

TEXAS PARKS AND WILDLIFE  
INFRASTRUCTURE DIVISION

## **ENCHANTED ROCK SNA**

**PROJECT NO: 1112549**

CENTENNIAL PARK #1 PH.1



**NORTH ROCK INITIAL PUBLIC USE  
BID READY CONSTRUCTION DOCUMENTS**

**PROJECT MANUAL**

December 19, 2025

**TPWD #1112549 – Enchanted Rock SNA**  
**North Rock IPU**  
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ENCHANTED ROCK  
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BID READY CDS 12.19.25

12-19-2025

The following sections were prepared by:

Ten Eyck Landscape Architects, Inc.  
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DIVISION 01 – GENERAL REQUIREMENTS

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017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

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END OF SECTION

ENCHANTED ROCK  
SEALS PAGE FOR CIVIL ENGINEER SPECIFICATIONS  
BID READY CDS 12.19.25

12-19-2025

The following sections were prepared by:

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TEXAS DEPARTMENT OF TRANSPORTATION SPECIFICATIONS

ITEM 105	REMOVING TREATED AND UNTREATED BASE AND ASPHALT PAVEMENT
ITEM 106	OBLITERATING ABANDONED ROADWAY
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ITEM 531	SIDEWALKS
ITEM 636	SIGNS
ITEM 644	SMALL ROADSIDE SIGN ASSEMBLIES

END OF SECTION

**SECTION 011000**  
**SUMMARY OF WORK**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Project information.
  - 2. Work covered by Contract Documents.
  - 3. Contractor-furnished, Owner-installed products.
  - 4. Access to site.
  - 5. Work restrictions.
  - 6. Specification and Drawing conventions.
  - 7. Miscellaneous provisions.

**1.3 PROJECT INFORMATION**

- A. Project Identification: Enchanted Rock State Natural Area TPWD #1112549 North Rock Initial Public Use.
  - 1. Project Location: 16710 Ranch Rd 965, Fredericksburg, TX 78624.
- B. Owner: Texas Parks and Wildlife Department.
  - 1. Owner's Representative: Michael Deere, Texas Parks and Wildlife Department, Infrastructure Division, Design Project Manager, (512) 389-4598, Michael.Deere@tpwd.texas.gov.
- C. Landscape Architect: Ten Eyck Landscape Architects, Inc.

**1.4 WORK COVERED BY CONTRACT DOCUMENTS**

- A. The Work of Project is defined by the Contract Documents and consists of the following:
  - 1. Road, trail, parking, and access for acquired property and other Work indicated in the Contract Documents.
- B. Type of Contract:

1. Project will be constructed under a single prime contract.

#### 1.5 ACCESS TO SITE

- A. Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
- B. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.
- C. Contractors must keep all gates closed at all times and ensure they are closed and secured prior to leaving property for deer population control.

#### 1.6 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
  1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
  1. Notify Owner not less than two days in advance of proposed utility interruptions.
- C. Restricted Substances: Use of tobacco products and other controlled substances on Project site is not permitted.

#### 1.7 SPECIFICATION AND DRAWING CONVENTIONS

- A. Refer to "Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department".

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

## SECTION 013233

### PHOTGRAPHIC DOCUMENTATION

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section includes:
  - 1. Construction photographs.

##### 1.2 PHOTOGRAPHY

- A. Take construction record photographs during construction.
- B. Provide photographs taken each month just prior to date for each scheduled Application for Payment.
- C. Provide one aerial photograph of site at beginning and completion of work at site.
- D. Photograph project from four different views at each specified time; views as directed by Architect.
- E. After interior finish work is commenced, take four additional photographs of interior; views as directed by Architect.
- F. At successive periods of photography, take photographs from same overall view as previously taken.
- G. Utilize digital technology at minimum 1216 x 912 capture resolution.
- H. Provide factual presentation.
- I. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.

##### 1.3 DIGITAL FILES

- A. Index digital files in chronological sequence.
- B. Identify each view by listing:
  - 1. Name of Project.
  - 2. Orientation of view.
  - 3. Date taken.
  - 4. Sequential photograph number.

##### 1.4 SUBMITTAL

- A. Submit each month's digital files along with each Application for Payment.

B. Submit full set of digital files along with Project Record Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013233

## SECTION 015639

### TEMPORARY TREE AND PLANT PROTECTION

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

##### 1.2 SUMMARY

- A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.
- B. Related Requirements:
  - 1. Section 311000 "Site Clearing" for removing existing trees and shrubs.

##### 1.3 DEFINITIONS

- A. Caliper: Diameter of a trunk measured by a diameter tape or the average of the smallest and largest diameters at a height 6 inches above the ground for trees up to and including 4-inch size at this height and as measured at a height of 12 inches above the ground for trees larger than 4-inch size.
- B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape or the average of the smallest and largest diameters at a height 54 inches above the ground line for trees with caliper of 8 inches or greater as measured at a height of 12 inches above the ground.
- C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by a circle concentric with each tree with a radius 12 times the tree's caliper size and with a minimum radius of 96 inches unless otherwise indicated.
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

##### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

- a. Tree-service firm's personnel, and equipment needed to make progress and avoid delays.
- b. Arborist's responsibilities.
- c. Quality-control program.
- d. Coordination of Work and equipment movement with the locations of protection zones.
- e. Trenching by hand or with air spade within protection zones.
- f. Field quality control.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.
  - 2. Detail fabrication and assembly of protection-zone fencing and signage.
  - 3. Indicate extent of trenching by hand or with air spade within protection zones.
- C. Samples: For each type of the following:
  - 1. Organic Mulch: 1-quart volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
  - 2. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components.
  - 3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.
- D. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.
  - 1. Species and size of tree.
  - 2. Location on site plan. Include unique identifier for each.
  - 3. Reason for pruning.
  - 4. Description of pruning to be performed.
  - 5. Description of maintenance following pruning.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For arborist and tree service firm.
- B. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
- D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality-control program.

## 1.7 QUALITY ASSURANCE

- A. Arborist Qualifications: Certified Arborist as certified by ISA.
- B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
- C. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Include dimensioned diagrams for placement of protection zone fencing and signage, the arborist's and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

## 1.8 FIELD CONDITIONS

- A. The following practices are prohibited within protection zones:
  1. Storage of construction materials, debris, or excavated material.
  2. Moving or parking vehicles or equipment.
  3. Foot traffic.
  4. Erection of sheds or structures.
  5. Impoundment of water.
  6. Excavation or other digging unless otherwise indicated.
  7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Backfill Soil: Stockpiled topsoil from site of suitable moisture content and granular texture for placing around tree; 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. Topsoil should be stockpiles separately from subsoils.
- B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood mulch from construction operations.
2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
3. Color: Natural.

C. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements:

1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch (50-mm) opening, 0.148-inch-diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch-OD line posts, and 2-7/8-inch-OD corner and pull posts and 0.177-inch-diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
  - a. Height: Per Drawings.
2. Plywood Protection-Zone Fencing: Plywood framed with four 2-by-4-inch rails, with 4-by-4-inch preservative-treated wood posts spaced not more than 96 inches apart.
  - a. Height: Per Drawings.
  - b. Plywood and Lumber: Comply with requirements in Section 061063 "Exterior Rough Carpentry."
3. Wood Protection-Zone Fencing: Constructed of two 2-by-4-inch horizontal rails, with 4-by-4-inch preservative-treated wood posts spaced not more than 96 inches apart, and lower rail set halfway between top rail and ground.
  - a. Height: Per Drawings.
  - b. Lumber: Comply with requirements in Section 061063 "Exterior Rough Carpentry."
4. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch maximum opening in pattern and weighing a minimum of 0.4 lb/ft; remaining flexible from minus 60 to plus 200 deg F; inert to most chemicals and acids; minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi; secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 96 inches apart. Leave a 12" gap at the bottom of fencing to allow wildlife passage.
  - a. Height: 48 inches
  - b. Color: High-visibility orange, nonfading.

D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: As shown on Drawings
2. Lettering: 3-inch-high minimum, black characters on white background.

## PART 3 - EXECUTION

### 3.1 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 protection zones.

- B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

### 3.2 PREPARATION

- A. Locate and clearly identify trees, shrubs, and other vegetation to be removed. Tie a 1-inch vinyl tape around each tree trunk at 54 inches (1372 mm) above the ground.
- B. Trimming of any oaks should be avoided February 1 to October 31 and wounds should be painted immediately. Refer to Drawings for additional notes.
- C. Regardless of season, all pruning cuts or other wounds to oak trees, including freshly-cut stumps and damaged surface roots, should be treated immediately with paint to prevent exposure to contaminated materials.
- D. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- E. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.
  - 1. Apply 2-inch uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 6 inches of tree trunks.

### 3.3 PROTECTION ZONES

- A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
  - 1. Chain-Link Fencing: Install to comply with ASTM F567 and with manufacturer's written instructions.
  - 2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Landscape Architect.
- B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Landscape Architect. Install one sign spaced approximately every 50 feet on protection-zone fencing, but no fewer than four signs with each facing a different direction.
- C. Maintain protection zones free of weeds and trash.
- D. Maintain protection-zone fencing and signage in good condition as acceptable to Landscape Architect and remove when construction operations are complete and equipment has been removed from the site.
  - 1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.

2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

### 3.4 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in TXDot Item 110 "Excavation" unless otherwise indicated.
- B. Do not excavate within the dripline of trees greater than 3" DBH without approval from Owner or Landscape Architect.
- C. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.
- D. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.
- E. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

### 3.5 ROOT PRUNING

- A. Tree roots should not be pruned unless required by direct impacts. Prune roots as shown on Drawings and as follows:
  1. Cut roots manually by digging a trench and cutting exposed roots 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.
  2. Cut Ends: Coat cut ends of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist.
  3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
  4. Cover exposed roots with burlap and water regularly.
  5. Backfill as soon as possible according to requirements in TXDot Item 110 "Excavation".
- B. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

### 3.6 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction. Prune branches as directed by a certified arborist.
  - 1. Prune utilizing the 3-point cut method.
  - 2. Prune to remove only broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
  - 3. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
  - 4. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and as indicated on Drawings.
- B. Unless directly approved by TPWD Natural Resources, 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 except for oaks.
- E. Chip removed branches and spread over areas identified by Landscape Architect.

### 3.7 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
  - 1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
- C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with backfill soil. Place backfill topsoil in a single uncompacted layer and hand grade to required finish elevations, not to exceed 2" depth.

### 3.8 FIELD QUALITY CONTROL

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

### 3.9 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.
  - 1. Submit details of proposed pruning and repairs.

2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to 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.

B. Excess Mulch: Rake mulched area within protection zones, being careful not to injure roots. Rake to loosen and remove mulch that exceeds a 2-inch uniform thickness to remain.

C. Soil Aeration: Where directed by Landscape Architect, aerate surface soil compacted during construction. Aerate 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch- diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augered soil and sand.

### 3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 015639

## SECTION 016000

### PRODUCT REQUIREMENTS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

##### 1.2 SUMMARY

- A. Section includes:
  - 1. Products.
  - 2. Transportation and handling.
  - 3. Storage and protection.
  - 4. Product options.

##### 1.3 PRODUCTS

- A. Provide interchangeable components by the same manufacturer for identical items.
- B. Do not use products containing asbestos or other known hazardous materials.
- C. Do not use materials containing asbestos or other known hazardous materials in the Work.

##### 1.4 TRANSPORTATION AND HANDLING

- A. Coordinate delivery of Products to prevent conflict with Work and adverse conditions at site.
- B. Transport and handle Products in accordance with manufacturer's instructions.
- C. Promptly inspect shipments to ensure that Products comply with requirements of Contract Documents, are undamaged, and quantities are correct.
- D. Provide equipment and personnel to handle products by methods to prevent damage.

##### 1.5 STORAGE AND PROTECTION

- A. Store and protect Products in accordance with manufacturer's instructions with manufacturer's seals and labels intact and legible.
- B. Store Products on site unless prior written approval to store off site has been obtained from Owner.

- C. Store Products subject to damage by elements in weathertight enclosures. Maintain temperature and humidity within ranges required by manufacturer's instructions.
- D. Exterior Storage:
  - 1. Store fabricated Products above ground; prevent soiling and staining.
  - 2. Cover products subject to deterioration with impervious sheet coverings; provide ventilation to prevent condensation.
  - 3. Store loose granular materials in well drained area on solid surfaces; prevent mixing with foreign matter.
- E. Arrange storage areas to permit access for inspection. Periodically inspect stored products to verify that products are undamaged and in acceptable condition.

## 1.6 PRODUCT OPTIONS

- A. Products specified by reference standard only:
  - 1. Select any Product meeting the specified standard.
  - 2. Submit Product Data to substantiate compliance of proposed Product with specified requirements.
- B. Products specified by naming two or more acceptable Products: Select any named Product.
- C. Products specified by stating that the Contract Documents are based on a Product by a single manufacturer followed by the statement "Equivalent products by the following manufacturers are acceptable":
  - 1. Select the specified Product or a Product by a named manufacturer having equivalent or superior characteristics to the specified Product and meeting the requirements of the Contract Documents.
  - 2. If the specified Product is not selected, submit Product Data to substantiate compliance of proposed Product with specified requirements.
  - 3. The specified Product establishes the required standard of quality.
- D. Products specified by naming one or more Products followed by "or approved substitute" or similar statement:
  - 1. The specified Product establishes the required standard of quality.
- E. Products specified by naming one or more Products or manufacturers followed by the statement "Substitutions: Under provisions of Uniform General Conditions":
  - 1. The specified Product establishes the required standard of quality.
- F. Products specified by naming one Product followed by the statement "Substitutions: Not permitted": Substitutions will not be allowed.
- G. Products specified by required performance or attributes, without naming a manufacturer or Product:
  - 1. Select any Product meeting specified requirements.
  - 2. Submit Product Data to substantiate compliance of proposed Product with specified requirements.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

## SECTION 017419

### CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Construction waste management goals, plan, and records.

##### 1.2 WASTE MANAGEMENT GOALS

###### A. Reuse, salvage, or recycle non-hazardous waste materials.

###### B. Minimize waste sent to landfills and incinerators.

###### C. Prioritize non-hazardous construction waste management to:

1. Reduce amount of waste generated.
2. Reuse material through on-site reuse or off-site salvaging, including sale or donation.
3. Recycle material including diverting materials for secondary uses whenever economically feasible.

###### D. Dispose of materials with no practical use or economic benefit at landfill.

###### E. Calculations may be performed using weight or volume but must be consistent throughout Project.

##### 1.3 WASTE MANAGEMENT

###### A. Pro-actively manage construction waste:

1. Practice efficient waste management when sizing, cutting, and installing products.
2. Use all reasonable means to divert construction waste from landfills and incinerators, and to facilitate recycling and reuse.
3. Return unused products and overages to supplier, or donate to non-profit group.
4. Carefully install products; avoid removal of ill-timed and poorly installed products.
5. Use centralized cutting areas to facilitate waste collection.
6. Deliver, store, and handle products to prevent damage.

###### B. Require subcontractors and suppliers to participate in waste management efforts.

###### C. Construction waste includes:

1. Excess and unusable construction products.
2. Packaging materials for construction products.
3. Wood waste converted to biofuel.
4. Other materials generated during construction process but not incorporated into the Work.

###### D. Construction waste excludes:

1. Excavated soil and land-clearing debris.
  2. Alternative daily cover.
- E. Give consideration to:
1. Availability of viable recycling markets.
  2. Condition of materials.
  3. Ability to provide material in suitable condition and in quantities acceptable to available markets.
  4. Time constraints imposed by internal project completion mandates.
- F. Be responsible for implementation of special programs involving rebates and similar incentives related to recycling of waste.
- G. Revenues and other savings obtained for salvage and recycling accrue to Contractor.
- H. Ensure that firms and facilities used for recycling, reuse, and disposal have legal permits for intended uses.

#### 1.4 SUBMITTALS

- A. Waste Management Plan:
1. Submit waste management plan within ten days after Notice to Proceed to Construction Project Manager and prior to initiating site preparation.
  2. Include:
    - a. Name of individual on Contractor's staff responsible for waste prevention and management.
    - b. Actions proposed to reduce solid waste generation and achieve waste management goal.
    - c. Description of proposed methods for recycling and reuse of materials generated, including areas and equipment for processing, sorting, and temporary storage.
    - d. Estimated types and quantities of waste to be generated.
    - e. Name of landfills and incinerators to be used.
    - f. Identification of local and regional reuse programs that will accept waste materials.
    - g. List of waste materials to be salvaged for resale, salvaged and reused, or recycled. Identify recycling facilities to be used.
    - h. Identification of materials that cannot be recycled or reused, with justification.
  3. Submit electronically in Adobe PDF format.
  4. If required, revise and resubmit plan within ten days after receipt of comments.
  5. Distribute copies of approved Waste Management Plan to concerned parties.
  6. Update Waste Management Plan periodically through duration of Project to reflect changed conditions.
- B. Sustainable Design Record Documents:
1. Maintain records to document:
    - a. Quantities of waste generated, in tons or cubic yards.
    - b. Types and quantities of materials diverted through sale, reuse, or recycling, in tons or cubic yards, and diversion location.
    - c. Quantities of waste sent to landfill or incinerator, in tons or cubic yards.

- d. Name of hauler and location where disposed of.
2. Submit summary of waste disposal and diversion to date along with each Application for Payment.
3. Submit hauling receipts or certificates for diverted and recycled materials including material description, hauler name and location, and quantity (by weight) of diverted and recycled materials.
4. Deliver final summary of solid waste disposal and diversion to Architect upon completion of project.
5. Submit electronically in Adobe PDF format.

#### 1.5 QUALITY ASSURANCE

- A. Review and discuss waste management plan implementation and progress at Preconstruction Conference and Progress Meetings.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Designate separate areas to facilitate separation of materials for potential recycling, salvage, reuse and return.
- B. Clearly identify areas and receptacles.
- C. Keep storage areas and receptacles clean and orderly; prevent contamination of materials.
- D. Monitor storage areas; correct problems and implement preventative measures.

#### 1.7 TRAINING

- A. Provide training of waste management methods to be used at appropriate stages of Project.
- B. Require participation of all subcontractors.

### PART 2 PRODUCTS

Not used

### PART 3 EXECUTION

#### 3.1 WASTE COLLECTION

- A. Provide containers and storage areas to facilitate waste management, clearly identified.
- B. Handle recyclable materials to prevent contamination by incompatible products and materials.
- C. Separate materials by:
  1. Placing into marked separate containers, then transporting to recycling facility.
  2. Placing into single container, then transporting to recycling facility for separation.

#### 3.2 DISPOSAL

- A. Dispose of nonhazardous waste materials that cannot be reused, recycled, or salvaged at licensed landfill or incinerator.

- B. Handle, store, and dispose of hazardous wastes in accordance with applicable codes, ordinances, rules, and regulations.

END OF SECTION 017419

## SECTION 024119

### SELECTIVE DEMOLITION

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Demolition and removal of selected site elements.
  - 2. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
  - 1. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
  - 2. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.

##### 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and store.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

##### 1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

- B. Historic items, relics, antiques, and archeological materials, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
  - 1. If historic/archeological materials are discovered during demolition, stop work in the area and contact the park superintendent and/or TPWD cultural resources staff.

#### 1.5 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
  - 1. Inspect and discuss condition of construction to be selectively demolished.
  - 2. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 3. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
  - 4. Review areas where existing construction is to remain and requires protection.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Schedule of Selective Demolition Activities: Indicate the following:
  - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
  - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
- B. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.
- C. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

#### 1.8 FIELD CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- B. Notify Landscape Architect and TPWD Construction Project Manager of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Landscape Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- D. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
1. Hazardous material remediation is specified elsewhere in the Contract Documents.
  2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
  3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
1. Maintain fire-protection facilities in service during selective demolition operations.

#### 1.9 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

#### 1.10 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Verify that hazardous materials have been remediated before proceeding with demolition operations.
- D. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or video.
  - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
  - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
  - 3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

### 3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

### 3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
  - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
  - 2. Arrange to shut off utilities with utility companies.
  - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
  - 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
    - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.

- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

### 3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
  - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
  - 5. Maintain fire watch during and for at least 4 hours after flame-cutting operations.

6. Maintain adequate ventilation when using cutting torches.
  7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers.
  3. Store items in a secure area until delivery to Owner.
  4. Transport items to Owner's storage area designated by Owner.
  5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
  2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  3. Protect items from damage during transport and storage.
  4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

### 3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

### 3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
  - 4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

### 3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

### 3.9 SELECTIVE DEMOLITION SCHEDULE

- A. Remove: Existing mobile home, fence mesh material, existing road wearing course, culverts noted on Drawings; debris at former shooting range.
- B. Remove and Salvage: Cattleguards, interior fence gates, steel fenceposts, and cedar posts, electric gate motor.
- C. Remove and Reinstall: Granite boulders larger than 2'x2' collected from within project limits of construction to be stockpiled for installation at entry sign; existing road base to be removed and reinstalled for new road.
  - 1. Any materials taken from outside the limits of construction will need to be reviewed by TPWD archaeology and Natural Resources departments.
- D. Existing to Remain: All perimeter fencing, except where noted; existing culverts except where noted.

END OF SECTION 024119

## SECTION 061063

### EXTERIOR ROUGH CARPENTRY

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Log barriers.
  - 2. Route markers.
  - 3. Signs.
  - 4. Tree protection planking.
- B. Related Requirements:
  - 1. Section 061533 "Wood Decking."

##### 1.3 DEFINITIONS

- A. Boards: Lumber of less than 2 inches nominal in thickness and 2 inches nominal or greater in width.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- C. Timber: Lumber of 5 inches nominal or greater in least dimension.
- D. Lumber grading agencies, and the abbreviations used to reference them, include the following:
  - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
  - 2. NLGA: National Lumber Grades Authority.
  - 3. RIS: Redwood Inspection Service.
  - 4. SPIB: The Southern Pine Inspection Bureau.
  - 5. WCLIB: West Coast Lumber Inspection Bureau.
  - 6. WWPA: Western Wood Products Association.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

## 1.5 INFORMATIONAL SUBMITTALS

### A. Material Certificates:

1. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

### B. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

### C. Evaluation Reports: For preservative-treated wood products, from ICC-ES.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- ### A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

## PART 2 - PRODUCTS

### 2.1 LUMBER, GENERAL

- ### A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.

1. Factory mark each item with grade stamp of grading agency.
2. For items that are exposed to view in the completed Work, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
4. Provide dressed lumber, S4S, unless otherwise indicated.

### B. Maximum Moisture Content:

1. Boards: 15 percent.
2. Dimension Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness.
3. Timber. No limit.

### 2.2 LUMBER

- ### A. Hand select wood for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

### B. Dimension Lumber: No. 2 or better grade and any of the following species:

1. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.

2. Mixed southern pine; SPIB.

C. Boards: Any of the following species and grades:

1. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
2. Southern pine, B & B finish; SPIB.

D. Boards:

1. Mixed southern pine; No. 2 grade; SPIB.

## 2.3 POSTS

A. Dimension Lumber Posts: No. 2 grade of the following species:

1. Mixed southern pine; SPIB.

B. Timber Posts: Southern pine; No. 2; SPIB.

C. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200, with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

1. Species: Local.

## 2.4 PRESERVATIVE TREATMENT

A. Pressure treat boards and dimension lumber with waterborne preservative according to AWPA U1; Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

B. Pressure treat timber with waterborne preservative according to AWPA U1; Use Category UC4a.

1. Treatment with CCA shall include post-treatment fixation process.

C. Pressure treat poles with waterborne preservative according to AWPA U1; Use Category UC4a.

1. Treatment with CCA shall include post-treatment fixation process.

D. Preservative Chemicals: Acceptable to authorities having jurisdiction.

1. Do not use chemicals containing arsenic or chromium.

E. Use process that includes water-repellent treatment.

F. After treatment, redry dimension lumber to 19 percent maximum moisture content.

G. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.

