving installation has been completed.
- F. Use care when placing paving or other backfill on top of Silva Cell system to prevent damage to the Silva Cell system or its components.

### **3.16 INSTALLATION OF ROOT BARRIERS**

- A. Install root barrier in accordance with manufacturer's installation instructions.

### **3.17 INSTALLATION OF PLANTING SOIL WITHIN THE TREE PLANTING AREA**

- A. Remove rubble, debris, dust and silt from the top of the planting soil within the tree opening that may have accumulated after the initial installation of the planting soil within the Silva Cells.
- B. Install additional planting soil within the tree openings, to the depths indicated on the Drawings.
  - 1. Use the same soil used within the Silva Cells for planting soil within the tree openings.
- C. Compact planting soil under the tree root ball as needed to prevent settlement of the root ball.
- D. Place trees in accordance with the Drawings.

### **3.18 PROTECTION**

- A. Keep construction traffic away from the limits of the Silva Cells until the final pavement profile is in place. The Silva Cell system does not fully meet loading strength until the final paving is installed.
  - 1. Do not operate equipment directly on top of the Silva Cell system until paving installation has been completed.
  - 2. Provide fencing and other barriers to prevent vehicles from entering into the Silva Cell area.
- B. When the Silva Cell installation is completed and the permanent pavement is in place, limit traffic and construction related activities to only loads less than the design loads.

### **3.19 CLEAN UP**

- A. Perform clean up during installation and upon completion of the Work. Maintain the site free of soil, sediment, trash and debris. Remove excess soil materials, debris, and equipment from the site following completion of the Work of this Section.
- B. Repair damage to adjacent materials and surfaces resulting from installation of this Work using mechanics skilled in remedial work of the construction type and trades affected.

END OF SECTION