H. Application: Treat items indicated on Drawings.

## 2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
  - 1. Use fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329 unless otherwise indicated.
  - 2. For pressure-preservative-treated wood, use stainless steel fasteners.
- B. Nails: ASTM F1667.
- C. Power-Driven Fasteners: ICC-ES AC70.
- D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.
- E. Carbon-Steel Bolts: ASTM A307 with ASTM A563 hex nuts and, where indicated, flat washers all hot-dip zinc coated.
- F. Stainless Steel Bolts: ASTM F593, Alloy Group 1 or 2; with ASTM F594, Alloy Group 1 or 2 hex nuts and, where indicated, flat washers.
- G. Postinstalled Anchors: Stainless steel anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing according to ASTM E488, conducted by a qualified independent testing and inspecting agency.
  - 1. Stainless steel bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Prime wood indicated to be painted, including both faces and edges. Cut to required lengths and prime ends.
- B. Stain wood indicated to be stained, including both faces and edges. Cut to required lengths and stain ends.

### 3.2 INSTALLATION

- A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.
- B. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.
- C. Install metal framing anchors to comply with manufacturer's written instructions.
- D. Do not splice structural members between supports unless otherwise indicated.

- E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- F. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- G. Apply copper naphthenate field treatment to comply with AWPA M4, to cut surfaces of preservative-treated lumber.
- H. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
  - 1. ICC-ES AC70 for power-driven fasteners.
  - 2. "Fastening Schedule" in ICC's International Building Code.
  - 3. "Fastener Schedule for Structural Members" and "Alternate Attachments" in ICC's International Residential Code for One- and Two-Family Dwellings.
- I. Use common wire nails unless otherwise indicated. Select fasteners of size that do not fully penetrate members where opposite side is exposed to view. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.

END OF SECTION 061063

## SECTION 061533

### WOOD DECKING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Wood decking.
  - 2. Support framing for elevated decks.

##### 1.3 DEFINITIONS

- A. Boards: Lumber of less than 2 inches nominal in thickness and 2 inches nominal or greater in width.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal least dimension.
- C. Timber: Lumber of 5 inches nominal or greater in least dimension.
- D. Lumber grading agencies, and the abbreviations used to reference them, include the following:
  - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
  - 2. NLGA: National Lumber Grades Authority.
  - 3. RIS: Redwood Inspection Service.
  - 4. SPIB: The Southern Pine Inspection Bureau.
  - 5. WCLIB: West Coast Lumber Inspection Bureau.
  - 6. WWPA: Western Wood Products Association.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For preservative-treated wood products, Kebony wood decking, and metal framing anchors.
  - 1. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

2. For Kebony wood decking. Provide 12" long samples that show color and texture range for final approval.

## 1.5 INFORMATIONAL SUBMITTALS

### A. Material Certificates:

1. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

### B. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

### C. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood products.
2. Plastic decking.
3. Expansion anchors.
4. Metal framing anchors.
5. Decking fasteners.

## 1.6 DELIVERY, STORAGE, AND HANDLING

### A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

### B. Handle and store plastic lumber to comply with manufacturer's written instructions.

## PART 2 - PRODUCTS

### 2.1 LUMBER, GENERAL

#### A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.

1. Factory mark each item with grade stamp of grading agency.
2. For items that are exposed to view in the completed Work, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.

#### B. Maximum Moisture Content:

1. Boards: 15percent.

2. Dimension Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness.
3. Timber. 19 percent.

## 2.2 WOOD DECKING

- A. Dimension Lumber Decking:
  1. Kebony Character Boardwalk 28x120 or approved equal.

## 2.3 DIMENSION LUMBER FRAMING

- A. Deck Framing: No. 2 or greater grade and any of the following species:
  1. Southern pine; SPIB.
  2. Douglas fir-larch; WCLIB or WWPA.
  3. Mixed southern pine; SPIB.
  4. Douglas fir-south; WWPA.
- B. Deck Framing: Any species and grade with a modulus of elasticity of at least 900,000 psi and an extreme fiber stress in bending of at least 500 psi for 2-inch nominal thickness and 12-inch nominal width for single-member use.

## 2.4 POSTS

- A. Dimension Lumber Posts: No. 2 grade and any of the following species:
  1. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
  2. Mixed southern pine; SPIB.
- B. Timber Posts: Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); No. 2; NeLMA, NLGA, SPIB, WCLIB, or WWPA.
- C. Timber Posts: Southern pine; No. 2; SPIB.
- D. Round Wood Poles: Clean-peeled wood poles complying with ASTM D3200, with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

## 2.5 PRESERVATIVE TREATMENT

- A. Pressure treat dimension lumber with waterborne preservative according to AWPA U1; Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
- B. Pressure treat timber with waterborne preservative according to AWPA U1; Use Category UC4a.
- C. Pressure treat poles with waterborne preservative according to AWPA U1; Use Category UC4a.
- D. Preservative Chemicals: Acceptable to authorities having jurisdiction.
  1. Do not use chemicals containing arsenic or chromium.

- E. Use process for boards and dimension lumber that includes water-repellent treatment.
- F. After treatment, redry to 19 percent maximum moisture content.
- G. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
  - 1. For items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.
- H. Application: Treat all wood unless otherwise indicated.

## 2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
  - 1. Use fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329 unless otherwise indicated.
  - 2. For pressure-preservative-treated wood, use stainless steel fasteners.
- B. Nails: ASTM F1667.
- C. Power-Driven Fasteners: ICC-ES AC70.
- D. Wood Screws and Lag Screws: ASME B18.2.1, ASME B18.6.1, or ICC-ES AC233.
- E. Carbon-Steel Bolts: ASTM A307 with ASTM A563 hex nuts and, where indicated, flat washers all hot-dip zinc coated.
- F. Stainless Steel Bolts: ASTM F593, Alloy Group 1 or 2; with ASTM F594, Alloy Group 1 or 2 hex nuts and, where indicated, flat washers.
- G. Postinstalled Anchors: Stainless steel anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing according to ASTM E488 conducted by a qualified independent testing and inspecting agency.
  - 1. Stainless steel bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

## 2.7 METAL FRAMING ANCHORS

- A. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated on Drawings. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- B. Joist Hangers: U-shaped, with 2-inch-long seat and 1-1/4-inch-wide nailing flanges at least 85 percent of joist depth.

1. Thickness: 0.050 inch.
- C. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
  1. Strap Width: 1-1/2 inches.
  2. Thickness: 0.050 inch.
- D. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch above base and with 2-inch- minimum side cover, socket 0.062 inch thick, and standoff and adjustment plates 0.108 inch thick.
- E. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
  1. Width: 3/4 inch.
  2. Thickness: 0.050 inch.
  3. Length: 16 inches.

## 2.8 CONCEALED DECKING FASTENERS

- A. Deck Splines: Corrosion-resistant metal or plastic splines that fit in grooves routed into the sides of decking material and are fastened to deck framing with screws. Splines provide uniform spacing of decking material.
- B. Deck Clips: Black-oxide-coated, stainless steel clips designed to be fastened to deck framing with screws, and to secure decking material with teeth that also provide uniform spacing of decking material.
- C. Deck Tracks: Formed metal strips designed to be fastened to deck framing and to secure decking material from underside with screws. Made from epoxy-powder-coated, hot-dip galvanized steel or stainless steel.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

### 3.3 INSTALLATION, GENERAL

- A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.

- B. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.
- C. Install wood decking with crown up (bark side down).
- D. Install plastic lumber to comply with manufacturer's written instructions.
- E. Secure decking to framing with deck splines deck clips deck tracks or screws.
- F. Install metal framing anchors to comply with manufacturer's written instructions.
- G. Do not splice structural members between supports unless otherwise indicated.
- H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- I. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of members or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- J. Apply copper naphthenate field treatment to comply with AWPAC M4, to cut surfaces of preservative-treated lumber.
- K. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
  - 1. ICC-ES AC70 for power-driven fasteners.
  - 2. "Fastening Schedule" in ICC's International Building Code.
  - 3. "Fastener Schedule for Structural Members" and "Alternate Attachments" in ICC's International Residential Code for One- and Two-Family Dwellings.
- L. Use common wire nails unless otherwise indicated. Select fasteners of size that do not fully penetrate members where opposite side is exposed to view. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.
- M. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced and with adjacent rows staggered.

### 3.4 INSTALLATION OF ELEVATED DECK JOIST FRAMING

- A. General: Install joists with crown edge up and support ends of each member with not less than 1-1/2 inches of bearing on wood or metal, or 3 inches on masonry. Attach floor joists where framed into wood supporting members by using wood ledgers as indicated or, if not indicated, by using metal joist hangers. Do not notch joists.
- B. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches.
- C. Lap members framing from opposite sides of beams or girders not less than 4 inches or securely tie opposing members together. Provide solid blocking of 2-inch nominal thickness by depth of joist over supports.

- D. Provide solid blocking of 2-inch nominal thickness by depth of joist at intervals of 96 inches o.c., between joists.

END OF SECTION 061533

## SECTION 311000

### SITE CLEARING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

##### 1.2 SUMMARY

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

##### 1.3 DEFINITIONS

- A. 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.
- B. 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.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.
- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.
- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

#### 1.4 PREINSTALLATION MEETINGS

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

#### 1.5 MATERIAL OWNERSHIP

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

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
  - 1. Use sufficiently detailed photographs or video recordings.
  - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Topsoil stripping and stockpiling program, including locations for stockpiles.
- C. Rock stockpiling program.
- D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.
- E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

#### 1.7 QUALITY ASSURANCE

- A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.
- B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

#### 1.8 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
    1. Do not proceed with work on adjoining property until directed by Architect.
  - C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.
  - D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
  - E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
  - F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."
  - G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Satisfactory Soil Material: All soil to be salvaged from site. No soils shall be imported.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- C. Protect existing site improvements to remain from damage during construction.
  1. Restore damaged improvements to their original condition, as acceptable to Owner.

### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

- B. Only biodegradable natural fibers such as coir, jute, and coconut fiber can be used for erosion logs and erosion fabric.
- C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- D. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- E. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

### 3.3 TREE AND PLANT PROTECTION

- A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

### 3.4 EXISTING UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
  - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
  - 1. Arrange with utility companies to shut off indicated utilities.
  - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Architect's written permission.
- E. Excavate for and remove underground utilities indicated to be removed.

### 3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

2. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and stockpile in areas approved by Landscape Architect.
5. Materials resulting from full removals shall be removed from site by Contractor.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

### 3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

### 3.7 STOCKPILING ROCK

A. Remove from construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to 36 inches.
2. Do not stockpile rock within protection zones.
3. Stockpile surplus rock to allow later use by the Owner.

### 3.8 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
  - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

### 3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

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

END OF SECTION 311000

**SECTION 321313**  
**CONCRETE PAVING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes concrete paving including the following:
  - 1. Vehicular concrete.
  - 2. Pedestrian concrete.
  
- B. Related Requirements:
  - 1. TXDot Item 421 "Hydraulic Cement Concrete" for general 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.
  - 3. Section 321713 "Parking Bumpers."
  - 4. Section 321723 "Pavement Markings."

**1.2 DEFINITIONS**

- A. Cementitious Materials: Materials that have cementing value if used in grout, mortar, or concrete, including portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, ground-glass pozzolan, silica fume, calcined clay, and/or other pozzolans.
  
- B. W/C Ratio: The ratio by weight of water to cementitious materials.
  
- C. Embodied Carbon of a Building Material or Product: The greenhouse gas emissions associated with the cradle-to-grave life cycle stages, raw material extraction, transportation, and manufacturing and processing, of a building material. On an Environmental Product Declaration (EPD), the Global Warming Potential (GWP) for scopes A1-A3.

**1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
    - a. Concrete mixture design.
    - b. Quality control of concrete materials and concrete paving construction practices.
    - c. Concrete finishes.
  
  - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

- a. Contractor's superintendent.
- b. Concrete paving Subcontractor.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Embodied Carbon Limit Compliance: Documentation shall be submitted for each type of concrete mix design by strength and/or application type and for each type of steel reinforcing installed on the project.
  1. Proof of Compliance: A Type III Environmental Product Declaration (EPD) shall be provided
  2. Bill of Materials: Provide the following information, itemized for each unique concrete mix design and each associated steel reinforcement type:
    - a. Quantities of each material reports in applicable Declared Units required in Part 2 Performance Requirements.
    - b. Location where each material was manufactured.
    - c. Timing: At a minimum, provide at the following milestones:
      - 1) As soon as materials sources are known.
      - 2) If design changes occur during construction, provide an updated bill of materials.
- D. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For the following, from manufacturer:
  1. Cementitious materials.
  2. Admixtures.
  3. Applied finish materials.

#### 1.6 QUALITY ASSURANCE

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

- C. 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.
  - 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.

#### 1.7 PRECONSTRUCTION TESTING

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

#### 1.8 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.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Embodied Carbon – Cast-in-Place Concrete: Provide a Type III, Product-Specific Environmental Product Declaration (EPD) for each concrete mix design that documents compliance with the following:
  - 1. System Boundary: Product Stage, A1-A3.
  - 2. Declared Units: [yd<sup>3</sup>].
  - 3. Product Category Rule(s): Maximum of 257 kgCO<sub>2</sub>e embodied per 1 yd<sup>3</sup>
- B. Embodied Carbon – Steel Rebar: Provide a Type III, Product -Specific Environmental Product Declaration (EPD) that documents compliance with the following:
  - 1. System Boundary: Product Stage A1-A3.
  - 2. Declared Units: [kg] [metric ton].
  - 3. Product Category Rule(s): maximum 850 *per metric ton - kgCO<sub>2</sub>e/ t* (0.3855 kgCO<sub>2</sub>e/lb)

Note: Limit to 500-mile radius

### 2.2 CONCRETE, GENERAL

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

### 2.3 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. 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.

### 2.4 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. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
- D. Steel Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed.
- E. 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.
- F. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.

- G. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.
- H. Plain-Steel Wire: ASTM A1064/A1064M, as drawn.
- I. Deformed-Steel Wire: ASTM A1064/A1064M.
- J. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, deformed.
- K. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- L. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 plain-steel bars.
- M. Tie Bars: ASTM A615/A615M, Grade 60; deformed.
- N. 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.
- O. 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.
  - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- Q. Zinc Repair Material: ASTM A780/A780M.

## 2.5 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Portland Cement: ASTM C150/C150M, gray portland cement Type I or Type III.
  - 2. Blended hydraulic cement: ASTM C595 – Type IL, IP, IS, or IT
  - 3. Performance hydraulic cement: ASTM C1157 – Type GU, HE, MS, HS, MH, LH
  - 4. Coal Ash – ASTM C618 - Class C or F. Document changes in the coal ash used if it varies from a single source for the whole project, including validation through acceptance of a newly submitted mixture design.
  - 5. Ground Glass Pozzolan: ASTM C1866
  - 6. Natural Pozzolan, raw or calcined: ASTM C618 – Class N
  - 7. Silica Fume: ASTM C1240.
  - 8. Slag Cement: ASTM C989/C989M, Grade 80, 100, or 120.

- B. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
  - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Air-Entraining Admixture: ASTM C260/C260M.
- D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
  - 1. Retarding Admixture: ASTM C494/C494M, Type B.
  - 2. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  - 3. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
  - 4. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- E. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
- F. Water: Potable and complying with ASTM C94/C94M.

## 2.6 CURING MATERIALS

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

## 2.7 RELATED MATERIALS

- A. Joint Fillers: ASTM D8139, semirigid, closed-cell polypropylene foam 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, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

## 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.
  - 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.
- B. 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.
- C. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- D. 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. Furnish batch certificates for each batch discharged and used in the Work.
  - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
  - 1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

2. For concrete batches larger than 1 cu. Yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
  1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
  2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

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

### 3.3 EDGE FORMS AND SCREED CONSTRUCTION

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

### 3.4 INSTALLATION OF STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

### 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. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
  - 4. 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 per Geotech report 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. 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.
- 2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, 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.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

### 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. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

### 3.8 INSTALLATION OF DETECTABLE WARNINGS

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Materials Schedule.
  - 1. Tolerance for Opening Size: Plus 1/4 inch, no minus.
- B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Materials Schedule. Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete immediately after screeding concrete surface.

### 3.9 CONCRETE PROTECTION AND CURING

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

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

### 3.10 PAVING TOLERANCES

#### A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 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: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

### 3.11 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 5000 sq. ft. 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 (4.4 deg C) and below and when it is 80 deg F (27 deg C) 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.

### 3.12 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by 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.

END OF SECTION 321313

## SECTION 321373

### CONCRETE PAVING JOINT SEALANTS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, 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 joint sealants as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. Section Includes:
  - 1. Joint sealants.
  - 2. Joint-sealant backer materials.
  - 3. Primers.
- C. Related Requirements:
  - 1. TXDot Item 421 “Hydraulic Cement Concrete” for related items.
  - 2. Section 321313 “Concrete Paving” for related concrete paving items.

##### 1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
  - 2. ASTM C1193 - Standard Guide for Use of Joint Sealants.
  - 3. ASTM D5249 - Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints.
  - 4. ASTM D 5893/D 5893M-10: Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

##### 1.4 ACTION SUBMITTALS

- A. General: See Uniform General Conditions 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, installation instructions, and recommendations of sealant manufacturer in the form of published data or sealant manufacturer's letter for each type of sealant and associated miscellaneous material required. Include complete instructions for handling, storage, mixing, priming, installation, curing, and protection for each material.
1. List of Installers: If sealant work is installed by more than one installer, provide a listing of each sealant installer and what part of the work each is doing. Provide one coordinated submittal for all sealant work. If all sealant work is installed by one installer, confirm with list of the work and the installer's name.
  2. Material List: Furnish list of each sealant for each substrate, listing all materials used such as cleaners, primers, sealers, and joint fillers.
- C. Samples for Verification: For each kind and color of joint sealant required, provide three (3) Samples with 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.
- D. 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.

## 1.5 INFORMATIONAL SUBMITTALS

- A. 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.
- B. Test Reports:
1. Submit compatibility and adhesion test reports from elastomeric sealant manufacturer indicating that materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants and actual substrates for this Project. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.
  2. Submit product test reports for each type of joint sealant indicated, evidencing compliance with requirements specified.
- C. Certificates:
1. Submit certifications from manufacturer of high modulus silicone sealants as described in Part 2 PRODUCTS of this Section.
  2. Submit certification from the manufacturer that the Installer is approved specifically for this Project.

3. Submit certification that any materials by other manufacturers which may affect sealant performance, are approved.
4. Submit certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOC's).

## 1.6 QUALITY ASSURANCE

### A. Qualifications:

1. **Manufacturer Qualifications:** Manufacturer shall be a firm engaged in the manufacture of joint protection of types required, and whose products have been in satisfactory use in similar service for a minimum of five years.
2. **Installer Qualifications:** Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing joint protection similar in type and scope to that required for this Project, and shall be approved by the manufacturer.
3. Employ only workmen who are experienced in the use of the materials specified. Use only the types of equipment recommended by the manufacturer for mixing and application of products.

### B. Inspecting and Testing Agency Qualifications:

To qualify for acceptance, an independent inspecting and testing agency hired by the Contractor or manufacturer to test products shall demonstrate to the Landscape Architect's satisfaction that they are qualified according to ASTM E 329 to conduct testing indicated.

### C. 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.

### D. Mock Ups:

Prior to installation of the work, fabricate and erect mock ups for each type of finish and application required to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock ups to comply with the following requirements, using materials indicated for final unit of work.

1. Locate mock ups on site in location and of size indicated or, if not indicated, as directed by the Landscape Architect.
2. Apply sealants to fill joints in field constructed mock ups of assemblies specified in other sections that are indicated to receive joint sealants specified in this Section.
3. Demonstrate the proposed range of aesthetic effects and workmanship to be expected in the completed work.
4. Obtain the Landscape Architect's acceptance of mock ups before start of final unit of work.
5. Retain and maintain mock ups during construction in undisturbed condition as a standard for judging completed unit of work.
6. When directed, demolish and remove mock ups from the Project site.
7. Accepted mock ups in undisturbed condition at time of Substantial Completion may become part of completed unit of work.

## 1.7 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 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors: To be selected from manufacturer's full color range.
- C. Silica Sand: To be approved prior to construction.

### 2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.
- C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.
- D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.
- E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

### 2.3 MANUFACTURERS

- A. Acceptable Manufacturers:
  1. BASF Building Systems. ([www.buildingsystems.basf.com](http://www.buildingsystems.basf.com))
  2. Dow Corning Corp. ([www.dowcorning.com](http://www.dowcorning.com))
  3. GE Silicones. ([www.siliconeforbuilding.com](http://www.siliconeforbuilding.com))
  4. Pecora Corp. ([www.pecora.com](http://www.pecora.com))
  5. Sika Corp. ([www.sikausa.com](http://www.sikausa.com))
  6. Tremco, Inc. ([www.tremcosealants.com](http://www.tremcosealants.com))

## 2.4 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Provide sealant backings of materials and type that are nonstaining; are 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-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

## 2.5 MISCELLANEOUS MATERIAL

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.
- B. Masking Tape: Provide non staining, non absorbent material compatible with joint sealants and surfaces adjacent to joints.

## 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 Contractor in writing, with a copy to the Owner and the Landscape Architect, 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. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance.
  - 2. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:
  - 1. Remove foreign material from joint substrates that could interfere with adhesion of joint sealant, including, but not limited to, dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost, unless a durability test of bond/cohesion has been performed in accordance with ASTM C 794, successfully demonstrating that bond shall be durable.
  - 2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by methods which shall produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations.
  - 3. Remove laitance and form release agents from concrete.

- 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.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 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 backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of joint-sealant backings.
  - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
  - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
  - 1. Place joint sealants so they fully contact joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
  - 1. Remove excess joint sealant from surfaces adjacent to joints.
  - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
- G. Dust wet sealant with silica sand.

### 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 321373

## SECTION 321500

### STABILIZED DECOMPOSED GRANITE PAVING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, 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 decomposed granite as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. Section Includes:
  - 1. Decomposed granite surfacing.
  - 2. Stabilizer.
  - 3. Soil Barrier.
  - 4. Herbicide.

##### 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 Society for Testing and Materials (ASTM):
  - 1. ASTM C 33, "Standard Specification for Concrete Aggregates."
  - 2. ASTM International (ASTM) D698 - 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>).
  - 3. ASTM D1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
  - 4. ASTM D 2940, "Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports."
- D. AASHTO: American Association of State Highway and Transportation Officials.
- E. Standard Specifications: Highway Department, Standard Specifications for Highways and Bridges, latest edition.

- F. Code of Federal Regulation (CFR):
  - 1. 28 CFR Part 36, "Americans With Disabilities Act" hereinafter referred to as ADA.

#### 1.4 SCOPE OF WORK

- A. Work of this Section includes all labor, materials, equipment, and services necessary to provide and complete the stabilized decomposed granite paving system as shown on the Contract Drawings and/or specified herein, including but not limited to, the following:
  - 1. Compacted stabilized decomposed granite paving mix over compacted aggregate (crushed stone) base coarse and prepared sub-grade.
- B. The following items of related work are specified and included in other Sections of the Specifications:
  - 1. Section 329113 "Soil Preparation."

#### 1.5 SUBMITTALS

- A. General: See Uniform General Conditions for Submittal Procedures.
- B. 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.
- C. Product Data: For each type of product indicated as work of this Section, submit manufacturer's technical product data. Include technical specifications and installation instructions and tested physical and performance properties as applicable to product.
- D. Samples: For the following products, in sizes indicated, showing the full range of color, texture, and pattern variations expected. Prepare Samples from the same material proposed to be used for the Work.
  - 1. Samples for Initial Selection:
    - a. Decomposed granite material component of each type and color: One (1) lb. in labeled plastic bag. Sample shall illustrate the full range of colors and textures available.
    - b. Aggregate Binder component, each type: One (1) lb. in labeled plastic bag.
    - c. Decomposed granite and aggregate binder mixed in proposed proportions for Project: Two (2) lbs. in labeled plastic bag.
    - d. Three samples of soil barrier material.
  - 2. Samples for Verification: Submit prior to Field Samples/Mock-ups for Decomposed Granite material selection installation.
    - a. Decomposed granite material component of each type and color selected by Landscape Architect for use in Initial Field Samples/Mock-ups for Decomposed Granite Material Selection: One (1) lb. in labeled plastic bag. Sample shall illustrate the full range of color and texture.
    - b. Aggregate Binder component, each type to be used in Initial Field Samples/Mock-ups for Decomposed Granite Material Selection: One (1) lb. in labeled plastic bag.

- c. Decomposed granite and aggregate binder mixed in proposed proportions of type to be used in Initial Field Samples/Mock-ups for Decomposed Granite Material Selection and pavement surfacing: Two (2) lbs. in labeled plastic bag.
- d. Separation Geotextile Fabric: 12-by-12 inch (300-by-300 mm).
- e. Base Course Aggregate: One (1) lb. in labeled plastic bag.

E. Quality Control Submittals:

- 1. Material Certificates: For each decomposed granite paving material component, signed by suppliers.
- 2. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

1.6 MOCK-UPS

A. Field Samples/Mock-Ups: Construct Field Samples/Mock-Ups for decomposed granite pavement system at earliest possible time and at approved location before proceeding with respective work and after Landscape Architect's approval of Samples For Initial Selection and Samples For Verification. Allow sufficient time in Project Construction Schedule for submittal process, construction of all Field Samples/Mock-Ups, and Landscape Architect's evaluations before system installation.

- 1. For Decomposed Granite Material Selection: Prepare Initial Field Samples/Mock-ups for each of three (3) decomposed granite material systems selected by Landscape Architect for review and selection of one (1) material system to be used on the Project.
- 2. Each Initial Field Sample/Mock-up for the selection process shall be constructed at an approved location on-site of the same size, 5 feet by 5 feet minimum. The compacted decomposed granite paving surface shall be presented placed fully compacted as specified on a firm subbase representing the specified base course. Each Field Sample/Mock-up to include cast-in-place concrete header on at least one side.
- 3. Selection by Landscape Architect will be based upon a visual evaluation of proposed finish components to include color, texture, material blends, other characteristics as related to on-site conditions, compatibility, and to confirm that system is complimentary with other finish materials on site.
- 4. For Stabilized Decomposed Granite Pavement Installation: After final selection of decomposed granite material, provide and construct one (1) decomposed granite paving surfacing Field Sample/Mock-up, 10 feet long by 6 feet wide, complete with base course, cast-in-place concrete header, and compacted decomposed granite paving surface as specified in this Section. Include adjustments, if any, as determined and approved by Landscape Architect from selection mockup process.
  - a. Coordinate sample work with conditions and material placement of other sample work for concrete header and adjacent conditions.
  - b. Mock-up construction for decomposed granite pavement work will be utilized as a visual confirmation of proposed finish components in addition to establishing a standard for judging Project construction.
- 5. Both the decomposed granite material selection mock-up and full stabilized decomposed granite pavement installation mock-up of surfacing must be approved by Landscape Architect before actual on-site paving work may proceed. If necessary, remove and reconstruct Field Sample/Mock-up surfacing until approved.
- 6. Removal of Field Samples/Mock-Ups:

- a. Demolish and remove Field Samples/Mock-Ups at a time approved by Landscape Architect and when no longer required to serve for material selection or as a standard of work.
- b. Accepted Decomposed Granite Pavement Installation Field Sample/Mock-up may remain and may be incorporated for use in the completed Project if conforming to specified requirements and approved by Landscape Architect.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Installation of Stabilized Decomposed Granite Pavement shall be by a firm that can exhibit proof of a minimum of five (5) years prior successful experience with completed decomposed granite pavement in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
  1. Use numbers of skilled workmen equal to work requirement or occasion. The skilled workmen shall be thoroughly trained and experienced in the necessary crafts and shall be completely familiar with the specific requirements and methods needed for performance of the work in this Section.
- B. Pre-installation Conference: Together with Owner's Representative conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination". Review methods and procedures related to decomposed granite pavement including, but not limited to, the following:
  1. Review condition of sub-grade and other preparatory work including sequencing of other Project work (drainage system, irrigation system, and landscape boulders installation) in areas of decomposed granite paving.
  2. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
  3. Review and finalize construction schedule and verify availability of materials. Review Installer's personnel, equipment, and facilities needed to perform work of this Section and make progress and avoid delays.
- C. 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.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. A. General: Deliver, store, handle and protect aggregate and decomposed granite material with provision for drainage and intrusion of dirt, debris, or other foreign matter.
- B. Decomposed granite material and mix components shall be stored under cover to prevent accumulation of moisture until placed.

## 1.9 PROJECT / SITE CONDITIONS

- A. Environmental Requirements:
  1. Prevent wind or rain disturbance of setting materials, protect from sheet flow from adjacent areas, and generally maintain optimum installation conditions.

2. Do not install base coarse and decomposed granite paving in conditions of standing water or rainfall. Surface and sub-drainage must be assured at all times.
3. Cold Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen sub-grade or setting beds. Temperature: Do not place stone dust (fines) paving when the ambient temperature is below 40 degrees F., or when there is frost in the base course, or any other time when weather conditions are unsuitable for the type of material being placed. Remove and replace decomposed granite paving system work damaged by frost or freezing.

B. Protection, General:

1. Protect decomposed granite paving system, including metal edgings, from heavy traffic using planks, plywood panels, or other effective materials in all areas that could be or is subject to continued movement of materials and equipment.
2. Protect decomposed granite paving installations from deterioration, discoloration, or other damage during subsequent construction and until final acceptance of Project work.

1.10 SEQUENCING AND SCHEDULING

- A. Do not begin installation of the decomposed granite pavement system (both base and paving surface courses) until the completion and approval of the storm drainage system and irrigation system below the stone dust pavement area.
- B. Complete stone dust pavement system installation only after the completion of the tree planting soils, landscape boulders installation, and compacted sub-grade within the stone dust pavement areas.

1.11 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty executed by the installer agreeing to repair or replace components of Stabilized Paving Material that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:
  1. Premature wear and tear, provided the material is maintained in accordance with manufacturer's written maintenance instructions.
  2. Failure of system to meet performance requirements.
- C. Warranty Period: Contractor shall provide warranty for performance of product. Contractor shall warranty installation of product for the time of one year from substantial completion.
- D. Contractor shall provide, for a period of sixty days, unconditional maintenance and repairs as required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Stabilized Decomposed Granite Paving Material shall be provided by the following Manufacturer:
  - 1. Stabilizer Solutions, Inc. 33 South 28<sup>th</sup> St., Phoenix, AZ 85034; phone (602) 225-5900, (800) 336-2468; [www.stabilizersolutions.com](http://www.stabilizersolutions.com); [info@stabilizersolutions.com](mailto:info@stabilizersolutions.com)
- B. Or approved equal.

2.2 BASE COURSE AGGREGATE

- A. Materials for base course aggregate shall consist of crushed aggregate of washed, hard, durable crushed rock, gravel, approved blast furnace slag or stone. All materials furnished from off-site sources and shall be well-graded from coarse to fine and free from organic matter or other deleterious materials:
  - 1. Gradation: Base course aggregate (crushed stone) shall conform to the following gradation:

Screen Size	Percent Passing by Weight
2"	100
3/4"	30 to 65
No. 40	5 to 40
No. 200	0 to 10
  - 2. Soundness: Material will be accepted on the basis of a Magnesium sulfate soundness loss after 4 cycles of 20 percent or less.
  - 3. Plasticity Index: The Plasticity Index of the material passing the No. 40 mesh sieve shall not exceed 5.0.
  - 4. Elongated Particles: Not more than 30 percent by weight of the particles retained on a 1/2 inch sieve shall consist of flat or elongated particles. A flat or elongated particle is defined herein as one that has its greatest dimension more than 3 times its least dimension. Acceptance for this requirement will be based on visual inspection by the Landscape Architect. Material with a percentage greater than 30 percent will be rejected.
- B. It shall be the Contractor's responsibility to provide a base course material that meets the specification and is within its capabilities to allow performance of fine grading of the base course within the required tolerances. Should the Base Course become unstable at any time prior to the placement of the overlying decomposed granite surfacing course due to the gradation of the base course material furnished, the Contractor shall, at its own expense, correct the unstable condition to the satisfaction of the Landscape Architect.

2.3 DECOMPOSED GRANITE

- A. Decomposed Granite of 1/4" minus crushed aggregate screenings.
- B. Stabilized Decomposed Granite Systems: Provide granular pavement stone blended with stone dust and aggregate binder (stabilizer). Decomposed granite material and mixes with approved color range shall be as selected and approved by Landscape Architect using Field Sample/Mock-ups for paving material selection.

1. Decomposed granite pavement shall consist of virgin natural granite stone materials free from soil debris, clay clumps, conglomerate rocks, shale, coal or other lignitic materials. Stone shall be free of organic contaminants.

a. Stone Dust: Provide coarse stone dust consisting of inert materials that are hard, durable stone, free from surface coatings and deleterious materials. Stone dust color shall be approved by the Landscape Architect. Gradation requirements shall be as follows:

Screen Size	Percent Passing by Weight
3/8"	100
No. 4	95 – 100
No. 8	75 – 80
No. 16	55 – 65
No. 30	40 – 50
No. 50	25 – 35
No. 100	20 – 25
No. 200	5 – 15

b. Fines shall be evenly mixed throughout the aggregate.

c. Available Stone Dust Suppliers: Subject to compliance with requirements, suppliers offering products that may be incorporated into the Work include, and are harvested within 500 miles of Project Site.

d. Particles shall be clean, hard, durable fragments of 1/4 inch minus select crushed stone. When produced from gravel, 50 percent, by weight, of the material retained on a No. 4 sieve shall have one fractured face.

e. The portion retained on the No. 4 sieve shall have a maximum percentage wear of 50 at 500 revolutions as determined by AASHTO T96-77.

f. The portion passing a No. 40 sieve shall have a maximum liquid limit of 25 and a maximum plasticity index of 7, as determined by AASHTO T89-91 and AASHTO T90-81, respectively.

2. Aggregate Binder (Stabilizer): The aggregate binder shall be a natural, non-toxic, non-staining, odorless, environmentally safe powder consisting of 95% Psyllium with a 70% mucilliod content. The powder shall be of a size that not more than 10% is retained on a U.S. Standard #40 mesh sieve. The powder binder shall be with color to match stone.

a. Available Aggregate Binder Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1) Stabilizer Solutions, Inc., Phoenix, Arizona.

2) Or approved equal.

## 2.4 STABILIZED DECOMPOSED GRANITE MIX

A. Mix Design, Proportions: Decomposed granite material shall be measured completely dry, mixed and blended (mixed) using the rate of 14.5 pounds of stabilizer (aggregate binder) per ton of decomposed granite mix (1/2-inch granite stone (gravel) and coarse stone dust).

B. Mixing: Mixing of decomposed granite with aggregate binder shall be immediately before placement.

1. Thoroughly pre-mix aggregate binder (stabilizer) with decomposed granite at a minimum rate of "Mix Design, Proportions" specified.

2. Mixing shall be done in a concrete mixing drum or transit mix truck equipped with proper mixing blades. Decomposed granite shall be damp but not wet prior to mixing. Mix decomposed granite aggregate and aggregate binder (stabilizer) for a minimum 15 minutes.
  - a. Bucket blending is not acceptable. Blending with a rake and or shovel is not acceptable.
3. The adding of the decomposed granite and stabilizer should end almost simultaneously when the capacity of the mixer is reached.
4. No segregation of large or fine materials shall be allowed.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions: Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for subgrade and substrate conditions and for other conditions affecting performance.
  1. Sub-grade for decomposed granite pavement system installation is to be provided.
  2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Layout and Field Survey Work: For decomposed granite pavement system installation, coordinate with layout requirements.
  1. Accurately lay out decomposed granite pavement system to fit conditions as indicated, encountered on site, and specified for installation. Comply with set out control points as indicated and coordinate with other work of Project. Provide additional control points and stakeouts as required to effect correct alignments and grade elevations. Advise Construction Manager of any discrepancies or on-site conditions detrimental to critical layouts and obtain approved correction.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by decomposed granite pavement installation.
- C. Proof-roll prepared subgrade surface in presence of Testing Agency for earthwork to check for unstable areas and areas requiring additional compaction. Proceed with installation only after deficient subgrades have been corrected and are ready to receive base course for decomposed granite pavement.
  1. Compacted soil subgrade shall be of uniform compaction, to at least 95 percent of ASTM D1557 (Modified Proctor) density. Compaction testing to be provide no less than one test per 2,000 square feet of pavement base layer.
- D. Remove loose material from compacted sub-grade surface and trim and shape compacted sub-grade for correct drainage slopes.

### 3.3 BASE COURSE INSTALLATION

- A. Place aggregate base course material in thickness indicated and as per manufacturer's recommendations. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent (Modified Proctor) of maximum dry density according to ASTM D1557.

### 3.4 STABILIZED DECOMPOSED GRANITE INSTALLATION

#### A. Installation:

1. Place decomposed granite paving material proportioned mix in two, 2-inch, lifts raked smooth as required to obtain a minimum, after compaction, 4 inches total (compacted) thickness.
2. For each lift, spread mixed decomposed granite while material is moist to extent indicated, uniformly covering the course below to a minimum total depth of two inches (2") with allowance for compaction and to the depth required to provide crown and pitch as indicated on the Contract Drawings.
3. Watering: After spreading, water each lift of decomposed granite paving surface using a garden hose with coarse spray nozzle to achieve full depth moisture penetration and saturation of the spread mixed material and to activate the aggregate binder. Applied water pressure shall not be allowed to disturb the leveled surface and shall be allowed to evenly pond on the surface (manufacturer's suggested rate is at approximately 20 gpm per 1,000 square feet of decomposed granite surface). Let watered mix stand until surface water is no longer present (suggested 6 to 24 hours) and the mix is moist but not wet. Allow each lift to dry out before placing second lift.
  - a. During watering operations, test for depth of water penetration by random inspection test core taken at a minimum of one (1) test per each 500 square feet.
  - b. After inspection, fill test core holes with material removed, smooth, and hand tamp to match adjoining surface grade.

#### B. Compaction: Compact each lift of decomposed granite paving surface with a minimum of two (2) compaction operations after watering.

1. Compact decomposed granite material until surface elevations are within tolerance specified herein and to a uniform density within approved range of 95 percent at optimum moisture content. Hand tamp near edges of adjoining material to avoid damage to adjoining curbs, lawns, tree and bed planting areas, edge materials, and other work.
  - a. Initial Compaction Operation: While the decomposed granite mix is still thoroughly moist, roll with a heavy lawn type roller (minimum 225 pounds and maximum 30 inch width), to achieve finish grade and initial compaction. Hand tamp at edges as specified to avoid damage to adjoining work.
  - b. Subsequent Compaction Operation: Use a heavy (1 ton minimum) small rider equipment type, after having initially used the lawn roller, to obtain the desired final dense, smooth uniform texture.
  - c. Do not use wackers or vibratory rollers.
2. Decomposed granite pavement shall be allowed to settle naturally (as approved) within the eventual root zone (drip-line) of the tree planting material.

### 3.5 INSTALLATION TOLERANCES

- A. Thickness: Compact each course (base and surfacing) to produce the thickness indicated within the following tolerances:
  - 1. Base Course Aggregate: Plus or minus 1/2 inch.
  - 2. Decomposed Granite Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: The final decomposed granite surface level shall not deviate from the design levels by more than plus or minus 1/4 inch. The surface level of the paving immediately adjacent to drainage outlets, gutter, and channels shall not deviate by more than 1/4 inch. The final surface, when measured under a 10 feet long steel or aluminum straightedge, shall not vary by more than 1/4 inch.
  - 1. The decomposed granite surfaces with adjacent metal restraint edging, pavements, and utility structures shall not show any difference in level. All humps or depressions exceeding the specified tolerance shall be corrected at no additional cost the Owner. All finished paving shall be smooth and even with no trip hazards.

### 3.6 FIELD QUALITY CONTROL AND ADJUSTMENTS

- A. Notices: Furnish to Owner and/or Owner's Representative at least three working days (72 hours) notice prior to start of each or any phase of stone dust pavement operations.
- B. Quality Control Testing During Construction:
  - 1. Owner's Field Density Testing of Base Course Aggregate Installation: Field density tests to check the degree of compaction of subgrades and base course shall be taken by the Owner's Testing Laboratory/Agency.
- C. Quality Control Testing and Adjustments/Corrections By Contractor:
  - 1. Finished decomposed granite surface shall be smooth, uniform and solid, with no evidence of chipping or cracking. Dried, compacted decomposed granite surface material shall be firm all the way through with no spongy areas. Loose material shall not be present on the surface initially.
  - 2. Loose decomposed granite on the surface, or unconsolidated decomposed granite below the surface, is considered evidence of improper bonding due to poor mixing or insufficient watering. Contractor shall furnish tests for questionable conditions or as directed by Landscape Architect.
    - a. Test the loose material for adequate Aggregate Binder by wetting, then tamping, and allowing it to dry. If the decomposed granite material still is unconsolidated, the Aggregate Binder did not get mixed adequately throughout the decomposed granite. If the material now is solid, initial watering was insufficient.
    - b. Cracking or sponginess is evidence of excessive Aggregate Binder in the mix.
  - 3. Unconsolidated areas shall be dug out, and shall be replaced with new decomposed granite material with a high proportion of stone dust meeting the grading requirements as specified and, pre-blended to specified proportions. Patched areas then shall be wetted thoroughly and rolled smooth as specified for installations.
  - 4. Any significant irregularities shall be smoothed out prior to final acceptance of work. Smoothing shall be accomplished by re-wetting/saturating rough areas thoroughly, and then

rolling the surface again with a heavy roller (1000 - 1500 lbs powered walk-behind or small rider type).

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove waste material, including unsatisfactory base course aggregate, decomposed granite, gravel, stone dust, trash and debris, and legally dispose of removed material off Owner's property.

3.8 CLEANING AND PROTECTION

- A. Protect newly installed decomposed granite areas from traffic and erosion. Maintain surfaces free of trash and debris until Owner's final acceptance of Project. Replenish pavement surfaces with matching material, repair, and reestablish densities and finish elevations where surfaces become eroded, rutted, or settled or where they lose compaction and depth, until date of Substantial Completion.

END OF SECTION 321500

**SECTION 321713**  
**PARKING BUMPERS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Timber wheel stops.

**PART 2 - PRODUCTS**

**2.1 PARKING BUMPERS**

- A. Timber, railroad ties, per Drawings. Secure with rebar stakes.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install wheel stops in accordance with Drawings unless otherwise indicated.
- B. Securely anchor wheel stops to substrate with rebar ties. Recess head of hardware beneath top of wheel stop.

END OF SECTION 321713

**SECTION 321723**  
**PAVEMENT MARKINGS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

**1.2 SUMMARY**

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

**1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to marking asphalt paving or concrete surfaces including, but not limited to, the following:
    - a. Asphalt-paving or concrete-surface aging period before application of pavement markings.
    - b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

**1.4 ACTION SUBMITTALS**

- A. Product Data: Include technical data and tested physical and performance properties.
- B. Shop Drawings:
  - 1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
  - 2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Texas Department of Transportation for pavement-marking work.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials and 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain pavement-marking paints from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design".

2.3 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint, Alkyd: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N; colors complying with FS TT-P-1952F.
- B. Pavement-Marking Paint, Solvent-Borne: MPI #32, solvent-borne traffic-marking paint.
- C. Pavement-Marking Paint, Acrylic: Acrylic, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952F, Type II, with drying time of less than 45 minutes.
- D. Pavement-Marking Paint, Latex: MPI #97, latex traffic-marking paint.
- E. Glass Beads: AASHTO M 247, Type 1 or FS TT-B-1325D, Type 1, made of 100 percent recycled glass.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.

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

### 3.2 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
  - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
  - 2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.

### 3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

## SECTION 323119

### METAL FENCES AND GATES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Metal fences.
- 2. Swing gates.
- 3. Gate operators, including controls.

- B. Related Requirements:

- 1. TXDot Item 421 “Hydraulic Cement Concrete” for concrete bases for gate operators, drives, and controls and post concrete fill.

##### 1.3 PREINSTALLATION MEETINGS

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

##### 1.4 ACTION SUBMITTALS

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

- B. Shop Drawings: For fencing and gates.

- 1. Include plans, elevations, sections, gate locations, post spacing, and mounting details, and grounding details.
- 2. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
- 3. Wiring Diagrams: Include diagrams for power, signal, and control wiring.

- C. Samples: For each fence material and for each color specified.

- 1. Provide Samples 12 inches in length for linear materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For gate operators to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metal Fences and Gates: Refer to Drawings and Materials Schedule for configurations:
- B. Steel:
  - 1. Shapes: ASTM A36/A36M.
  - 2. Tube: ASTM A500/A500M.
  - 3. Salvaged, where noted.
- C. Fence Mesh: Refer to Materials Schedule.

2.2 SWING GATES

- A. Gate Configuration: As indicated.
- B. Gate Frame Height: As indicated.
- C. Gate Opening Width: As indicated.
- D. Automated vehicular gates shall comply with ASTM F2200, Class I.
- E. Additional Rails: Provide as indicated, complying with requirements for fence rails.
- F. Infill: Comply with requirements for adjacent fence.
- G. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates.
- H. Steel Finish: As indicated.

2.3 ACCESSORIES

- A. Gate Hardware:
  - 1. Swinging gates:
    - a. Hinges: Heavy Duty type.
    - b. Bottom roller with sealed ball bearing wheels.
    - c. Galvanized steel bottom track.
  - 2. Manual gates:
    - a. Hinges: Heavy Duty type.
    - b. Latch and lock.

- c. Rpvode drop bolt and hold closed/open recessed drop bold sleeve at double gates.
- B. Gate Operators:
  - 1. Meet UL 325.
  - 2. Polyethylene plastic cover.
  - 3. Minimum 1/2HP, 120 volt AC, single phase motor; 24 volt DC control circuit.
  - 4. Solid state circuitry with adjustable time delay to close feature.
  - 5. Adjustable limit switches.
  - 6. Automatically reversing by means of digital current sensor.
- C. Linkage: As required by conditions of use.
- D. Vehicle Detector: Mounted in gate operator housing, designed for use in temperature range from minus 40 degrees to plus 160 degrees F, used in conjunction with buried sensing loop to detect presence of vehicle and activate gate.
- E. Loop: 14 gage, Teflon coated copper wire in plastic housing.
- F. Loop Groove Filler: Cold-poured rubberized asphalt emulsion.
- G. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with enclosure for pedestal mounting. Provide the following remote-control device(s):
  - 1. Digital Keypad Entry Unit: Programmable, multiple-code capability of not less than 500 possible individual codes, consisting of 5-digit codes.
    - a. Face-lighted unit with metal-keyed keypad fully visible at night.
- H. Vehicle Presence Detector: System includes automatic closing timer with adjustable time delay and presence detector designed to open and close gate. System includes detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway when infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.
- I. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
  - 1. Action: Reverse gate in both opening and closing cycles, and hold until clear of obstruction.
  - 2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
- J. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
- K. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.
  - 1. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge.

## 2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in TXDot Item 421 "Hydraulic Cement Concrete".
- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

## 2.5 GROUNDING MATERIALS

- A. Grounding Conductors: Size as indicated on Drawings. Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
  - 1. Material above Finished Grade: Copper.
  - 2. Material on or below Finished Grade: Copper.
  - 3. Bonding Jumpers: Braided copper tape, 1-5/8 inch wide and 1/16 inch thick, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- B. Grounding Connectors and Grounding Rods: Comply with UL 467.
  - 1. Connectors for Below-Grade Use: Exothermic-welded type.
  - 2. Grounding Rods: Copper-clad steel.
    - a. Size: 5/8 by 96 inches.

## 2.6 STEEL FINISHES

- A. As noted on Drawings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

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

### 3.3 INSTALLATION

- A. Project site must remain enclosed by high fences at all times. Installation of new gate and fencing must occur prior to demolish of existing gate.
- B. Install fences and gates according to manufacturer's written instructions and approved Shop Drawings.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.
- D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
  - 3. Space posts uniformly per Drawings.

### 3.4 GATE INSTALLATION

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

### 3.5 GATE OPERATOR INSTALLATION

- A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Excavation for Pedestals: Hand-excavate holes for bases in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated.
- C. Concrete Bases: Cast-in-place or precast concrete, depth not less than 12 inches, dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.
- D. Vehicle Loop Detector System: Bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
- E. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

### 3.6 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Automatic Gate Operators: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, and limit switches.
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lubricate hardware, gate operators, and other moving parts.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION 323119

**SECTION 323300**  
**SITE FURNISHINGS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

**1.2 SUMMARY**

A. Section Includes:

- 1. Benches.
- 2. Picnic Tables.
- 3. Trash receptacles.
- 4. Bollards.
- 5. Detectable warning plates.

B. Related Requirements:

- 1. TXDOT Item 421 "Hydraulic Cement Concrete".
- 2. TXDOT Item 110 "Excavation" for excavation for installing concrete footings.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.
- C. Samples for Initial Selection: For units with factory-applied finishes.
- D. Samples for Verification: For each type of exposed finish, not less than 6-inch-long linear components and 4-inch- square sheet components.
- E. 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.

## 1.5 CLOSEOUT SUBMITTALS

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

## 1.6 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. Bench Replacement Slats: No fewer than two full-size units for each size indicated.
  - 2. Trash Receptacle Inner Containers: Two full-size units for each size indicated.
  - 3. Anchors: Eight.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS, MATERIALS

- A. Bench.
  - 1. Dumor 535-60 TM Bench
  - 2. Material, slats: Thermally modified red oak
  - 3. Material, frame: Steel
  - 4. Color, slats: Natural
  - 5. Color, frame: Bronze
  - 6. Finish, slats: Unfinished
  - 7. Finish, frame: Powdercoated
  - 8. Mounting: Freestanding
- B. Picnic Table.
  - 1. Dumor 537-60 TMR Picnic Table
  - 2. Material, slats: Thermally modified red oak
  - 3. Material, frame: Steel
  - 4. Color, slats: Natural
  - 5. Color, frame: Bronze
  - 6. Finish, slats: Unfinished
  - 7. Finish, frame: Powdercoated
  - 8. Mounting: Freestanding
- C. Trash Receptacle.
  - 1. Bearsaver CE240-CHR; Pull-down chute and 5" Recycle Tube
  - 2. Material: Steel
  - 3. Color: Forest Brown
  - 4. Finish: Textured Powdercoat
  - 5. Mounting: Freestanding
- D. Bollards.
  - 1. Custom, ref Drawings.
  - 2. Material: ¼" Thick Steel tube, concrete filled
  - 3. Color: Natural
  - 4. Finish: Natural
  - 5. Mounting: Ref Drawings
- E. Detectable Warning Plate.

1. Reliance Foundry, or approved equal.
2. Material: Cast iron, 24"x26"
3. Color: Natural
4. Finish: Raw
5. Mounting: Per manufacturer recommendations

## 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. 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.
- E. 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 or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
- F. 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 or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 323300

**SECTION 329113**  
**SOIL PREPARATION**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including Uniform General Conditions for State of Texas Construction Contracts, including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department, and TPWD Division 1 – General Requirements, Section 01000, Special Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

**1.2 SUMMARY**

- A. The scope of work includes all labor, materials, tools, supplies, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of Planting Soil and /or the modification of existing site soil for use as Planting Soil, complete as shown on the Drawings and as specified herein.
- B. The scope of work in this section includes, but is not limited to, the following:
  - 1. Harvest and stockpile existing site soils suitable for Planting Soil.
  - 2. Modify existing stockpiled site soil.
    - a. Modify existing site soil in place for use as Planting Soil.
    - b. Install existing or modified existing soil for use as Planting Soil.
  - 3. Fine grade Planting Soil.
  - 4. Install Compost into Planting Soil.
  - 5. Clean up and disposal of all excess and surplus material.
- C. References: 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.
  - 1. ASTM: American Society of Testing Materials cited section numbers.
  - 2. U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI. Available Online.
  - 3. US Composting Council ([www.compostingcouncil.org](http://www.compostingcouncil.org)).
  - 4. Methods of Soil Analysis, as published by the Soil Science Society of America ([www.soils.org](http://www.soils.org)).
  - 5. Up by Roots: healthy soils and trees in the built environment. 2008. J. Urban. International Society of Arboriculture, Champaign, IL.

**1.3 DEFINITIONS**

- A. AAPFCO: Association of American Plant Food Control Officials.

- B. Acceptable drainage: Drainage rate is sufficient for the plants to be grown. Not too fast and not too slow. Typical rates for installed Planting Soil are between 1 - 5 inches per hour. Turf soils are often higher, but drainage rates above 2 - 3 inches per hour will dry out very fast. In natural undisturbed soil a much lower drainage rate, as low as 1/8th inch per hour can still support good plant growth. Wetland plants can grow on top of perched water layers or even within seasonal perched water layers, but could become unstable in high wind events.
- C. Amendment: material added to Topsoil to produce Planting Soil Mix. Amendments are classified as general soil amendments, fertilizers, biological, and pH amendments.
- D. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- E. Biological Amendment: Amendments such as Mycorrhizal additives, compost tea or other products intended to change the soil biology.
- F. CEC: Cation exchange capacity.
- G. Compacted soil: soil where the density of the soil is greater than the threshold for root limiting, and further defined in this specification.
- H. 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 as defined by the US Composting Council and further defined in this specification.
- I. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- J. End of Warranty Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of the warranty. Refer to the Uniform General Conditions for State of Texas Construction Contracts for specifics for this contracts.
- K. Existing Soil: Mineral soil existing at the locations of proposed planting after the majority of the construction within and around the planting site is completed and just prior to the start of work to prepare the planting area for soil modification and/or planting, and further defined in this specification.
- L. Fine grading: The final grading of the soil to achieve exact contours and positive drainage, often accomplished by hand rakes or drag rakes or other suitable devices, and further defined in this specification, and further defined in this specification.
- M. Finished grade: surface or elevation of Planting Soil after final grading and 12 months of settlement of the soil, and further defined in this specification.
- N. Graded soil: Soil where the A horizon has been stripped and relocated or re-spread; cuts and fills deeper than 12 inches, and further defined in this specification.
- O. Installed soil: Planting soil and existing site soil that is spread and or graded to form a planting soil, and further defined in this specification.
- P. Imported Soil: Soil that is transported to Project site for use.

- Q. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- R. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- S. Minor disturbance: Minor grading as part of agricultural work that only adjusts the A horizon soil, minor surface compaction in the top 6 inches of the soil, applications of fertilizers, installation of utility pipes smaller than 18 inches in diameter thru the soil zone.
- T. 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.
- U. 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."
- V. 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.
- W. Poor drainage: Soil drainage that is slower than that to which the plants can adapt. This is a wide range of metrics, but generally if the soil is turning grey in color it is reasonable preferable to either to plant moisture adaptive plants at smaller sizes that are young in age with shallow root balls or look at options to improve the drainage
- X. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- Y. Soil Fracturing: Deep loosening the soil to the depths specified by using a back hoe, and further defined in this specification.
- Z. Soil Horizons: as defined in the USDA National Soil Survey Handbook.
- AA. Soil Ripping: Loosening the soil by dragging a ripping shank or chisel thru the soil to the depths and spacing specified, and further defined in this specification.
- BB. Soil Tilling: Loosening the surface of the soil to the depths specified with a rotary tine tilling machine, roto tiller, (or spade tiller), and further defined in this specification.
- CC. Soil trenching: Cutting narrow trenches thru the soil at the depths and spacing specified to loosen the soil profile, and further defined in this specification.
- DD. SSSA: Soil Science Society of America.
- EE. 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.
- FF. 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.

- GG. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Owner accepts that all work in these sections is complete and the Warranty period has begun.
- HH. 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.
- II. Topsoil: naturally produced and harvested soil from the A horizon or upper layers or the soil as further defined in this specification
- JJ. Undisturbed soil: Soils with the original A horizon intact that have not been graded or compacted. Soils that have been farmed, subjected to fire or logged but not graded, and natural forested land will be considered as undisturbed
- KK. USCC: U.S. Composting Council.

#### 1.4 PREINSTALLATION MEETINGS

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

#### 1.5 ACTION SUBMITTALS

- A. Provide all submittals minimum eight (8) weeks prior to the start of the soil work.

- B. 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.

- C. Soil testing for Existing Topsoil.

1. Existing site soil: Submit soil test analysis report for each sample of existing site soil to Texas Plant and Soil Lab (<https://www.tpslab.com>) and where indicated in Part 2 of the specification as follows:
  - a. Submit Topsoil for testing at least 8 weeks before scheduled installation.
  - b. If tests fail to meet the specifications, obtain other sources of material, retest and resubmit until accepted by the Owner's Representative.
  - c. All soil testing will be at the expense of the Contractor.
2. Provide a particle size analysis (% dry weight) and USDA soil texture analysis. Soil testing shall also include USDA gradation (percentage) of gravel, coarse sand, medium sand, and fine sand in addition to silt and clay.
  - a. pH and buffer pH.
  - b. Percent organic content by oven dried weight.
  - c. Nutrient levels by parts per million including: phosphorus, potassium, magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
  - d. Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.

- e. Cation Exchange Capacity (CEC).
- f. Solvita maturity test

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- C. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: The installer shall be a firm having at least 5 years of experience of a scope similar to that required for the work, including the preparation, mixing and installation of soil mixes to support planting. The installer of the work in Section 329219: Seeding, shall be the same firm installing the work in this section.
  - 1. The bidders list for work under this section shall be approved by the Landscape Architect.
  - 2. Installer Field Supervision: When any Soil work is in progress, installer shall maintain, on site, an experienced full-time supervisor who can communicate in English with the Landscape Architect.
  - 3. Installer's field supervisor shall have a minimum of five years experience as a field supervisor installing soil, shall be trained and proficient in the use of field surveying equipment to establish grades and can communicate in English with the Owner's Representative.
  - 4. The installer's crew shall be experienced in the installation of Harvested Soil and seeding, and interpretation of planting plans and soil installation plans.
  - 5. Submit references of past projects and employee training certifications that support that the Contractors meet all of the above installer qualifications and applicable licensures.
- B. Testing Agency Qualifications: Texas Plant and Soil Lab 4915 W. Monte Cristo Road., Edinburg, TX 78541 phone: (956) 383-0739 web: tpslab.com
- C. Soil compaction testing: following installation or modification of soil, test soil compaction with a penetrometer.
  - 1. Maintain at the site at all times a soil cone penetrometer with pressure dial and a soil moisture meter to check soil compaction and soil moisture.
    - a. Penetrometer shall be AgraTronix Soil Compaction Meter distributed by Forestry Suppliers, [www.forestry-suppliers.com](http://www.forestry-suppliers.com) or approved equal.
    - b. Moisture meter shall be "general digital soil moisture meter" distributed by Forestry Suppliers, [www.forestry-suppliers.com](http://www.forestry-suppliers.com) or approved equal.
  - 2. Prior to testing the soil with the penetrometer check the soil moisture and penetrometer readings in the mockup soils. Penetrometer readings are impacted by soil moisture and excessively wet or dry soils will read significantly lower or higher than soils at optimum moisture.
  - 3. The penetrometer readings shall be within 20% plus or minus of the readings in the approved mockup when at similar moisture levels.

## 1.8 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and subsurface conditions, and to notify the Landscape Architect, 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 Landscape Architect in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Landscape Architect of such conditions, they shall remain responsible for plant material under the warranty clause of the specifications.
  - 2. This specification requires that all Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.
  - 3. Project site has multiple archeologically sensitive areas. Soils from construction in known archeological sites should not be spread elsewhere. Contact Owner or Landscape Architect if archeological materials are encountered during construction.

## 1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site 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.

## 1.10 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 state-certified, -licensed, or -registered soil scientist under the direction of the testing agency.
  - 1. Number and Location of Samples: Minimum of five (5) 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.

## 1.11 SOIL COMPACTION – GENERAL REQUIREMENTS

- A. Except where more stringent requirements are defined in this specification, the following parameters shall define the general description of the threshold points of soil compaction in existing, modified or installed soil and subsoil.
- B. The following are threshold levels of compaction as determined by each method.
  - 1. Acceptable Compaction: Good rooting anticipated, but increasing settlement expected as compaction is reduced and/or in soil with a high organic matter content.
    - a. Bulk Density Method – Varies by soil type see Chart on page 32 in “Up By Roots.”
    - b. Standard Proctor Method – 75-85%; soil below 75% is unstable and will settle excessively.
    - c. Penetration Resistance Method – about 75-250 psi, below 75 psi soil becomes increasingly unstable and will settle excessively.
  - 2. Root limiting Compaction: Root growth is limited with fewer, shorter and slower growing roots.
    - a. Bulk Density Method – Varies by soil type see Chart on page 32 in “Up By Roots.”
    - b. Standard Proctor Method – above approximately 85%.
    - c. Penetration Resistance Method – about 300 psi.
  - 3. Excessive Compaction: Roots not likely to grow but can penetrate soil when soil is above field capacity.
    - a. Bulk Density Method – Varies by soil type see Chart on page 32 in “Up By Roots.”
    - b. Standard Proctor Method – Above 90%.
    - c. Penetration Resistance Method – Approximately above 400 psi

## 1.12 DELIVERY, STORAGE, AND HANDLING

- A. Weather: Do not mix, deliver, place, or grade soils when frozen or with moisture above field capacity.
- B. Protect soil and soil stockpiles from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage. Cover stockpiles with plastic sheeting or fabric at the end of each workday.
- C. 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.
- D. 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 soil amendments with appropriate certificates.

### 1.13 EXCAVATING AND GRADING 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 damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the 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.

## PART 2 - PRODUCTS

### 2.1 HARVESTED TOPSOIL

- A. Topsoil shall be harvested from the site and stockpiled for reuse.
- B. Harvested topsoil shall be used on-site in lieu of importing topsoil.

### 2.2 EXISTING SOIL

- A. General definition of existing soil: Surface soil in the areas designated on the soils plan as existing soil, that is not altered, compacted to root limiting density, graded or contaminated before or during the construction process and considered acceptable for planting and long term health of the plants specified either as it exists or with only minor modification.
  - 1. The Landscape Architect shall verify that the soil in the designated areas is suitable at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for use as Planting Soil to the point where the soil is no longer suitable to support the plants specified, the Landscape Architect may require modification of the damaged soil up to and including airspade or tillage and the additional of compost or removal and replacement with soil of equal quality to the soil that existed prior to construction. Examples of damage include further compaction, contamination, grading, creation of hard pan or drainage problems, and loss of the O, and or A horizon.
    - a. Amendments per laboratory recommendations are to be provided by the Contractor.
    - b. Do not begin work on additional modifications until changes to the contract price are approved by Landscape Architect.
- B. Protect existing soil from compaction, contamination, and degradation during the construction process through the use of coarse ground mulch and fencing. All soils that are disturbed/compacted during construction and are to be revegetated shall be restored prior to planting as directed by the Landscape Architect.
- C. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not increase compaction of soil to root limiting levels.
- D. Modifications:
  - 1. Remove existing grass thatch, ground cover plants, mulch and weeds.

2. When results of soil tests recommend organic matter adjustments, till or airspade the surface soil to six inches or greater after compost has been evenly spread.

### 2.3 MODIFIED EXISTING SOIL (Soil suitable for planting with indicated modification.)

A. General definition: Surface soil in the areas designated on the soils plan as Modified Existing Soil has been altered and or graded before or during the construction process but is still considered acceptable for planting and long term health of the plants specified with the proposed modifications. Modifications respond to the soil problems expected or encountered. The Landscape Architect shall verify that the soil in the designated areas is suitable for modification at the beginning of planting bed preparation work in that area.

1. The Landscape Architect shall verify that the soil in the designated areas is suitable for the specified modification at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for modification to the point where the soil is no longer suitable to support the plants specified with the specified modification, the Landscape Architect may require further modification of the damaged soil up to an including removal and replacement with soil of equal quality to the soil that would have resulted from the modification. Damage may include further compaction, contamination, grading, creation of hard pan or drainage problem, and loss of the O, and or A horizon.
2. General requirements for all soil modifications:
  - a. Take soil samples, test for chemical properties and organic matter. Make appropriate adjustments.
  - b. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not add to the compaction in the soil.
  - c. All soil grading, tilling and loosening must be completed at times when the soil moisture is below field capacity. Allow soil to drain for at least two days after any rain event more than 1 inch in 24 hours, or long enough so that the soil does not make the hand muddy when squeezed.

B. Modified existing soil – soil removed, stockpiled, and spread

1. Description of condition to be modified: Existing soils that have been identified for harvest and/or are suitable for reuse as Planting Soil but is in the wrong place of elevation, or cannot be adequately protected during construction. Soil is to be harvested, stockpiled and re-spread with or without further modifications as indicated.

C. Modified existing soil – compacted surface soil (Tilling Option)

1. Description of condition to be modified: Surface soil compaction to a maximum of 6 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required. Soil may only be tilled in areas outside of the driplines of trees and shrubs. An airspade should be used to modify soil compaction under tree and shrub driplines.
2. Modifications:
  - a. Till top 6 inches or deeper of the soil surface, with a roto tiller, spade tiller, ripper or agricultural plow. Spread 2 inches of Compost on the surface of the tilled soil.
  - b. Till or disk the Compost into the loosened soil. Smooth out grades with a drag rake or drag slip.

D. Modified existing soil – compacted surface soil (Radial Trenching Option)

1. Description of condition to be modified: Surface soil compaction to a maximum of 24 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile below 24 inches intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.
2. Modifications:
  - a. Using a trenching machine, dig trenches to the extent and depth shown on the plans and details.
  - b. Backfill the trench with the soil removed from the trench. Add additional site soil if needed to fill the trench to be flush to the existing grade after the soil settlement.

E. Modified existing soil – compacted subsoil

1. Description of condition to be modified: Deep soil compaction the result of previous grading, filling and dynamic or static compaction forces. Original A horizon likely removed or buried. The soil organic matter, pH and chemistry in the A horizon is likely not suitable for the proposed plants and should be modified as required.
2. Soil Ripping:
  - a. Step one: After grading and removing all plants and debris from the surface, using a tracked dozer or similar large grading equipment, loosen the soil by dragging a ripping shank or chisel thru the soil to depths of 24 inches with ripping shanks spaced 18 inches or less apart in two directions. The number of shanks per pull is dependent on the degree of soil compaction and the size of the dozer.
3. Soil Fracturing:
  - a. Step one: After grading and removing all plants and debris from the surface, spread 2 inches of Compost over the surface of the soil. Loosen the soil to depth of 18 - 24 inches, using a backhoe to dig into the soil through the Compost. Lift and then drop the loosened soil immediately back into the hole. The bucket then moves to the adjacent soil and repeats the process until the entire area indicated has been loosened.
  - b. Step 2: Spread 3-4 inches of Compost over the ripped area and till into the top 6 inches of the soil surface.
4. Trenching:
  - a. Step one: After grading and removing all plants and debris from the surface using a chain trenching machine, dig 24 inch deep trenches, 24 inches apart across the entire area. Maintain an 18-inch standoff from the edges of all curbs, paving and structures. Backfill the trenches with Compost.
  - b. Step 2: Spread 3-4 inches of Compost over the trenches area and till into the top 6 inches of the soil surface. Compost tilling treatment shall extend to the edges of curbs, paving and structures.
5. Following soil ripping or fracturing the average penetration resistance should be less than 250 psi to the depth of the ripping or fracturing.
6. Do not start planting into ripped or fractured soil until soil has been settled or leave grades sufficiently high to anticipate settlement of 10 – 15% of ripped soil depth.

F. Modified existing soil – soil within the root zone of existing established trees

1. Description of condition to be modified: Surface compaction near or above root limited levels in the upper soil horizon the result of traffic or other mechanical compaction.
2. Modifications:
  - a. Remove the tops of all plants to be removed from the root zone. Do not grub out the roots of plants to be removed.
  - b. Use a pneumatic air knife/airspade to loosen the top 9 – 12 inches of the soil. Surface roots may move and separate from soil during this process but the bark on roots should not be broken
    - 1) Pneumatic air knife shall be as manufactured by:
      - a) Concept Engineering Group, Inc., Verona, PA (412) 826-8800
      - b) Supersonic Air Knife, Inc., Allison Park, PA (866) 328 5723
      - c) Approved equal.

## 2.4 COMPOST

- A. Compost: Blended and ground leaf, wood and other plant based material, composted for a minimum of 9 months and at temperatures sufficient to break down all woody fibers, seeds and leaf structures, free of toxic material at levels that are harmful to plants or humans. Source material shall be yard waste trimmings blended with other plant or manure based material designed to produce Compost high in fungal material.
  1. Compost shall be commercially prepared Compost and meet US Compost Council STA/TMECC criteria or as modified in this section for “Compost as a Landscape Backfill Mix Component”.
  2. [www.compostingcouncil.org/resource/resmgr/images/Landscape-Architecture-Specs.pdf](http://www.compostingcouncil.org/resource/resmgr/images/Landscape-Architecture-Specs.pdf)
  3. Compost shall comply with the following parameters:
    - a. pH: 5.5 - 8.0.
    - b. Soil salt (electrical conductivity): maximum 5 dS/m (mmhos/cm).
    - c. Moisture content %, wet weight basis: 30 – 60.
    - d. Particle size, dry weight basis: 98% pass through 3/4 inch screen or smear.
    - e. Stability carbon dioxide evolution rate: mg CO<sub>2</sub>-C/ g OM/ day < 2.
    - f. Solvita maturity test: > 6.
    - g. Physical contaminants (inerts), %, dry weight basis: <1%.
    - h. Chemical contaminants, mg/kg (ppm): meet or exceed US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels.
    - i. Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) level requirements.
- B. Provide a two-gallon sample with manufacturer’s literature and material certification that the product meets the requirements.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Notify the Landscape Architect 10 days in advance of soil installation. Inspection shall take place during the placement of the planting soils layers while the subsoil is still visible, and another inspection shall take place during installation of the topsoil layer.

- B. Vehicular access to the site is restricted. Prior to construction, the Contractor shall submit for approval a plan to the Landscape Architect showing proposed routing for deliveries and site access, which shall include, but not be limited to, equipment movements and staging locations. The plan shall illustrate how newly installed soils will not be compacted or otherwise damaged throughout the installation process. Reducing the amount of compaction to the soils can be accomplished by beginning the work in corners, against walls, or at the center of isolated beds, and progressing outwards. This limits the amount of traffic on the placed soil during installation.
- C. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to soil placement. The Contractor shall place barricades as required to prevent any unnecessary compaction of planting soil from vehicles, equipment, or pedestrian traffic.
- D. Soil materials shall be covered two weeks prior to installation to prevent excess moisture from saturating the soil stockpile.
- E. Use low-impact equipment with track belts, large tires, or low tire pressure to lower compaction and soil damage. All equipment to grade and move the soils shall be rated for ground pressure of 5 psi or lower. Submit list of low-impact equipment with the corresponding ground pressure psi to Landscape Architect for approval prior to use.
  - 1. Back-blading the topsoil will orient soil particles, causing over compaction. Back-blading is prohibited.
- F. Place planting soil and fertilizers according to requirements in other Specification Sections.
- G. 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.
- H. Proceed with placement only after unsatisfactory conditions have been corrected.

### 3.2 SITE EXAMINATION

- A. Prior to installation of Stockpiled Top Soil, examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.
  - 1. Confirm that the subgrade is at the proper elevation and compacted as required.
  - 2. Confirm that surface all areas to be filled with Top Soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches diameter, soil crusting films of silt or clay that reduces or stops drainage from the Planting Soil into the subsoil; and/or standing water. Remove unsuitable material from the site.
  - 3. Confirm that no adverse drainage conditions are present.
  - 4. Confirm that no conditions are present which are detrimental to plant growth.
  - 5. Confirm that utility work has been completed per the drawings.
- B. If unsatisfactory conditions are encountered, notify the Owner's Representative immediately to determine corrective action before proceeding.

### 3.3 GRADE AND ELEVATION CONTROL

- A. Provide grade and elevation control during installation of Planting Soil. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

### 3.4 SITE PREPARATION

- A. Excavate to the proposed subgrade. Maintain all required angles of repose of the adjacent materials as shown on the drawings or as required by this specification. Do not over excavate compacted subgrades of adjacent pavement or structures. Maintain a supporting 1:1 side slope of compacted subgrade material along the edges of all paving and structures where the bottom of the paving or structure is above the bottom elevation of the excavated planting area.
- B. Remove all construction debris and material including any construction materials from the subgrade.
- C. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope approximately parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.
- D. In areas where Top Soil is to be spread, confirm subgrade has been scarified.
- E. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 1/2 inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.
  - 1. At the end of each working day, clean up any soil or dirt spilled on any paved surface.
  - 2. Any damage to the paving or site features or work shall be repaired at the Contractor's expense.

### 3.5 SOIL MOISTURE

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

B.

Soil texture	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%

- C. The Contractor shall confirm the soil moisture levels with a moisture meter (Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent). If moisture is found to be too low, the planting holes shall be filled with water and allowed to drain before starting any planting operations. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

### 3.6 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE SOIL INSTALLATION

- A. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid,

### 3.7 COMPACTION REQUIREMENTS FOR INSTALLED OR MODIFIED PLANTING SOIL

- A. Compact installed Top Soil to the compaction rates indicated and using the methods approved for the soil mockup. Compact each soil lift as the soil is installed.
- B. Existing soil that is modified by tilling, ripping or fracturing shall have a density to the depth of the modification, after completion of the loosening, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilting point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.
- C. Installed Top Soil Mix and re-spread existing soil shall have a soil density through the required depth of the installed layers of soil, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilt point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.
- D. Top Soil compaction shall be tested at each lift using a penetrometer calibrated to the mockup soil and its moisture level. The same penetrometer and moisture meter used for the testing of the mockup shall be used to test installed soil throughout the work.
- E. Maintain moisture conditions within the Top Soil during installation or modification to allow for satisfactory compaction. Suspend operations if the Top Soil becomes wet. Apply water if the soil is overly dry.
- F. Provide adequate equipment to achieve consistent and uniform compaction of the Top Soils. Use the smallest equipment that can reasonably perform the task of spreading and compaction. Use the same equipment and methods of compaction used to construct the Top Soil mockup.
- G. Do not pass motorized equipment over previously installed and compacted soil except as authorized below.
  - 1. Light weight equipment such as trenching machines or motorized wheel barrows is permitted to pass over finished soil work.
  - 2. If work after the installation and compaction of soil compacts the soil to levels greater than the above requirements, follow the requirements of the paragraph "Over Compaction Reduction" below.

### 3.8 OVER COMPACTION REDUCTION

- A. Any soil that becomes compacted to a density greater than the specified density and/or the density in the approved mockup shall be dug up and reinstalled. This requirement includes compaction caused by other sub-contractors after the Top Soil is installed and approved.
- B. Surface roto tilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.

### 3.9 FINE GRADING

- A. The Owner's Representative shall approve all rough grading prior to the installation of Compost, fine grading, planting, and mulching.
- B. Grade the finish surface of all planted areas to meet the grades shown on the drawings, allowing the finished grades to remain higher (10 – 15% of depth of soil modification) than the grades on the grading plan, as defined in paragraph Top Soil Installation, to anticipate settlement over the first year.

- C. Utilize hand equipment, small garden tractors with rakes, or small garden tractors with buckets with teeth for fine grading to keep surface rough without further compaction. Do not use the flat bottom of a loader bucket to fine grade, as it will cause the finished grade to become overly smooth and/or slightly compressed.
- D. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Owner's Representative in the event that conditions make it impossible to achieve positive drainage.
- E. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that the finish grade before adding mulch and after settlement is one or two inches below all paving surfaces or as directed by the drawings.
- F. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 2 inch deviation from the plane in 10 feet. The tolerance for dips and bumps in lawn areas shall be a 1 inch deviation from the plane in 10 feet.

### 3.10 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.
- D. Construction Pathways and Storage - All temporary construction pathways or storage areas that will be revegetated and are located under tree canopies or in areas prone to water ponding shall include 10" of coarse wood mulch overlaid with Presto GeoTerra GTO mat or similar approved product.

### 3.11 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 as per Construction Waste Management Plan (CWMP), as defined in Section 017419 "Construction Waste Management."

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

## SECTION 329219

### SEEDING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Provide labor and materials necessary for seeding and other related work as required.
- B. Related work described elsewhere:
  - 1. Section 329113 – Soil Preparation

##### 1.2 SUBMITTALS

- A. Submit seed producer's certification including manufacturers label stating botanical name and common name. Identify source location. All seed to be from plant material sourced from Central Texas.
- B. Submit required material samples and certifications.
- C. Submit the following materials certification: Ingredient analysis.
- D. Submit one-pound samples of each material specified in this section with certified laboratory analysis of each sample as follows:
  - 1. Topsoil from on-site
  - 2. Specified amendments

##### 1.3 QUALITY ASSURANCE

- A. Provide and pay for materials testing. Submit name of testing agency for approval by Landscape Architect.
- B. A certified laboratory retained by the contractor shall provide testing and verification of representative soil from seeding area proposed for use on this project. Refer to Section 329113 – Soil Preparation for testing requirements.
- C. No later than 30 days after Notice to Proceed, submit to Construction Project Manager for approval documentation confirming seed has been ordered from a recognized seed supplier.

##### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver amendments in original unopened containers, showing weight, analysis, and name of manufacturer. Store in manner to prevent wetting and deterioration.
- B. Provide bulk materials processed and blended off-site when specified. Deliver materials in clean, washed, and covered trucks to eliminate contamination during transportation. Coordinate on-site stockpiling locations with Owner. Stockpile in areas free of debris and away from drainage routes. Cover bulk material with plastic or geotextile if material is to be stockpiled more than 24 hours.
- C. Protect seed from sun, wind and dehydration prior to installation.

1.5 PROJECT CONDITIONS

- A. Work notifications: Notify Owner at least 7 working days prior to start of seed installation.
- B. Protect existing utilities, paving, and other facilities from damage caused by seed installation.
- C. Install seed only after planting and other work affecting ground surface has been completed.
- D. Restrict traffic from seeded areas. Erect signs and barriers as required.
- E. Provide hose and watering equipment as required.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All seeds and raw materials shall be manufactured and/or extracted or harvested within the following radii from the Project site:

Material Type	Distance Requirements
Soils, Compost, and Mulch	Extraction, harvest or recovery, must occur on site
Seed	Extraction, harvest or recovery, and manufacture must occur within 50 miles

2.2 MATERIAL

- A. Seed:

- 1. Weeds: Seed mix shall be 100% free of all noxious weeds and shall be free of grassy and broad leaf weeds. Seed containing Old-World bluestem, Johnsongrass, bermudagrass, or other deleterious weeds shall not be accepted.
- 2. Mix:

Species	Scientific Name	%	PLS#/ac
Little Bluestem	<i>Schizachyrium scoparium</i>	45.45%	10
Sideoats Grama	<i>Bouteloua curtipendula</i>	22.73%	5
Green Sprangletop	<i>Leptochloa dubia</i>	22.73%	5
Sand Dropseed	<i>Sporobolus cryptandrus</i>	9.09%	2
	Total	100.00%	22

- 3. Seed mix is intended for planting from Sept 15-June 15. Plantings between Sept 15-Feb 15 should also include cereal rye grain (13 PLS#/ac) and Canada wildrye (6 PLS#/ac). If project is complete outside of this window, cereal rye grain should be added at a rate of 25 PLS#/ac, follow-up with a biodegradable erosion-control mat, and watered through duration of project. Seed should be sourced from plant materials originating and grown in central Texas.

- B. Plant species substitutions shall be approved by Owner or Ecologist.
- C. Soil Amendments

1. Compost shall be used to increase organic matter content where needed. Compost shall be a well-decomposed, stable, weed free organic matter derived from agricultural, food, or yard trimmings. The product shall contain no substances toxic to plants and shall be reasonably free (<1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw materials from which it was derived. All compost shall be tested by a reputable laboratory and must meet the following parameters:
  - a. pH range of 6.0 – 8.5
  - b. Maximum soluble salt concentration of 10 dS/m
  - c. Moisture content of 20 – 60 percent wet weight basis
  - d. Organic matter content of 30 – 60 percent dry weight basis
2. To minimize damage to the soils, the contractor shall avoid driving or parking construction equipment on any soils that have been restored for planting.
3. Amendments should be gathered from a location within 50 miles of the project site.
4. No seed shall be placed on soil which has been treated with herbicide until sufficient time has elapsed to permit dissipation of all harmful materials (see manufacturers recommendations for re-entry date calculation). The general contractor shall assume full responsibility for any loss or damage to seed arising from improper use of chemicals or due to failure to allow sufficient time to permit dissipation of chemical residues, whether or not such materials are specified herein.

D. Native Hay Mulch

1. Native hay mulch shall be specified as follows:
  - a. Sourced from within 50 miles.
  - b. Free of invasive Old-world bluestem, Johnsongrass, bermudagrass, or other invasive weed species.
  - c. Harvested within the last year.
2. Native hay shall not be harvested from on-site.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine finish surfaces, grades, topsoil quality, and depth. Do not start seed installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Limit preparation to areas that will be immediately seeded.
- B. Thoroughly clean all equipment of soil, mud, grass, seed, or other debris that could contaminate the site with invasive species.
- C. Outside the dripline of trees and shrubs, Rip existing soil surface to minimum 8-inch depth to alleviate compaction from site excavation work with tines 8 to 12" on center. Do not over-cultivate the soil or break it down into small, uniform particles. Incorporate following soil amendments into top 6-inches of scarified soil:
  1. Compost– add compost based on organic matter percent testing with a target of at least 5% organic matter to a depth of 6" ONLY AS REQUESTED BY OWNER, LANDSCAPE ARCHITECT, AND ECOLOGIST BASED ON SOIL ANALYSIS.

- D. Cultipack or lightly harrow to break up large clods or fill soil voids if necessary. Leave contour furrows, do not smooth finish. Preparation shall not occur while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed for seeding. Soil decompaction will be considered complete when the penetration resistance is between 75 and 250 psi in all areas ripped to the depth of ripping.
- E. Restore prepared area to specified condition if eroded, settled, or otherwise disturbed after fine grading and soil preparation prior to seeding.

### 3.3 INSTALLATION

#### A. Seeding

1. Proceed with seeding when the following conditions are met:
  - a. Approval of landscape architect or ecologist
  - b. Soil temperatures are above 65 degrees F.
  - c. Rain events greater than 1" are not forecasted in the next 10 days.
  - d. Wind speeds are below 10mph.
  - e. Average daily temperatures are forecasted to be below 90 degrees Fahrenheit for the next ten days.
2. Work shall be performed by hand or with rubber-tired agricultural equipment.
3. Install all seed with a rangeland drill or no-till seeder (such as Truax Trillion or approved equal) where conditions permit. If hydroseeding is suggested as an alternative, service provider must demonstrate how their means and methods result in good seed to soil contact, and all hydroseeding materials (tackifier, mulch, etc.) are subject to TPWD requirements.
4. Hand-broadcast seed in areas that are difficult to access with large equipment.
5. Provide 1 cup of each seed mix to the ecologist for inspection and approval.
6. Mulch seeded areas with 1" native hay, if available.
7. Seeding on slopes greater than 5% shall receive 100% biodegradable erosion control jute netting or approved equal to control erosion.
8. Seeding on slopes greater than 10% shall receive 100% biodegradable straw logs in addition to the jute netting.
  - a. Straw logs shall be installed parallel to contour lines and spaced every 5' vertical feet on slopes.

### 3.4 MAINTENANCE AND PROTECTION

- A. General: Site shall be maintained and monitored for a minimum of two years. Seeded areas shall be regularly inspected—at least once a month—for germination and vigor of seeded species. Where there are areas of greater than 10 sq ft of non-natives or bare patches of greater than 10 sq ft, those areas will be treated, prepped and reseeded within 14 days or other time determined in conjunction with the landscape architect or ecologist. Maintenance of these areas includes and establish seeded areas by monitoring invasive species, avoiding mowing, reseeding, and performing other operations as required to establish a healthy plant community. Where there are areas of greater than 10 sq ft of non-natives or bare patches of greater than 10 sq ft, those areas will be treated, prepped and reseeded within 14 days or other time determined in conjunction with the landscape architect or ecologist. Maintenance and monitoring work during the construction period should provide materials and installation the same as those used in the original installation.
- B. Watering: There is no irrigation system or water on site. Water trucks must be utilized to haul water from off site. Contractor to seed disturbed areas as work progresses and take advantage of natural precipitation when possible. Contractor to convey water from sources and to keep seeded areas uniformly moist to a depth of 2 inches for the first two months following seeding. Reduce watering frequency as conditions permit.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
2. Use water truck where accessible from existing roads to maintain watering for the first two months after seeding.
3. Water seeded areas with fine spray at a minimum rate of 1/2 inch per week unless rainfall precipitation is adequate.
4. Water for 1 year or until successful establishment.

### 3.5 SATISFACTORY SEEDING

- A. Seedings shall meet the following criteria as determined by Landscape Architect or Ecologist:
  1. Satisfactory Seeding: At end of maintenance period, a healthy, well-rooted seeded area has been established, with no more than 5% cover of invasive species, and no greater than 5% bare areas. No area of non-native species and/or bare soil is greater than 10 sq ft.
- B. Use specified materials to reseed areas that do not comply with requirements and continue maintenance until seeding is satisfactory.

### 3.6 CLEANING

- A. Perform cleaning during installation and upon completion of work. Remove excess materials, debris, and equipment. Repair damage resulting from seeding.

END OF SECTION 329219

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## Item 105

# Removing Treated and Untreated Base and Asphalt Pavement



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### 1. DESCRIPTION

Break, remove, and store or dispose of existing asphalt pavement, including surface treatments, and treated or untreated base materials.

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### 2. CONSTRUCTION

Break material retained by the Department into pieces not larger than 24 in. unless otherwise shown on the plans. Remove existing asphalt pavement before disturbing stabilized base. Avoid contamination of the asphalt materials and damage to adjacent areas. Repair material damaged by operations outside the designated locations.

Stockpile materials designated salvageable at designated sites when shown on the plans or as directed. Prepare stockpile site by removing vegetation and trash and by providing for proper drainage. Material not designated to be salvaged will become the property of the Contractor. When this material is disposed of, do so in conformance with federal, state, and local regulations.

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### 3. MEASUREMENT

This Item will be measured by the 100-ft. station along the baseline of each roadbed, by the square yard of existing treated or untreated base and asphalt pavement in their original position, or by the cubic yard of existing treated or untreated base and asphalt pavement in their original position, as calculated by the average end area method or as shown on the plans. Square yard and cubic yard measurement will be established by the widths and depths shown on the plans and the lengths measured in the field.

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### 4. PAYMENT

The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Treated and Untreated Base and Asphalt Pavement" of the depth specified. This price is full compensation for breaking the material, loading, hauling, unloading, and stockpiling or disposing; repair to areas outside designated locations for removal; and equipment, labor, tools, and incidentals.

# Item 106

## Obliterating Abandoned Roadway




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### 1. DESCRIPTION

Obliterate designated sections of abandoned roadway.

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### 2. CONSTRUCTION

Strip and windrow existing topsoil before shaping operations. Remove asphaltic concrete pavement in conformance with applicable Item. Remove material designated as salvageable in conformance with applicable Items. Remove abandoned structures unless otherwise shown on the plans. Scarify and blend the abandoned roadbed with soil. Break down clods or lumps of material. Fill, cut, and shape the designated sections of the abandoned roadway to blend into the surrounding terrain. Eliminate ditches except where needed to facilitate drainage. Cover disturbed areas with topsoil after shaping operations to facilitate establishment of vegetation.

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### 3. MEASUREMENT

This Item will be measured by the 100-ft. station along the baseline of the abandoned roadway or by the square yard of the roadway in its original position.

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### 4. PAYMENT

The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Obliterating Abandoned Road." This price is full compensation for salvaging and replacing topsoil; stockpiling or disposing of materials; removing asphaltic concrete pavement; removing abandoned structures; scarifying, blending, and shaping abandoned roadway; furnishing and operating equipment; and labor, tools, and incidentals.

# Item 110

## Excavation



### 1. DESCRIPTION

Excavate areas as shown on the plans or as directed. Remove materials encountered to the lines, grades, and typical sections shown on the plans and cross-sections.

### 2. MATERIALS

Accept ownership of unsuitable or excess material and dispose of material in conformance with local, state, and federal regulations, at locations outside the right of way.

### 3. CONSTRUCTION

Maintain drainage in the excavated area to avoid damage to the roadway section. Correct any damage to the subgrade caused by weather at no additional cost to the Department.

Shape slopes to avoid loosening material below or outside the proposed grades. Remove and dispose of slides or slope failures as directed.

Excavate to the grade and sections shown on the plans. Manipulate and compact subgrade in accordance with Section 132.3.4., "Compaction Methods," unless excavation is to clean homogenous rock at final grade.

Correct unsuitable material encountered at or below subgrade as directed.

- 3.1. **Rock Cuts.** Use approved embankment material compacted in accordance with Section 132.3.4., "Compaction Methods," to replace undercut material at no additional cost if excavation extends below the grade shown on the plans.
- 3.2. **Earth Cuts.** Scarify remaining material to a depth at least 6 in. below the grade shown on the plans in areas where pavement structure will be placed. Compact subgrade in accordance with Section 132.3.4., "Compaction Methods."
- 3.3. **Acceptance Criteria.**
- 3.3.1. **Grade Tolerances.**
- 3.3.1.1. **Staged Construction.** Grade to within 1.25 in. in the cross-section and 1.25 in. in 16 ft. measured longitudinally.
- 3.3.1.2. **Turnkey Construction.** Grade to within 0.5 in. in the cross-section and 0.5 in. in 16 ft. measured longitudinally.

### 4. MEASUREMENT

This Item will be measured by the cubic yard in its original position as computed by the method of average end areas or as shown on the plans.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Limits of measurement for excavation in retaining wall areas will be as shown on the plans.

Shrinkage or swelling factors will not be considered in determining the calculated quantities.

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## 5. PAYMENT

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 "Excavation (Roadway)," "Excavation (Channel)," "Excavation (Special)," or "Excavation (Roadway and Channel)." This price is full compensation for authorized excavation; drying; undercutting subgrade in rock cuts and reworking or replacing the undercut material; hauling; disposal of material not used elsewhere on the project; scarification and compaction; and equipment, labor, materials, tools, and incidentals.

Drying subgrade deeper than 6 in. below grade as shown on the plans will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Excavation and replacement of unsuitable material below grade as shown on the plans will be performed and paid for in conformance with the applicable bid items. However, if Item 132, "Embankment," is not included in the Contract, payment for replacement of unsuitable material will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

Removing, reworking, reshaping, or re-laying existing pavement structure will be paid for in conformance with the appropriate item.

When a slide or slope failure not due to the Contractor's negligence or operation occurs, payment for removal and disposal of the slide material will be in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

Excavation in backfill areas of retaining walls will not be measured or paid for directly, but will be subsidiary to pertinent items.

# Item 132

## Embankment



### 1. DESCRIPTION

Furnish, place, and compact materials for construction of roadways, embankments, levees, dikes, or any designated section of the roadway where additional material is required.

### 2. MATERIALS

Furnish approved material capable of forming a stable embankment from required excavation in the areas shown on the plans or from sources outside the right of way. Provide one or more of the following types as shown on the plans.

- **Type A.** Granular material that is free of vegetation or other objectionable material and meets the requirements shown in Table 1.

**Table 1**  
**Testing Requirements**

Property	Test Method	Specification Limit
Liquid limit	<a href="#">Tex-104-E</a>	≤45
Plasticity index (PI)	<a href="#">Tex-106-E</a>	≤15
Bar linear shrinkage	<a href="#">Tex-107-E</a>	≥2

Perform the linear shrinkage test only as indicated in [Tex-104-E](#).

- **Type B.** Materials such as rock, loam, clay, or other approved materials.
- **Type C.** Material meeting the specification requirements shown on the plans. Type C may be further designated as Type C1, C2, etc.
- **Type D.** Material from required excavation areas shown on the plans.

Meet the requirements of the pertinent retaining wall Items for retaining wall backfill material.

### 3. CONSTRUCTION

Meet the requirements of Item 7, "Legal Relations and Responsibilities," when off right of way sources are used. Notify the Engineer before opening a material source to allow for required testing. Complete preparation of the right of way in accordance with Item 100, "Preparing Right of Way," for areas to receive embankment.

Backfill tree-stump holes or other minor excavations with approved material and tamp. Restore the ground surface, including any material disked loose or washed out, to its original slope. Compact the ground surface by sprinkling in accordance with Item 204, "Sprinkling," and by rolling using equipment complying with Item 210, "Rolling," when directed.

Scarify and loosen the unpaved surface areas, except rock, to a depth of at least 6 in. unless otherwise shown on the plans. Bench slopes before placing material. Begin placement of material at the toe of slopes. Do not place trees, stumps, roots, vegetation, or other objectionable material in the embankment. Simultaneously recompact scarified material with the placed embankment material. Do not exceed the layer depth specified in Section 132.3.4., "Compaction Methods."

Construct embankments to the grade and sections shown on the plans. Construct the embankment in layers approximately parallel to the finished grade for the full width of the individual roadway cross-sections unless otherwise shown on the plans. Ensure that each section of the embankment conforms to the detailed sections or slopes. Maintain the finished section, density, and grade until the project is accepted.

- 3.1. **Earth Embankments.** Earth embankment is mainly composed of material other than rock. Construct embankments in successive layers, evenly distributing materials in lengths suited for sprinkling and rolling.

Obtain approval to incorporate rock and broken concrete produced by the construction project in the lower layers of the embankment. Place the rock and concrete outside the limits of the completed roadbed when the size of approved rock or broken concrete exceeds the layer thickness requirements in Section 132.3.4., "Compaction Methods." Cut and remove all exposed reinforcing steel from the broken concrete.

Move the material dumped in piles or windrows by blading or by similar methods and incorporate it into uniform layers. Featheredge or blend abutting layers of dissimilar material for at least 100 ft. to ensure there are no abrupt changes in the material. Break down clods or lumps of material.

Apply water free of industrial wastes and other objectionable matter to achieve the uniform moisture content specified for compaction.

Roll and sprinkle each embankment layer in accordance with Section 132.3.4.1., "Ordinary Compaction," when ordinary compaction is specified. Compact the layer to the required density in accordance with Section 132.3.4.2., "Density and Moisture Control," when density control is specified.

- 3.2. **Rock Embankments.** Rock embankment is mainly composed of rock. Construct rock embankments in successive layers for the full width of the roadway cross-section with a depth of 18 in. or less. Increase the layer depth for large rock sizes as approved. Do not exceed a depth of 2-1/2 ft. in any case. Fill voids created by the large stone matrix with smaller stones during the placement and filling operations.

Ensure the depth of the embankment layer is greater than the maximum dimension of any rock. Do not place rock greater than 2 ft. in its maximum dimension, unless otherwise approved. Construct the final layer with graded material so that the density and uniformity are in accordance with Section 132.3.4., "Compaction Methods." Break up exposed oversized material as approved.

Roll and sprinkle each embankment layer in accordance with Section 132.3.4.1., "Ordinary Compaction," when ordinary compaction is specified. Compact each layer to the required density in accordance with Section 132.3.4.2., "Density and Moisture Control," when density control is specified. Proof-roll each rock layer as directed, where density testing is not possible, in accordance with Item 216, "Proof Rolling," to ensure proper compaction.

- 3.3. **Embankments Adjacent to Culverts and Bridges.** Compact embankments adjacent to culverts and bridges in accordance with Item 400, "Excavation and Backfill for Structures."

- 3.4. **Compaction Methods.** Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller. Begin rolling at the lower side and progress toward the high side on superelevated curves. Alternate roller trips to attain slightly different lengths. Compact embankments in accordance with Section 132.3.4.1., "Ordinary Compaction," or Section 132.3.4.2., "Density and Moisture Control," as shown on the plans.

- 3.4.1. **Ordinary Compaction.** Use approved rolling equipment complying with Item 210, "Rolling," to compact each layer. Use specific equipment when required by the Engineer or as shown on the plans. Do not allow the loose depth of any layer to exceed 8 in., unless otherwise approved. Bring each layer to the moisture content directed before and during rolling operations. Compact each layer until there is no evidence of further consolidation. Maintain a level layer to ensure uniform compaction. Recompact and refinish the subgrade at no additional expense to the Department if the required stability or finish is lost for any reason.

3.4.2. **Density and Moisture Control.** Compact each layer to the required density using equipment complying with Item 210. Determine the maximum lift thickness based on the ability of the compacting operation and equipment to meet the required density. Do not exceed layer thickness of 16 in. loose or 12 in. compacted material unless otherwise approved. Maintain a level layer to ensure uniform compaction.

The Engineer will use [Tex-114-E](#) to determine the maximum dry density ( $D_a$ ) and optimum moisture content ( $W_{opt}$ ). Meet the requirements for field density and moisture content shown in Table 2 unless otherwise shown on the plans.

**Table 2**  
**Field Density Control Requirements**

Description	Density	Moisture Content
	<a href="#">Tex-115-E</a>	
PI ≤15	≥98% $D_a$	–
15 <PI ≤35	≥98% $D_a$ and ≤102% $D_a$	≥ $W_{opt}$ .
PI > 35	≥ 95% $D_a$ and ≤100% $D_a$	≥ $W_{opt}$ .

Each layer is subject to testing by the Engineer for density and moisture content. Each layer must be brought to the moisture content necessary to obtain the required density and placed in a manner to ensure uniform compaction over the entire layer. The density and moisture contents for the descriptions shown in Table 2 are illustrated in the Moisture-Density Curve of [Tex-114-E](#).

Provide the Engineer with the beginning and ending station numbers of the area completed for testing. The Engineer will determine roadway density and moisture content of completed sections in accordance with [Tex-115-E](#), Part I. The Engineer will determine random locations for testing in accordance with [Tex-115-E](#), Part IV. When the density is less than the required density shown in Table 2, the Engineer may perform additional testing to determine the extent of the area to correct.

Remove small areas of the layer to allow for density tests as required. Replace the removed material and recompact at no additional expense to the Department. Proof-roll in accordance with Item 216, when shown on the plans or as directed. Correct soft spots as directed.

3.5. **Maintenance of Moisture and Reworking.** Maintain the density and moisture content once all requirements shown in Table 2 are met. Maintain the moisture content no lower than 4% below optimum for soils with a PI greater than 15. Rework the material to obtain the specified compaction when the material loses the required stability, density, moisture, or finish. Alter the compaction methods and procedures on subsequent work to obtain specified density as directed.

3.6. **Acceptance Criteria.**

3.6.1. **Grade Tolerances.**

3.6.1.1. **Staged Construction.** Grade to within 1.25 in. in the cross-section and 1.25 in. in 16 ft. measured longitudinally.

3.6.1.2. **Turnkey Construction.** Grade to within 0.5 in. in the cross-section and 0.5 in. in 16 ft. measured longitudinally.

3.6.2. **Gradation Tolerances.** Ensure no more than one of the five most recent gradation tests is outside the specified limits on any individual sieve by more than 5% when gradation requirements are shown on the plans.

3.6.3. **Density Tolerances.** Ensure no more than one of the five most recent density tests for compaction work is outside the specified density limits and no test is outside the limits by more than 3 pcf.

- 3.6.4. **Plasticity Tolerances.** Ensure no more than one of the five most recent PI tests for material is outside the specified limit by more than 2 points.

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#### 4. MEASUREMENT

Shrinkage or swell factors are the Contractor's responsibility. When shown on the plans, factors are for informational purposes only.

Measurement of retaining wall backfill in embankment areas will be paid for as embankment unless otherwise shown on the plans. Limits of measurement for embankment in retaining wall areas are shown on the plans.

Embankment will be measured by the cubic yard. Measurement will be further defined for payment as follows.

- 4.1. **Final.** The cubic yard will be measured in its final position using the average end area method or as shown on the plans. The volume is computed between the original ground surface or the surface upon which the embankment is to be constructed and the lines, grades, and slopes of the embankment. In areas of salvaged topsoil, payment for embankment will be made in accordance with Item 160, "Topsoil." Shrinkage or swell factors will not be considered in determining the calculated quantities.

When measured by the cubic yard in its final position, this is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

- 4.2. **Original.** The cubic yard will be measured in its original and natural position using the average end area method or as shown on the plans.

- 4.3. **Vehicle.** The cubic yard will be measured in vehicles at the point of delivery.

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#### 5. PAYMENT

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 "Embankment (Final)," "Embankment (Original)," or "Embankment (Vehicle)" of the compaction method and type specified. This price is full compensation for furnishing embankment; hauling; placing, compacting, finishing, and reworking; disposal of waste material; and equipment, labor, tools, and incidentals.

When proof rolling is directed, it will be paid for in accordance with Item 216.

All sprinkling and rolling, except proof rolling, will not be paid for directly, but will be subsidiary to this Item, unless otherwise shown on the plans.

In fill sections, excavation and replacement of unsuitable material below existing elevations will be performed and paid for in conformance with the applicable bid items. However, if Item 110, "Excavation," is not included in the Contract, payment for replacement of unsuitable material will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

When rework, removal, or scarification is required for existing pavement structure that will remain, it will be measured and paid for as shown on the plans for the appropriate type.

# Item 247

## Flexible Base



### 1. DESCRIPTION

Construct a foundation course composed of flexible base.

### 2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer may sample and test project materials at any time before compaction throughout the duration of the project to assure specification compliance.

- 2.1. **Aggregate.** Furnish aggregate of the type and grade shown on the plans and meeting the requirements shown in Table 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for the grade specified. Do not use additives, such as but not limited to lime, cement, or fly ash to modify aggregates to meet the requirements of Table 1, unless shown on the plans.

Unless otherwise shown on the plans, the unconfined compressive strength is waived when the flexible base material meets the #200 sieve requirement. When the #200 sieve requirement does not meet the specification in Table 1, the unconfined compressive strength is required.

**Table 1**  
**Material Requirements**

Property	Test Method	Grade 1-2 <sup>3</sup>	Grade 3	Grade 4	Grade 5
Master gradation sieve size (cumulative % retained)	Tex-110-E			As shown on the plans	
2-1/2"		0	0		0
1-3/4"		0-10	0-10		0-5
7/8"		10-35	-		10-35
3/8"		30-65	-		35-65
#4		45-75	45-75		45-75
#40		65-90	50-85		70-90
#200 <sup>1, 2</sup>		85-95	-		-
Liquid limit, % Max	Tex-104-E	40	40	35	
Plasticity index, Max	Tex-106-E	10	12	10	
Plasticity index, Min		As shown on the plans	As shown on the plans	As shown on the plans	
Wet ball mill, % Max	Tex-116-E	40	-	40	
Wet ball mill, % Max increase passing the #40 sieve		20	-	20	
Min compressive strength <sup>2</sup> , psi	Tex-117-E				
lateral pressure 0 psi		35	-	-	
lateral pressure 3 psi		-	-	90	
lateral pressure 15 psi		175	-	175	

- The #200 sieve test is only required to meet the waiver of the unconfined compressive strength requirement. The #200 sieve test requirement is only applicable to stockpile samples from Section 247.2.4.
- Compressive strength and #200 sieve requirements are waived when the flexible base is mixed with or without existing material and treated with cement, emulsion, foamed asphalt, or lime, unless otherwise shown on the plans.
- Grade 3 may be substituted for Grade 1-2 or Grade 5 when the flexible base is mixed with or without existing material and treated with cement, emulsion, foamed asphalt, or lime, as approved. The Grade 3 flexible base must meet the wet ball mill requirements of Grade 1-2 or Grade 5 as applicable.

- 2.1.1. **Material Tolerances.** The Engineer may accept material if no more than one of the five most recent gradation tests has an individual sieve outside the specified limits of the gradation. This allowance does not apply to the #200 sieve requirement.
- The Engineer may accept material if no more than one of the five most recent liquid limit or plasticity index tests is outside the specified limit. No single failing liquid limit or plasticity index test may exceed the allowable limit by more than 2 percentage points.
- 2.1.2. **Material Types.** Do not use fillers or binders unless approved. Furnish the type shown on the plans in accordance with the following.
- 2.1.2.1. **Type A.** Crushed stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source. Do not use gravel or multiple sources.
- 2.1.2.2. **Type B.** Crushed or uncrushed gravel. Blending of two or more sources is allowed.
- 2.1.2.3. **Type C.** Crushed gravel with a minimum of 60% of the particles retained on a No. 4 sieve with two or more crushed faces as determined in accordance with [Tex-460-A](#), Part I. Blending of two or more sources is allowed.
- 2.1.2.4. **Type D.** Type A material or crushed concrete. Crushed concrete containing gravel will be considered Type D material. Crushed concrete must meet the requirements of Section 247.2.1.2.6., "Recycled Material," and be managed in a way to provide for uniform quality. The Engineer may require separate dedicated stockpiles to verify compliance.
- 2.1.2.5. **Type E.** Caliche, iron ore, or as otherwise shown on the plans.
- 2.1.2.6. **Recycled Material.** Reclaimed asphalt pavement (RAP) and other recycled materials may be used when shown on the plans. Request approval to blend two or more sources of recycled materials. When RAP is allowed, do not exceed 20% RAP by weight, unless otherwise shown on the plans. The percentage limitations for other recycled materials will be as shown on the plans.
- Provide recycled materials, other than RAP, that have a maximum sulfate content of 3,000 ppm when tested in accordance with [Tex-145-E](#). Certify compliance with [DMS-11000](#), "Evaluating and Using Nonhazardous Recyclable Materials Guidelines." In addition, recycled materials must be free of reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with [Tex-413-A](#). The liquid limit, plasticity index, wet ball mill, and compressive strength for all recycled materials are waived. When using RAP, crush RAP so that 100% passes the 2-in. sieve and does not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with [Tex-406-A](#). Test RAP without removing the asphalt. The final product must meet the requirements shown in Table 1 for the grade specified except when the Department requires a specific amount of Department-furnished RAP be added to the blend, unless otherwise shown on the plans.
- The Contractor is responsible for uniformly blending the recycled material with the flexible base material to build a stockpile to meet the percentages required. Any Contractor-furnished surplus of recycled materials will remain the property of the Contractor. Remove Contractor-owned recycled materials from the project and dispose of them in accordance with federal, state, and local regulations before project acceptance.
- 2.2. **Water.** Furnish water free of industrial wastes and other objectionable matter.
- 2.3. **Material Sources.** Expose the vertical faces of all strata of material proposed for use when non-commercial sources are used. Secure and process the material by successive vertical cuts extending through all exposed strata, when directed.
- 2.4. **Stockpile Approval.** Stockpile is approved when the Engineer's test results meet the material requirements shown in Table 1.

- 2.4.1. **Sampling.** The Contractor and the Engineer will sample flexible base from completed stockpiles in accordance with [Tex-100-E](#). Personnel conducting sampling must be certified by the Department-approved soils and base certification program.

Sampling stockpiles may be located at the production site or at the project location. The Contractor will witness the Engineer's sampling and sample the stockpile for their own testing, and label as deemed necessary.

Sample the stockpile for the Engineer when shown on the plans. When the Contractor samples the stockpile for the Engineer, the Engineer must witness the sampling of material designated for the Engineer and the Materials and Tests Division (MTD). The Engineer will label their sampling containers as "Engineer" and "MTD," or as deemed necessary.

The Engineer will take immediate possession of the sample containers for the Engineer and MTD. The Engineer will maintain custody of the samples until all testing and reporting are completed.

- 2.4.2. **Referee Testing.** Referee testing is applicable for stockpile testing only. MTD is the referee laboratory. MTD may designate a laboratory from the Department's MPL for Commercial Laboratories Approved for Flexible Base Referee Requests as the referee laboratory as deemed necessary. The designated laboratory cannot be performing any testing under this Item for the Engineer or Contractor.

The Contractor may request referee testing when the Engineer's test results fail to meet any of the material requirements shown in Table 1 and the Contractor's sample from Section 2.4.1., "Sampling," for the same failing Department test, passes. The tests must be performed by a laboratory listed on the Department's MPL for Commercial Laboratories Approved for Flexible Base Referee Requests. Submit the request by email within 5 working days after receiving failing test results from the Engineer. Include completed test reports passing the applicable requirements shown in Table 1 in the email.

Record and submit completed test reports electronically on Department-provided templates in their original format meeting the applicable material requirements shown in Table 1. Use Department-provided templates to record and calculate all test data. The Engineer and the Contractor will provide any available test results to the other party when requested.

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### 3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work.

- 3.1. **Rollers.** Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with Item 216, "Proof Rolling," when required.
- 3.2. **Inertial Profiler.** When ride quality measurement is required, provide a high-speed or lightweight inertial profiler certified at the Texas A&M Transportation Institute. Provide equipment certification documentation. Display a current decal on the equipment indicating the certification expiration date.

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### 4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

Stockpile base material temporarily at an approved location before delivery to the roadway. Build stockpiles in layers no greater than 2 ft. thick. Stockpiles must have a total height between 10 and 16 ft. unless otherwise approved. After construction and acceptance of the stockpile in accordance with Section 247.2.4., "Stockpile Approval," loading from the stockpile for delivery is allowed. Load by making successive vertical cuts through the entire depth of the stockpile.

Do not add or remove material from temporary stockpiles that require sampling and testing before delivery, unless otherwise approved. Charges for additional sampling and testing required as a result of adding or removing material will be deducted from the Contractor's estimates.

Haul approved flexible base in clean trucks. Deliver the required quantity to each 100-ft. station or designated stockpile site as shown on the plans. Prepare stockpile sites as directed. When delivery is to the 100-ft. station, manipulate in conformance with the applicable Items.

- 4.1. **Preparation of Subgrade or Existing Base.** Remove or scarify existing asphalt concrete pavement in accordance with Item 105, "Removing Treated and Untreated Base and Asphalt Pavement," when shown on the plans or as directed. Shape the subgrade or existing base to conform to the typical sections shown on the plans or as directed.

When new base is required to be mixed with existing base, deliver, place, and spread the new flexible base in the required amount per station. Manipulate and thoroughly mix the new base with existing material to provide a uniform mixture to the specified depth before shaping.

Proof roll the roadbed in accordance with Item 216 before pulverizing or scarifying when shown on the plans or directed. Correct soft spots as directed.

- 4.2. **Placing.** Spread and shape flexible base into a uniform layer using an approved spreader the same day as delivered unless otherwise approved. Construct layers to the thickness shown on the plans. Maintain the shape of the course. Control dust by sprinkling, as directed. Correct or replace segregated areas as directed at no additional expense to the Department.

Place successive base courses and finish courses using the same construction methods required for the first course.

- 4.3. **Compaction.** Compact using density control unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. When necessary, sprinkle the material in accordance with Item 204, "Sprinkling." Maintain moisture during compaction within  $\pm 2.0\%$  of the optimum moisture content as determined in accordance with [Tex-113-E](#).

Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller unit. Begin rolling at the low side and progress toward the high side on superelevated curves. Offset alternating trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish requirements before the next course is placed or the project is accepted. Continue work until specification requirements are met. Perform the work at no additional expense to the Department.

Before final acceptance, the Engineer will select the locations of tests and measure the flexible base depth in accordance with [Tex-140-E](#). Correct areas deficient by more than 1/2 in. in thickness by scarifying, adding material as required, reshaping, recompacting, and refinishing at the Contractor's expense.

- 4.3.1. **Ordinary Compaction.** Roll using approved compaction equipment as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing approved material as required, reshaping, and recompacting.

- 4.3.2. **Density and Moisture Control.** Compact to a minimum of 100% of the maximum dry density and within  $\pm 2.0\%$  of the optimum moisture content as determined in accordance with [Tex-113-E](#), unless otherwise shown on the plans. Provide the Engineer with the beginning and ending station numbers of the area completed for testing. The Engineer will determine roadway density and moisture content of completed sections in accordance with [Tex-115-E](#), Part I. The Engineer will determine random locations for testing in accordance with [Tex-115-E](#), Part IV. Do not achieve density by drying the material after compaction.

When the density is less than 100% of the maximum dry density, the Engineer may perform additional testing to determine the extent of the area to correct. The Engineer may accept the section if no more than one of the five most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

- 4.3.3. **Miscellaneous and Small Areas.** Miscellaneous areas are those that typically involve handwork or discontinuous paving operations, such as temporary detours, driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous and small areas are not subject to density testing but may be tested as directed.
- 4.4. **Finishing.** After completing compaction, clip, skin, or tight-blade the surface using a maintainer or subgrade trimmer to a depth of approximately 1/4 in. Remove loosened material and dispose of it at an approved location. Seal the clipped surface immediately by rolling using a pneumatic tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades as shown on the plans or as directed.

Correct grade deviations greater than 1/4 in. in 16 ft. measured longitudinally. Correct grade deviations greater than 1/4 in. over the entire width of the cross-section in areas where surfacing is to be placed. Correct by loosening and adding or removing material. Reshape and recompact in accordance with Section 247.4.3., "Compaction."

- 4.5. **Curing.** Cure the finished section until the moisture content is at least 2 percentage points below optimum or as directed before applying the next successive course or prime coat.
- 4.6. **Ride Quality.** Measurement of ride quality only applies to the final travel lanes that receive a one- or two-course surface treatment for the final riding surface, unless otherwise shown on the plans. Measure the ride quality of the base course either before or after the application of the prime coat, as directed, and before placement of the surface treatment. Use a certified profiler operator listed on the Department's MPL. When requested, furnish the Engineer with documentation for the person certified to operate the profiler.

Provide all profile data to the Engineer in electronic data files within 3 days of measuring the ride quality using the format specified in [Tex-1001-S](#). The Engineer will use Department software to evaluate longitudinal profiles to determine areas requiring corrective action. Correct 0.1-mi. sections with an average international roughness index (IRI) value greater than 100 in. per mile to an IRI value of 100 in. per mile or less, unless otherwise shown on the plans. Reprofile and correct sections that fail to maintain ride quality before the placement of the surface treatment, as directed. Unless ride deterioration is due to environmental impact, traffic, or other incidents outside the Contractor's control, perform this work at no additional expense to the Department, as approved.

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## 5. MEASUREMENT

Flexible base will be measured as follows.

- **Flexible Base (Complete in Place).** The ton, square yard, or any cubic yard method.
- **Flexible Base (Roadway Delivery).** The ton or any cubic yard method.
- **Flexible Base (Stockpile Delivery).** The ton, cubic yard in vehicle, or cubic yard in stockpile.

Measurement by the cubic yard in final position and square yard is a plans quantity measurement. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Measurement is further defined for payment as follows.

- 5.1. **Cubic Yard in Vehicle.** By the cubic yard in vehicles of uniform capacity at the point of delivery.

- 5.2. **Cubic Yard in Stockpile.** By the cubic yard in the final stockpile position, by the method of average end areas, or as shown on the plans.
- 5.3. **Cubic Yard in Final Position.** By the cubic yard in the completed and accepted final position. The volume of base course is computed in place by the method of average end areas between the original subgrade or existing base surfaces and the lines, grades, and slopes of the accepted base course, or as shown on the plans.
- 5.4. **Square Yard.** By the square yard of surface area in the completed and accepted final position. The surface area of the base course is based on the width of flexible base, or as shown on the plans.
- 5.5. **Ton.** By the ton of dry weight in vehicles as delivered. The dry weight is determined by deducting the weight of the moisture in the material at the time of weighing from the gross weight of the material. The Engineer will determine the moisture content in the material in accordance with [Tex-103-E](#) from samples taken at the time of weighing.

When material is measured in trucks, the weight of the material will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at an approved location. Scales must meet the requirements of Item 520, "Weighing and Measuring Equipment."

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## 6. PAYMENT

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 types of work described below. No additional payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans for cubic yard in the final position or square yard measurement.

Sprinkling and rolling, except proof rolling, will not be paid for directly, but will be subsidiary to this Item unless otherwise shown on the plans. When proof rolling is shown on the plans or directed, it will be paid for in accordance with Item 216.

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade will be paid in conformance with pertinent Items or in accordance with Article 4.4., "Changes in the Work."

- 6.1. **Flexible Base (Complete in Place).** Payment will be made for the type and grade specified. For cubic yard measurement, "In Vehicle," "In Stockpile," or "In Final Position" will be specified. For square yard measurement, a depth will be specified. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement, loading, hauling, delivery of materials, spreading, blading, mixing, shaping, placing, compacting, reworking, finishing, correcting locations where thickness is deficient, curing, furnishing scales and labor for weighing and measuring, equipment, labor, tools, and incidentals.
- 6.2. **Flexible Base (Roadway Delivery).** Payment will be made for the type and grade specified. For cubic yard measurement, "In Vehicle," "In Stockpile," or "In Final Position" will be specified. The unit price bid will not include processing at the roadway. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement, loading, hauling, delivery of materials, furnishing scales and labor for weighing and measuring, equipment, labor, tools, and incidentals.
- 6.3. **Flexible Base (Stockpile Delivery).** Payment will be made for the type and grade specified. For cubic yard measurement, "In Vehicle" or "In Stockpile" will be specified. The unit price bid will not include processing at the roadway. This price is full compensation for furnishing and disposing of materials, preparing the stockpile area, temporary or permanent stockpiling, assistance provided in stockpile sampling and operations to level

stockpiles for measurement, loading, hauling, delivery of materials to the stockpile, furnishing scales and labor for weighing and measuring, equipment, labor, tools, and incidentals.

# Item 300

## Asphalts, Oils, and Emulsions



### 1. DESCRIPTION

Provide asphalt cements, cutback and emulsified asphalts, performance-graded asphalt binders, and other miscellaneous asphalt materials as shown on the plans.

### 2. MATERIALS

Provide asphalt materials that meet the stated requirements when tested in conformance with the referenced Department, AASHTO, and ASTM test methods. Use asphalt containing recycled materials only if the recycled components meet the requirements of Article 6.9., "Recycled Materials." Provide asphalt materials that the Department has preapproved for use in accordance with [Tex-545-C](#).

Inform the Department of all additives or modifiers included in the asphalt binder as part of the facility quality plan, as required by [Tex-545-C](#), and provide that information to Department personnel. The Department reserves the right to prohibit the use of any asphalt additive or modifier.

Limit the use of polyphosphoric acid to no more than 0.5% by weight of the asphalt binder.

The use of re-refined engine oil bottoms is prohibited.

Acronyms used in this Item are defined in Table 1.

**Table 1**  
**Acronyms**

Acronym	Definition
<b>Test Procedure Designations</b>	
Tex	Department
T or R	AASHTO
D	ASTM
<b>Polymer Modifier Designations</b>	
P	polymer-modified
SBS	styrene-butadiene-styrene block co-polymer
TR	tire rubber modifier (obtained from ground truck and passenger vehicle post-consumer tires)
AC	asphalt cement
AE	asphalt emulsion
AE-P	asphalt emulsion prime
A-R	asphalt-rubber
ARA	emulsified asphalt recycling agent
C	cationic
CRM	crumb rubber modifier
CSS	cationic slow setting
EAP&T	emulsified asphalt prime and tack
EBL	emulsified bonding layer
FDR	full-depth reclamation
H-suffix	harder residue (lower penetration)
HA	hot-applied
HF	high float
HRSS	hard residue surface sealant
HY	high yield

Acronym	Definition
MC	medium-curing
MS	medium-setting
MSCR	multiple stress creep recovery
NT	non-tracking
PCE	prime, cure, and erosion control
PG	performance grade
RC	rapid-curing
RS	rapid-setting
S-suffix	stockpile usage
SCM	special-use cutback material
SS	slow-setting
SY	standard yield
TRAIL	tracking resistant asphalt interlayer

2.1. **Asphalt Cement.** Provide AC that is homogeneous, water-free, and non-foaming when heated to 347°F, and in accordance with Table 2.

**Table 2  
Asphalt Cement**

Property	Test Procedure	Viscosity Grade			
		AC-0.6		AC-1.5	
		Min	Max	Min	Max
Viscosity 140°F, poise 275°F, poise	T 202	40	80	100	200
		0.4	–	0.7	–
Penetration, 77°F, 100g, 5 sec.	T 49	350	–	250	–
Flash point, C.O.C., °F	T 48	425	–	425	–
Solubility, %	T 44	99.0	–	99.0	–
Spot test	<a href="#">Tex-509-C</a>	Neg.		Neg.	
Tests on residue from RTFOT:	T 240				
Viscosity, 140°F, poise	T 202	–	400	–	1,000
Ductility, <sup>1</sup> 77°F 5 cm/min., cm	T 51	100	–	100	–

1. If AC-0.6 or AC-1.5 ductility at 77°F is less than 100 cm, material is acceptable if ductility at 60°F is more than 100 cm.

2.2. **Polymer-Modified Asphalt Cement.** Provide polymer-modified AC that is smooth, homogeneous, and meets the requirements shown in Table 3. Supply samples of the base AC and polymer additives if requested.

**Table 3**  
**Polymer-Modified Asphalt Cement**

Property	Test Procedure	Polymer-Modified Viscosity Grade											
		AC-12-5TR		NT-HA <sup>1</sup>		AC-15P		AC-20XP		AC-10-2TR		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Polymer		TR		-		SBS		SBS		TR		TR	
Polymer content, % (solids basis)	<a href="#">Tex-533-C</a> or <a href="#">Tex-553-C</a>	5.0	-	-	-	3.0	-	-	-	2.0	-	5.0	-
Dynamic shear, G*/sin δ, 82°C, 10 rad/s, kPa	T 315	-	-	1.0	-	-	-	-	-	-	-	-	-
Dynamic shear, G*/sin δ, 64°C, 10 rad/s, kPa	T 315	-	-	-	-	-	-	1.0	-	-	-	1.0	-
Dynamic shear, G*/sin δ, 58°C, 10 rad/s, kPa	T 315	1.0	-	-	-	-	-	-	-	1.0	-	-	-
Viscosity													
140°F, poise	T 202	1,200	-	-	-	1,500	-	2,000	-	1,000	-	2,000	-
275°F, poise	T 202	-	-	-	-	-	8.0	-	-	-	8.0	-	10.0
275°F, Pa-s	T 316	-	-	-	4.0	-	-	-	-	-	-	-	-
Penetration, 77°F, 100 g, 5 sec.	T 49	110	150	-	25	100	150	75	115	95	130	75	115
Elastic recovery, 50°F, %	<a href="#">Tex-539-C</a>	55	-	-	-	55	-	55	-	30	-	55	-
Polymer separation	<a href="#">Tex-540-C</a>	None		-		None		None		None		None	
Flash point, C.O.C., °F	T 48	425	-	425	-	425	-	425	-	425	-	425	-
Tests on residue from RTFOT aging and pressure aging:	T 240 and R 28												
Creep stiffness	T 313												
S, -18°C, MPa		-	300	-	-	-	300	-	300	-	300	-	300
m-value, -18°C		0.300	-	-	-	0.300	-	0.300	-	0.300	-	0.300	-

1. This is a hot-applied TRAIL product.

2.3. **Cutback Asphalt.** Provide cutback asphalt that meets the requirements shown in Tables 4, 5, and 6 for the specified type and grade. Supply samples of the base AC and polymer additives if requested.

**Table 4**  
**Rapid-Curing Cutback Asphalt**

Property	Test Procedure	Type-Grade	
		RC-250	
		Min	Max
Kinematic viscosity, 140°F, cSt	T 201	250	400
Water, %	D95	-	0.2
Flash point, T.O.C., °F	T 79	80	-
Distillation test:	T 78		
Distillate, percentage by volume of total distillate to 680°F			
to 437°F		40	75
to 500°F		65	90
to 600°F		85	-
Residue from distillation, volume %		70	-
Tests on distillation residue:			
Viscosity, 140°F, poise	T 202	600	2,400
Ductility, 5 cm/min., 77°F, cm	T 51	100	-
Solubility, %	T 44	99.0	-
Spot test	<a href="#">Tex-509-C</a>	Neg.	

**Table 5  
Medium-Curing Cutback Asphalt**

Property	Test Procedure	Type-Grade					
		MC-30		MC-800		MC-3000	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140°F, cSt	T 201	30	60	800	1,600	3,000	6,000
Water, %	D95	–	0.2	–	0.2	–	0.2
Flash point, T.O.C., °F	T 79	95	–	140	–	149	–
Distillation test:	T 78						
Distillate, percentage by volume of total distillate to 680°F							
to 437°F		–	35	–	–	–	–
to 500°F		30	75	–	40	–	15
to 600°F		75	95	45	85	15	75
Residue from distillation, volume %		50	–	75	–	80	–
Tests on distillation residue:							
Viscosity, 140°F, poise	T 202	300	1,200	300	1,200	300	1,200
Ductility, 5 cm/min., 77°F, cm	T 51	100	–	100	–	100	–
Solubility, %	T 44	99.0	–	99.0	–	99.0	–
Spot test	<a href="#">Tex-509-C</a>		Neg.		Neg.		Neg.

**Table 6  
Special-Use Cutback Asphalt**

Property	Test Procedure	Type-Grade	
		SCM I	
		Min	Max
Kinematic viscosity, 140°F, cSt	T 201	500	1,000
Water, %	D95	–	0.2
Flash point, T.O.C., °F	T 79	175	–
Distillation test:	T 78		
Distillate, percentage by volume of total distillate to 680°F			
to 437°F		–	–
to 500°F		–	0.5
to 600°F		20	60
Residue from distillation, volume %		76	–
Tests on distillation residue:			
Penetration, 100 g, 5 sec., 77°F	T 49	180	–
Solubility, %	T 44	99.0	–

2.4. **Emulsified Asphalt.** Provide emulsified asphalt that is homogeneous, does not separate after thorough mixing, and meets the requirements for the specified type and grade shown in Tables 7, 8, 9, 10, and 10A–C.

**Table 7  
Emulsified Asphalt**

Property	Test Procedure	Type-Grade							
		Rapid-Setting		Medium-Setting		Slow-Setting			
		HFRS-2		MS-2		SS-1		SS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	- 150	- 400	- 100	- 300	20 -	100 -	20 -	100 -
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1
Miscibility	T 59	-		-		Pass		Pass	
Cement mixing, %	T 59	-	-	-	-	-	2.0	-	2.0
Demulsibility, 35 mL of 0.02 N CaCl <sub>2</sub> , %	T 59	50	-	-	30	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	1	-	1
Freezing test, 3 cycles <sup>1</sup>	T 59	-		Pass		Pass		Pass	
Distillation test:	T 59								
Residue by distillation, % by wt.		65	-	65	-	60	-	60	-
Oil distillate, % by volume of emulsion		-	0.5	-	0.5	-	0.5	-	0.5
Tests on residue from distillation:									
Penetration, 77°F, 100 g, 5 sec.	T 49	100	140	90	160	90	160	40	100
Solubility, %	T 44	97.5	-	97.5	-	97.5	-	97.5	-
Ductility, 77°F, 5 cm/min., cm	T 51	100	-	100	-	100	-	80	-
Float test, 140°F, sec.	T 50	1,200	-	-	-	-	-	-	-

1. Applies only when the Engineer designates material for winter use.

**Table 8  
Cationic Emulsified Asphalt**

Property	Test Procedure	Type-Grade							
		Rapid-Setting		Medium-Setting		Slow-Setting			
		CRS-2		CMS-2		CSS-1		CSS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	- 150	- 400	- 100	- 350	20 -	100 -	20 -	100 -
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1
Cement mixing, %	T 59	-	-	-	-	-	0.2	-	0.2
Coating ability and water resistance:									
Dry aggregate/after spray	T 59	-		Good/Fair		-		-	
Wet aggregate/after spray		-		Fair/Fair		-		-	
Demulsibility, 35 mL of 0.8% Sodium dioctyl sulfosuccinate, %	T 59	70	-	-	-	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	1	-	1
Particle charge	T 59	Positive		Positive		Positive		Positive	
Distillation test:									
Residue by distillation, % by wt.	T 59	65	-	65	-	60	-	60	-
Oil distillate, % by volume of emulsion		-	0.5	-	7	-	0.5	-	0.5
Tests on residue from distillation:									
Penetration, 77°F, 100 g, 5 sec.	T 49	90	160	90	200	90	160	40	110
Solubility, %	T 44	97.5	-	97.5	-	97.5	-	97.5	-
Ductility, 77°F, 5 cm/min., cm	T 51	100	-	100	-	100	-	80	-

**Table 9**  
**Polymer-Modified Emulsified Asphalt**

Property	Test Procedure	Type-Grade	
		Rapid-Setting	
		HFRS-2P	
		Min	Max
Viscosity, Saybolt Furol 122°F, sec.	T 72	150	400
Sieve test, %	T 59	–	0.1
Demulsibility, 35 mL of 0.02 N CaCl <sub>2</sub> , %	T 59	50	–
Storage stability, 1 day, %	T 59	–	1
Distillation test: <sup>1</sup>	T 59		
Residue by distillation, % by wt.		65	–
Oil distillate, % by volume of emulsion		–	0.5
Tests on residue from distillation:			
Polymer content, wt. % (solids basis)	<a href="#">Tex-533-C</a>	3.0	–
Penetration, 77°F, 100 g, 5 sec.	T 49	90	140
Solubility, %	T 44	97.0	–
Viscosity, 140°F, poise	T 202	1,500	–
Float test, 140°F, sec.	T 50	1,200	–
Ductility, <sup>2</sup> 39.2°F, 5 cm/min., cm	T 51	50	–
Elastic recovery, <sup>2</sup> 50°F, %	<a href="#">Tex-539-C</a>	55	–

- Exception to T 59: Bring the temperature on the lower thermometer slowly to 350 ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from the first application of heat.
- HFRS-2P must meet one of either the ductility or elastic recovery requirements.

**Table 10**  
**Polymer-Modified Cationic Emulsified Asphalt**

Property	Test Procedure	Type-Grade											
		Rapid-Setting						Medium-Setting				Slow-Setting	
		CRS-2P		CHFRS-2P		CRS-2TR		CMS-1P <sup>3</sup>		CMS-2P <sup>3</sup>		CSS-1P	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	-	-	-	-	-	-	10	100	-	-	20	100
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Demulsibility, 35 ml of 0.8% sodium dioctyl sulfosuccinate, %	T 59	70	-	60	-	40	-	-	-	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	1	-	1	-	1	-	1
Particle charge	T 59	Positive		Positive		Positive		Positive		Positive		Positive	
Distillation test <sup>1</sup> :	T 59												
Residue by distillation, % by weight		65	-	65	-	65	-	30	-	60	-	62	-
Oil distillate, % by volume of emulsion		-	0.5	-	0.5	-	3	-	0.5	-	0.5	-	0.5
Tests on residue from distillation:													
Polymer content, wt. % (solids basis)	<a href="#">Tex-533-C</a> or <a href="#">Tex-553-C</a>	3.0	-	3.0	-	5.0 <sup>4</sup>	-	-	-	-	-	3.0	-
Penetration, 77°F, 100 g, 5 sec.	T 49	90	150	80	130	90	150	30	-	30	-	55	90
Viscosity, 140°F, poise	T 202	1,300	-	1,300	-	1,000	-	-	-	-	-	-	-
Solubility, %	T 44	97.0	-	95.0	-	98	-	-	-	-	-	97.0	-
Ductility, 77°F, 5 cm/min., cm	T 51	-	-	-	-	40	-	-	-	-	-	70	-
Float test, 140°F, sec.	T 50	-	-	1,800	-	-	-	-	-	-	-	-	-
Ductility, <sup>2</sup> 39.2°F, 5 cm/min., cm	T 51	50	-	-	-	-	-	-	-	-	-	-	-
Elastic recovery, <sup>2</sup> 50°F, %	<a href="#">Tex-539-C</a>	55	-	55	-	-	-	-	-	-	-	-	-
Tests on residue from evaporative recovery:	R 78, Procedure B												
Nonrecoverable creep compliance of residue, 3.2 kPa, 52°C, kPa <sup>-1</sup>	T 350	-	-	-	-	-	-	-	2.0	-	4.0	-	-

1. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350 ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from the first application of heat.
2. CRS-2P must meet one of either the ductility or elastic recovery requirements.
3. With all precertification samples of CMS-1P or CMS-2P, submit certified test reports showing the type and percent of rejuvenator and/or latex added. Submit samples of these raw materials if requested by the Engineer.
4. Modifier type is TR. Determined in accordance with [Tex-553-C](#).

**Table 10A**  
**Non-Tracking Tack Coat Emulsion<sup>1</sup>**

Property	Test Procedure	NT-HRE		NT-RRE		NT-SRE	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol, 77°F, sec.	T 72	15	-	15	-	10	100
Storage stability, 1 Day, %	T 59	-	1	-	1	-	1
Settlement, 5-day, %	T 59	-	5	-	5	-	5
Sieve test, %	T 59	-	0.30	-	0.30	-	0.1
Distillation test: <sup>2</sup>	T 59						
Residue by distillation, % by wt.		50	-	58	-	50	-
Oil distillate, by volume of emulsion		-	1.0	-	1.0	-	1.0
Test on residue from distillation:							
Penetration, 77°F, 100 g, 5 sec.	T 49	-	20	15	45	40	90
Solubility, %	T 44	97.5	-	97.5	-	97.5	-
Dynamic shear, G*/sin(δ), 82°C, 10 rad/s, kPa	T 315	1.0	-	-	-	-	-

1. These are emulsion-based TRAILs. Due to the hardness of the residue, these emulsions should be heated to 120–140° F prior to thorough mixing as the emulsion is being prepared for testing.
2. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350 ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from first application of heat.

**Table 10B**  
**Spray-Applied Underseal Membrane Polymer-Modified Emulsions**

Property	Test Procedure	EBL	
		Min	Max
Viscosity @ 77°F, SSF	T 72	20	100
Storage Stability <sup>1</sup> , %	T 59	–	1
Demulsibility <sup>2</sup> Anionic emulsions — 35 mL of 0.02 N CaCl <sub>2</sub> , % Cationic emulsions — 35 mL 0.8% sodium dioctyl sulfosuccinate, %	T 59	55	–
Sieve Test <sup>3</sup> , %	T 59	–	0.05
Distillation Test <sup>4</sup> Residue by distillation, % by wt. Oil portion of distillate, % by vol.	T 59	63 –	– 0.5
Test on Residue from Distillation Elastic Recovery @ 50°F, 50 mm/min., % Penetration @ 77°F, 100 g, 5 sec, 0.1 mm	<a href="#">Tex-539-C</a> T 49	60 80	– 130

1. After standing undisturbed for 24 hr., the surface must be smooth, must not exhibit a white or milky colored substance, and must be a homogeneous color throughout.
2. Material must meet demulsibility test for emulsions.
3. May be required by the Engineer only when the emulsion cannot be easily applied in the field.
4. The temperature on the lower thermometer should be brought slowly to 350 ± 10°F and maintained at this temperature for 20 min. The total distillation should be completed in 60 ± 5 min. from the first application of heat.

**Table 10C**  
**Full-Depth Reclamation Emulsion**

Property	Test Procedure	Standard Yield (FDR EM-SY)		High Yield (FDR EM-HY) <sup>2</sup>	
		Min	Max	Min	Max
Viscosity Saybolt Furol @ 77°F, sec.	T 72	20	100	20	100
Sieve test, %	T 59	–	0.1	–	0.1
Cement mixing, %	T 59	–	2.0	–	2.0
% Storage stability, 1 day, %	T 59	–	1	–	1
Distillation test <sup>1</sup> : Residue by distillation, % by wt. Oil portion of distillate, % by vol.	T 59	60 –	– 0.5	63 –	– 0.5
Test on residue from distillation: Penetration @ 77°F, dmm	T 49	40	95	120	–

1. The temperature on the lower thermometer should be brought slowly to 350 ± 10°F and maintained at this temperature for 20 min. The total distillation should be completed in 60 ± 5 min. from the first application of heat.
2. Provide a manufacturer's certificate of analysis (COA) with the type and percent of rejuvenator added.

2.5.

**Specialty Emulsions.** Provide specialty emulsion that is either asphalt-based or resin-based and meets the requirements shown in Table 11 or Table 11A.

**Table 11  
Specialty Emulsions**

Property	Test Procedure	Type-Grade					
		Medium-Setting				Slow-Setting	
		AE-P		EAP&T		PCE <sup>1</sup>	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	-	-	-	-	10	100
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1
Miscibility <sup>2</sup>	T 59	-		Pass		Pass	
Demulsibility, 35 mL of 0.10 N CaCl <sub>2</sub> , %	T 59	-	70	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	-
Particle size, <sup>5</sup> % by volume < 2.5 μm	<a href="#">Tex-238-F<sup>3</sup></a>	-	-	90	-	90	-
Asphalt emulsion distillation to 500°F followed by Cutback asphalt distillation of residue to 680°F: Residue after both distillations, % by wt. Total oil distillate from both distillations, % by volume of emulsion	T 59 and T 78	40	-	-	-	-	-
		25	40	-	-	-	-
Residue by distillation, % by wt.	T 59	-	-	60	-	-	-
Residue by evaporation, <sup>4</sup> % by wt.	T 59	-	-	-	-	60	-
Tests on residue after all distillation(s): Viscosity, 140°F, poise Kinematic viscosity, <sup>5</sup> 140°F, cSt Flash point C.O.C., °F Solubility, % Float test, 122°F, sec.	T 202 T 201 T 48 T 44 T 50	- - - 97.5 50	- - - - 200	800 - - - -	- - - - -	- 100 400 - -	- 350 - - -

1. Supply with each shipment of PCE:
  - a copy of a lab report from an approved analytical lab, signed by a lab official, indicating the PCE formulation does not meet any characteristics of a Resource Conservation Recovery Act (RCRA) hazardous waste;
  - a certification from the producer that the formulation supplied does not differ from the one tested and that no listed RCRA hazardous wastes or Polychlorinated Biphenyls have been mixed with the product; and
  - a Safety Data Sheet.
2. Exception to T 59: In dilution, use 350 mL of distilled or deionized water and a 1,000-mL beaker.
3. Use [Tex-238-F](#), beginning at "Particle Size Analysis by Laser Diffraction," with distilled or deionized water as a medium and no dispersant, or use another approved method.
4. Exception to T 59: Leave sample in the oven until foaming ceases, then cool and weigh.
5. PCE must meet either the kinematic viscosity requirement or the particle size requirement.

**Table 11A**  
**Hard Residue Surface Sealant**

Property	Test Procedure	HRSS	
		Min	Max
Viscosity, Krebs unit, 77°F, Krebs units	D 562	45	75
Softening point, °F	<a href="#">Tex-505-C</a> <sup>1</sup>	250	–
Uniformity	D 2939	Pass <sup>2</sup>	
Resistance to heat	D 2939	Pass <sup>3</sup>	
Resistance to water	D 2939	Pass <sup>4</sup>	
Wet flow, mm	D 2939	–	0
Resistance to Kerosene (optional) <sup>5</sup>	D 2939	Pass <sup>6</sup>	
Ultraviolet exposure, UVA-340, 0.77 W/m <sup>2</sup> , 50°C chamber, 8 hr. UV lamp, 5 min. spray, 3 hr. 55 min. condensation, 1,000 hr. total exposure <sup>7</sup>	G 154	Pass <sup>8</sup>	
Abrasion loss, 1.6 mm thickness, liquid only, %	ISSA TB-100	–	1.0
Residue by evaporation, % by weight	D 2939	33	–
Tests on residue from evaporation:			
Penetration, 77°F, 100 g, 5 sec.	T 49	15	30
Flash point, Cleveland open cup, °F	T 48	500	–
Tests on base asphalt before emulsification			
Solubility, %	T 44	98	–

- Cure the emulsion in the softening point ring in a 200 ± 5°F oven for 2 hr.
- Product must be homogenous and show no separation or coagulation that cannot be overcome by moderate stirring.
- No sagging or slippage of film beyond the initial reference line.
- No blistering or re-emulsification.
- Recommended for airport applications or where fuel resistance is desired.
- No absorption of Kerosene into the clay tile past the sealer film. Note sealer surface condition and loss of adhesion.
- Other exposure cycles with similar levels of irradiation and conditions may be used with Department approval.
- No cracking, chipping, surface distortion, or loss of adhesion. No color fading or lightening.

2.6.

**Diluted Emulsions.** Provide emulsified asphalt that is homogeneous, does not separate after thorough mixing, and meets the requirements for the specified type and grade shown in Tables 12 and 12A, where the suffixes 50/50, 40/60, and 30/70 mean 50% emulsion diluted with 50% water; 40% emulsion diluted with 60% water, and 30% emulsion diluted with 70% water, respectively. For example, CSS-1H 40/60 means 40% CSS-1H diluted with 60% water and AE-P 30/70 means 30% AE-P diluted with 70% water.

**Table 12**  
**Cationic Diluted Emulsified Asphalt**

Property	Test Procedure	Type-Grade					
		Diluted Slow-Setting					
		CSS-1H 50/50		CSS-1H 40/60		CSS-1H 30/70	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec.	T 72	Report only		Report only		Report only	
Distillation test							
Residue by distillation, % by wt.	T 59	30	–	24	–	18	–
Oil distillate, % by volume of emulsion		–	0.5	–	0.5	–	0.5
Tests on residue from distillation:							
Penetration, 77°F, 100 g, 5 sec.	T 49	40	110	40	110	40	110
Solubility, %	T 44	97.5	–	97.5	–	97.5	–
Ductility, 77°F, 5 cm/min., cm	T 51	80	–	80	–	80	–

**Table 12A**  
**Diluted Specialty Emulsions**

Property	Test Procedure	Type-Grade					
		Diluted Slow-Setting					
		AE-P 50/50		AE-P 40/60		AE-P 30/70	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 122°F, sec.	T 72	Report only		Report only		Report only	
Asphalt emulsion distillation to 500°F followed by cutback asphalt distillation of residue to 680°F: Residue after both distillations, % by wt. Total oil distillate from both distillations, % by volume of emulsion	T 59 and T 78	20 12.5	– 20	16 10.0	– 16	12 7.5	– 12
Tests on residue after all distillations:							
Solubility, %	T 44	97.5	–	97.5	–	97.5	–
Float test, 122°F, sec.	T 50	50	200	50	200	50	200

2.7.

**Recycling Agent.** Recycling agent and emulsified asphalt recycling agent (ARA) must meet the requirements shown in Table 13. Additionally, recycling agent and residue from ARA, when added in the specified proportions to the recycled asphalt, must meet the properties shown on the plans.

**Table 13**  
**Recycling Agent and Emulsified Asphalt Recycling Agent**

Property	Test Procedure	Recycling Agent		ARA-1		ARA-1P	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol, 77°F, sec.	T 72	–	–	15	100	15	110
Sieve test, %	T 59	–	–	–	0.1	–	0.1
Miscibility <sup>1</sup>	T 59	–		No coagulation		–	
Residue by evaporation <sup>2</sup> , % by wt.	T 59	–	–	60	–	–	–
Distillation test <sup>3</sup> :	T 59						
Residue by distillation, % by wt.		–	–	–	–	60	65
Oil distillate, % by volume of emulsion		–	–	–	–	–	2
Penetration of distillation residue at 39.2°F, 100 g, 5 sec.	T 49	–	–	–	–	110	190
Tests on recycling agent or residue from evaporation:							
Flash point, C.O.C., °F	T 48	400	–	400	–	400	–
Kinematic viscosity	T 201						
140°F, cSt		75	200	75	200	–	–
275°F, cSt		–	10.0	–	10.0	–	–

- Exception to T 59: Use 0.02 N CaCl<sub>2</sub> solution in place of water.
- Exception to T 59: Maintain sample at 300°F until foaming ceases, then cool and weigh.
- Exception to T 59: Bring the temperature on the lower thermometer slowly to 350 ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from first application of heat.

2.8.

**Crumb Rubber Modifier.** CRM consists of automobile and truck tires processed by ambient temperature grinding.

CRM must be:

- free of contaminants, including fabric, metal, and mineral and other non-rubber substances;
- free-flowing; and
- non-foaming when added to hot asphalt binder.

Ensure rubber gradation meets the requirements of the grades shown in Table 14 when tested in accordance with [Tex-200-E](#), Part I, using a 50-g sample.

**Table 14**  
**CRM Gradations**

Sieve Size (% Passing)	Grade A		Grade B		Grade C		Grade D	Grade E
	Min	Max	Min	Max	Min	Max		
#8	100	–	–	–	–	–	As shown on the plans	As approved
#10	95	100	100	–	–	–		
#16	–	–	70	100	100	–		
#30	–	–	25	60	90	100		
#40	–	–	–	–	45	100		
#50	0	10	–	–	–	–		
#200	–	–	0	5	–	–		

- 2.9. **Crack Sealer.** Provide polymer-modified emulsified asphalt crack sealer meeting the requirements shown in Table 15. Provide rubber-asphalt crack sealer meeting the requirements shown in Table 16.

**Table 15**  
**Polymer-Modified Emulsified Asphalt Crack Sealer**

Property	Test Procedure	Min	Max
Rotational viscosity, 77°F, cP	D2196, Method A	10,000	25,000
Sieve test, %	T 59	–	0.1
Storage stability, 1 day, %	T 59	–	1
Evaporation	<a href="#">Tex-543-C</a>		
Residue by evaporation, % by wt.		65	–
Tests on residue from evaporation:			
Penetration, 77°F, 100 g, 5 sec.	T 49	35	75
Softening point, °F	T 53	140	–
Ductility, 39.2°F, 5 cm/min., cm	T 51	100	–

**Table 16**  
**Asphalt-Rubber Crack Sealer**

Property	Test Procedure	Class A		Class B	
		Min	Max	Min	Max
CRM content, Grade A or Grade B, % by wt.	<a href="#">Tex-544-C</a>	22	26	–	–
CRM content, Grade B, % by wt.	<a href="#">Tex-544-C</a>	–	–	13	17
Virgin rubber content <sup>1</sup> , % by wt.		–	–	2	–
Flash point <sup>2</sup> , C.O.C., °F	T 48	400	–	400	–
Penetration <sup>3</sup> , 77°F, 150 g, 5 sec.	T 49	30	50	30	50
Penetration <sup>3</sup> , 32°F, 200 g, 60 sec.	T 49	12	–	12	–
Softening point, °F	T 53	–	–	170	–
Bond test, non-immersed, 0.5 in specimen, 50% extension, 3 cycles, 20°F <sup>4</sup>	D5329	–	–	–	Pass

1. Provide certification that the Min % virgin rubber was added.
2. Agitate the sealing compound using a 3/8–1/2-in. (9.5–12.7-mm) wide, square-end metal spatula to bring the material on the bottom of the cup to the surface (i.e., turn the material over) before passing the test flame over the cup. Start at one side of the thermometer, move around to the other, and then return to the starting point using 8–10 rapid circular strokes. Accomplish agitation in 3–4 sec. Pass the test flame over the cup immediately after stirring is completed.
3. Exception to T 49: Substitute the cone specified in D217 for the penetration needle.
4. Allow no crack in the crack-sealing materials or break in the bond between the sealer and the mortar blocks more than 1/4 in. deep for any specimen after completion of the test.

- 2.10. **Asphalt-Rubber Binders.** Provide A-R binders that are mixtures of asphalt binder and CRM that have been reacted at elevated temperatures. Provide A-R binders meeting D6114 and containing at least 15% CRM by weight. Provide Type I or Type II, containing CRM Grade C, for use in hot-mix aggregate mixtures. Provide Type II or Type III, containing CRM Grade B, for use in surface treatment binder. Ensure binder properties meet the requirements shown in Table 17.

**Table 17  
A-R Binders**

Property	Test Procedure	Binder Type					
		Type I		Type II		Type III	
		Min	Max	Min	Max	Min	Max
Apparent viscosity, 347°F, cP	D2196, Method A	1,500	5,000	1,500	5,000	1,500	5,000
Penetration, 77°F, 100 g, 5 sec.	T 49	25	75	25	75	50	100
Penetration, 39.2°F, 200 g, 60 sec.	T 49	10	–	15	–	25	–
Softening point, °F	T 53	135	–	130	–	125	–
Resilience, 77°F, %	D5329	25	–	20	–	10	–
Flash point, C.O.C., °F	T 48	450	–	450	–	450	–
Tests on residue from RTFOT:	T 240						
Retained penetration ratio, 39.2°F, 200 g, 60 sec., % of original	T 49	75	–	75	–	75	–

2.11. **Performance-Graded Binders.** Provide PG binders that are smooth and homogeneous, show no separation when tested in accordance with [Tex-540-C](#), and meet the requirements shown in Table 18.

Separation testing is not required if:

- a modifier is introduced separately at the mix plant by injection in either the asphalt line or mixer,
- the binder is blended onsite in continuously agitated tanks, or
- binder acceptance is based on field samples taken from an in-line sampling port at the hot-mix plant after the addition of modifiers.

**Table 18**  
**Performance-Graded Binders**

Property and Test Method	Performance Grade																	
	PG 58			PG 64				PG 70				PG 76				PG 82		
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Average 7-day Max pavement design temperature, °C <sup>1</sup>	58			64				70				76				82		
Min pavement design temperature, °C <sup>1</sup>	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
<b>Original Binder</b>																		
Flash point, T 48, Min, °C	230																	
Viscosity, T 316 <sup>2,3</sup> : Max, 3.0 Pa-s, test temperature, °C	135																	
Dynamic shear, T 315 <sup>4</sup> : G*/sin(δ), Min, 1.00 kPa, Max, 2.00 kPa <sup>5</sup> , Test temperature @ 10 rad/sec., °C	58			64				70				76				82		
Elastic recovery, D6084, 50°F, % Min <sup>6</sup>	-	-	30	-	-	30	50	-	30	50	60	30	50	60	70	50	60	70
<b>Rolling Thin Film Oven (RTFO) (T 240)</b>																		
Mass change, T 240, Max, %	1.0																	
Dynamic shear, T 315 G*/sin(δ), Min, 2.20 kPa, Max, 5.00 kPa <sup>5</sup> , Test temperature @ 10 rad/sec., °C	58			64				70				76				82		
MSCR, T 350, recovery, 0.1 kPa, high PG temperature, % Min <sup>6</sup>	-	-	20	-	-	20	30	-	20	30	40	20	30	40	50	30	40	50
<b>Pressure Aging Vessel (PAV) Residue (R 28)</b>																		
PAV aging temperature, °C	100																	
Dynamic shear, T 315 G*.sin(δ), Max, 5,000 kPa (Max, 6,000 kPa for δ ≥42°) Test temperature @ 10 rad/sec., °C	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22
Creep stiffness, T 313 <sup>7,8</sup> S, Max, 300 MPa, m-value, Min, 0.300 Test temperature @ 60 sec., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18
Direct tension, T 314 <sup>8</sup> Failure strain, Min, 1.0% Test temperature @ 1.0 mm/min., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18

1. Pavement temperatures are estimated from air temperatures using an algorithm contained in a Department-supplied computer program, may be provided by the Department, or may be obtained by following procedures outlined in AASHTO M 323 and R 25.
2. This requirement may be waived at the Department's discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
3. Viscosity at 135°C is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Contractors should be aware that variation could significantly impact their mixing and compaction operations. Contractors are therefore responsible for addressing any constructability issues that may arise.
4. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of G\*/sin(δ) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational (T 316) viscometry.
5. Max values for unaged and RTFO-aged dynamic shear apply only to materials used as substitute binders, as described in Item 341, "Dense-Graded Hot-Mix Asphalt," and Item 344, "Superpave Mixtures."
6. Elastic recovery (D6084) is not required unless MSCR (T 350) is less than the Min % recovery. Elastic recovery will be used for the acceptance criteria in this instance.
7. Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
8. If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

### 3. EQUIPMENT

Provide all equipment necessary to transport, store, sample, heat, apply, and incorporate asphalts, oils, and emulsions.

### 4. CONSTRUCTION

4.1. **Typical Material Use.** Use materials shown in Table 19, unless otherwise determined by the Engineer.

**Table 19**  
**Typical Material Use**

Material Application	Typically Used Materials
Hot-mixed, hot-laid asphalt mixtures	PG binders, A-R binder Types I and II
Surface treatment	PG 58-22, AC-15P, AC-20XP, AC-10-2TR, AC-20-5TR, HFRS-2, MS-2, CRS-2, CRS-2TR, CMS-2P, HFRS-2P, CRS-2P, CHFRS-2P, A-R binder Types II and III
Surface treatment (cool weather)	AC12-5TR, RC-250, MC-800, MC-3000, CMS-2P
Precoating	PG 58-22, PG 64-22, SS-1, SS-1H, CSS-1, CSS-1H
Tack coat	PG binders, SS-1H, CSS-1H, EAP&T, TRAIL, EBL
Fog seal	SS-1, SS-1H, CSS-1, CSS-1H, CSS-1H 50/50, CSS-1H 40/60, CSS-1H 30/70, CMS-1P
Hot-mixed, cold-laid asphalt mixtures	AC-0.6, AC-1.5, PG 58-22, CMS-2
Patching mix	MC-800, SCM I
Recycling	AC-0.6, AC-1.5, recycling agent, ARA-1, ARA-1P
Crack sealing	Polymer-modified AE crack sealant, asphalt-rubber crack sealers (Class A, Class B)
Microsurfacing	CSS-1P
Prime	MC-30, AE-P, AE-P 50/50, AE-P 40/60, AE-P 30/70, EAP&T, PCE
Curing membrane	SS-1, SS-1H, CSS-1, CSS-1H, PCE
Erosion control	SS-1, SS-1H, CSS-1, CSS-1H, PCE
FDR-foaming	PG 64-22, FDR EM-SY, FDR EM-HY

4.2. **Storage and Application Temperatures.** Use storage and application temperatures in accordance with Table 20. Store and apply materials at the lowest temperature yielding satisfactory results. Follow the manufacturer's instructions for any agitation requirements in storage. Manufacturer's instructions regarding recommended application and storage temperatures supersede those shown in Table 19.

**Table 20**  
**Storage and Application Temperatures**

Type-Grade	Application		Storage Max (°F)
	Recommended Range (°F)	Max Allowable (°F)	
AC-0.6, AC-1.5	200–300	350	350
AC-15P, AC-20-5TR, AC12-5TR, and AC10-2TR	300–375	375	360
RC-250	125–180	200	200
MC-30, AE-P	70–150	175	175
MC-800, SCM I	175–260	275	275
MC-3000	225–275	290	290
HFRS-2, MS-2, CRS-2, HFRS-2P, CRS-2P, CMS-2, CRS-2TR	120–160	180	180
SS-1, SS-1H, CSS-1, CSS-1H, PCE, EAP&T, CSS-1P, recycling agent, emulsified recycling agent, polymer-modified AE crack sealant	50–130	140	140
PG binders	275–350	350	350
Asphalt-rubber crack sealers (Class A, Class B)	350–375	400	–
A-R binder Types I, II, and III	325–425	425	425

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**5. MEASUREMENT AND PAYMENT**

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to or are included in payment for other pertinent Items.

# Item 302

## Aggregates for Surface Treatments



### 1. DESCRIPTION

Furnish aggregate for surface treatments in conformance with the type, grade, and Surface Aggregate Classification (SAC) shown on the plans.

### 2. MATERIALS

Furnish uncontaminated materials of uniform quality throughout that meet the requirements of the plans and specifications. Notify the Engineer of all proposed material sources and of changes to material sources. The Engineer will designate the sampling location.

- 2.1. **Aggregate.** Stockpile aggregates for each source and type separately. Do not add materials to approved stockpiles without approval.

Furnish aggregate of the type shown on the plans and in Table 1. Use [Tex-100-E](#) material definitions.

**Table 1**  
**Aggregate Types**

Type	Material
A	Gravel, crushed slag, crushed stone, or limestone rock asphalt (LRA)
B	Crushed gravel, crushed slag, crushed stone, or LRA
C	Gravel, crushed slag, or crushed stone
D	Crushed gravel, crushed slag, or crushed stone
E	Aggregate as shown on the plans
L	Lightweight aggregate
PA	Precoated gravel, crushed slag, crushed stone, or LRA
PB	Precoated crushed gravel, crushed slag, crushed stone, or LRA
PC	Precoated gravel, crushed slag, or crushed stone
PD	Precoated crushed gravel, crushed slag, or crushed stone
PE	Precoated aggregate as shown on the plans
PL	Precoated lightweight aggregate

Ensure the aggregate gradation meets the requirements shown in Table 2 for the specified grade, unless otherwise approved.

Furnish aggregate that meets the requirements shown in Table 3, unless otherwise shown on the plans. Furnish LRA in accordance with [DMS-9210](#), "Limestone Rock Asphalt," when used. Provide aggregates from sources listed in the Department's *Bituminous Rated Source Quality Catalog* (BRSQC). Use material not listed or not meeting the requirements of the BRSQC only when tested by the Engineer and approved before use. Allow 30 calendar days for testing of material from such sources.

Provide aggregates for final surfaces that meet the SAC shown on the plans. Do not blend to meet the SAC. The SAC requirement will apply only to the aggregate used on the travel lanes unless otherwise shown on the plans. The BRSQC lists the SAC for sources in the *Aggregate Quality Monitoring Program*.

**Table 2**  
**Aggregate Gradation Requirements (Cumulative % Retained<sup>1</sup>)**

Sieve	Grade								
	1	2	3S <sup>2</sup>	3		4S <sup>2</sup>	4	5S <sup>2</sup>	5
				Non-Lightweight	Lightweight				
1"	–	–	–	–	–	–	–	–	–
7/8"	0–2	0	–	–	–	–	–	–	–
3/4"	20–35	0–2	0	0	0	–	–	–	–
5/8"	85–100	20–40	0–5	0–5	0–2	0	0	–	–
1/2"	–	80–100	55–85	20–45	10–25	0–5	0–5	0	0
3/8"	95–100	95–100	95–100	80–100	60–80	60–85	20–45	0–5	0–5
1/4"	–	–	–	95–100	95–100	–	–	65–85	–
#4	–	–	–	–	–	95–100	95–100	95–100	50–80
#8	99–100	99–100	99–100	98–100	98–100	98–100	98–100	98–100	98–100

1. Round test results to the nearest whole number.
2. Single-size gradation.

**Table 3**  
**Aggregate Quality Requirements**

Property	Test Method	Requirement <sup>1</sup>	
		Minimum	Maximum
SAC	<a href="#">Tex-499-A</a>	As shown on the plans	
Deleterious Material <sup>2</sup> , %	<a href="#">Tex-217-F</a> , Part I	–	2.0
Decantation, %	<a href="#">Tex-406-A</a>	–	1.5
Flakiness Index, %	<a href="#">Tex-224-F</a>	–	17
Gradation	<a href="#">Tex-200-F</a> , Part I	Table 2 requirements	
Los Angeles Abrasion, %	<a href="#">Tex-410-A</a>	–	35
Magnesium Sulfate Soundness, 5 Cycle, %	<a href="#">Tex-411-A</a>	–	25
Coarse Aggregate Angularity <sup>3</sup> , 2 Crushed Faces, %	<a href="#">Tex-460-A</a> , Part I	85	–
<b>Additional Requirements for Lightweight Aggregate</b>			
Dry Loose Unit Wt., lb./cu. ft.	<a href="#">Tex-404-A</a>	35	65
Pressure Slaking, %	<a href="#">Tex-431-A</a>	–	6.0
Freeze-Thaw Loss, %	<a href="#">Tex-432-A</a>	–	10.0
Water Absorption, 24 hr., %	<a href="#">Tex-433-A</a>	–	12.0

1. Material requirements listed in the table, unless otherwise shown on the plans.
2. Not required for lightweight aggregate.
3. Required only for crushed gravel.

2.2. **Precoating.** Precoat aggregate uniformly and adequately with asphalt material to the satisfaction of the Engineer when shown on the plans. Specific aggregates may be prohibited from being precoated when shown on the plans. Meet requirements shown in Table 2 and Table 3 before precoating. Furnish precoated aggregate that spreads uniformly using approved mechanical spreading equipment. Precoat LRA in accordance with [DMS-9210](#), when used.

The Engineer retains the right to select a target value for the desired percent by weight of residual bitumen coating on the aggregate. Furnish precoated aggregate that is within  $\pm 0.3\%$  of the target value when tested in accordance with [Tex-236-F](#). The Engineer may require trial batches to assist in selecting the target value. LRA is exempt from these requirements.

The Engineer retains the right to remove precoat material from aggregate samples in accordance with [Tex-210-F](#), or as recommended by the Materials and Tests Division, and test the aggregate to verify compliance with requirements shown in Table 2 and Table 3. Gradation testing may be performed with precoat intact.

- 2.2.1. **Asphalt Material.** Precoat the aggregates with asphalt material that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions." Use any asphalt material that meets the requirements of Item 300 unless a specific precoat material is shown on the plans.
- 2.2.1.1. **Asphalt Material Sampling and Testing.** Sample each binder grade and source used in accordance with [Tex-500-C](#) and witnessed by the Engineer. The Contractor will notify the Engineer when the sampling will occur. The Engineer will submit the sample to the Materials and Tests Division to verify compliance with Item 300.
- 2.2.2. **Additives.** Use the type and rate of additive specified when shown on the plans. Add in accordance with Item 301, "Asphalt Antistripping Agents." Use [Tex-530-C](#) for verification during production testing unless otherwise directed.
- 2.3. **Sampling.** Personnel who conduct sampling and witnessing of sampling must be certified by the Department-approved certification program. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning construction and when personnel changes are made. At any time during the project, the Engineer may perform production tests as deemed necessary in accordance with Item 5, "Control of the Work."
- The Engineer, unless otherwise directed, will sample aggregate from stockpiles located at the production site, intermediate distribution site, or project location in accordance with [Tex-221-F](#). The Engineer, unless otherwise directed, will split each sample into two equal portions in accordance with [Tex-200-F](#), and label these portions for the Engineer and Contractor as deemed appropriate. Witness the sampling and splitting and take immediate possession of the samples labeled for the Contractor. When the Engineer does not sample, the Engineer must witness the sampling of aggregates designated for the Engineer and will take immediate possession of them.
- 2.4. **Reporting and Responsibilities.** The Engineer will provide test results to the Contractor and supplier within 10 working days from the date the stockpile was sampled for sources listed in the Department's BRSQC, unless otherwise directed. The Engineer will provide test results for the Los Angeles Abrasion ([Tex-410-A](#)) and Magnesium Sulfate Soundness ([Tex-411-A](#)) tests within 30 calendar days for sources not listed in the BRSQC. The Engineer will report to the other party within 24 hr. when any test result does not meet the requirements shown in Table 2 or Table 3.

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### 3. EQUIPMENT

Manufacture precoated aggregate at a mixing plant that produces uniformly coated aggregate.

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### 4. CONSTRUCTION

Deliver aggregate to the locations shown on the plans. Prevent segregation, mixing of the various materials or sizes, and contamination by foreign materials when aggregates are stockpiled. The Engineer will reject contaminated stockpiles.

Provide adequate initial cooling of precoated aggregate to prevent asphalt or aggregate damage due to excessive heat buildup in stockpiles. Limit stockpile height to 3 ft. immediately after production when asphalt cement is the precoating material. Consolidate stockpiles after adequate cooling, as approved. The Engineer will reject stockpiles showing evidence of damage due to excessive heat buildup.

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### 5. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, tools, and incidentals will not be measured or paid for directly but will be subsidiary to or included under "Payment" in other pertinent Items.

# Item 310

## Prime Coat



### 1. DESCRIPTION

Prepare and treat existing or newly constructed surface with an asphalt binder or other specialty prime coat binder material. Apply blotter material as required.

### 2. MATERIALS

- 2.1. **Binder.** Use material of the type and grade shown on the plans in accordance with Item 300, "Asphalts, Oils, and Emulsions."
- 2.2. **Blotter.** Use either base course sweepings obtained from cleaning the base or native sand as blotter materials unless otherwise shown on the plans or approved.

### 3. EQUIPMENT

Provide applicable equipment in accordance with Article 316.3., "Equipment."

### 4. CONSTRUCTION

- 4.1. **General.** Apply the mixture when the air temperature is at or above 60°F, or above 50°F and rising. Measure the air temperature in the shade away from artificial heat. The Engineer will determine when weather conditions are suitable for application.
- Do not permit traffic, hauling, or placement of subsequent courses over freshly constructed prime coats. Maintain the primed surface until placement of subsequent courses or acceptance of the work.
- 4.2. **Surface Preparation.** Prepare the surface by sweeping or other approved methods. Lightly sprinkle the surface with water before applying bituminous material, when directed, to control dust and ensure absorption.
- 4.3. **Application.**
- 4.3.1. **Binder.** The Engineer will select the application temperature within the limits recommended in Item 300, or by the material manufacturer. Apply material within 15°F of the selected temperature, but do not exceed the maximum allowable temperature.
- Distribute the material smoothly and evenly at the rate selected by the Engineer. Roll the freshly applied prime coat using a pneumatic-tire roller to ensure penetration when directed.
- 4.3.2. **Blotter.** Spread blotter material before allowing traffic to use a primed surface. Apply blotter material to primed surface at the specified rate when "Prime Coat and Blotter" is shown on the plans as a bid item or as directed. Apply blotter to spot locations when "Prime Coat" is shown on the plans as a bid item or as directed to accommodate traffic movement through the work area. Remove blotter material before placing the surface. Dispose of blotter material in conformance with applicable state and federal requirements.

### 5. MEASUREMENT

This Item will be measured by the gallon of binder placed and accepted.

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**6. PAYMENT**

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 "Prime Coat" or "Prime Coat and Blotter" of the type and grade of binder specified. This price is full compensation for cleaning and sprinkling the area to be primed; materials, including blotter material; and rolling, equipment, labor, tools, and incidentals.

# Item 316

## Seal Coat



### 1. DESCRIPTION

Construct a surface treatment consisting of one or more applications of a single layer of asphalt material covered with a single layer of aggregate.

### 2. MATERIALS

Furnish materials of the type and grade shown on the plans in conformance with the following.

#### 2.1. **Asphalt.** Furnish asphalt materials meeting the requirements of Item 300, "Asphalts, Oils, and Emulsions."

Furnish Type II or Type III asphalt-rubber (A-R) binder in accordance with Section 300.2.10., "Asphalt-Rubber Binders," as shown on the plans. Furnish a blend design for approval. Include in the design, at a minimum, the following:

- manufacturer and grade of asphalt cement;
- manufacturer and grade of crumb rubber;
- manufacturer, type, and percentage of extender oil, if used;
- test report pertinent to crumb rubber gradation in accordance with [Tex-200-F](#), Part I;
- design percentage of crumb rubber versus asphalt content;
- blending temperature; and
- test results pertinent to the properties at reaction times of 60, 90, 240, 360, and 1,440 min. in accordance with Section 300.2.10., "Asphalt-Rubber Binders."

Furnish a new A-R blend design if the grade or source for any of the components changes.

If a tack coat is specified when using A-R, unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a performance-grade (PG) binder with a minimum high-temperature grade of PG 58 for tack coat binder. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use. If required, verify that emulsified asphalt proposed for use meets the minimum residual asphalt percentage specified in Item 300.

#### 2.2. **Aggregate.** Furnish aggregate meeting Item 302, "Aggregates for Surface Treatments," of the type and grade shown on the plans. Unless otherwise shown on the plans, furnish aggregate with a minimum Surface Aggregate Classification B.

#### 2.3. **Materials Selections.** Furnish asphalt and aggregate as shown on the plans.

### 3. EQUIPMENT

#### 3.1. **Distributor.** Furnish a distributor that will apply the asphalt material uniformly at the specified rate or as directed.

#### 3.1.1. **Transverse Variable Rate.** When a transverse variable rate is shown on the plans, ensure that the nozzles outside the wheel paths will output a predetermined percentage more asphalt material by volume than the nozzles over the wheel paths. Use a dual spray bar distributor as desired to provide for a transverse variable rate.

- 3.1.2. **Agitation for Asphalt-Rubber.** If using A-R, furnish a distributor capable of keeping the rubber in uniform suspension and adequately mixing the asphalt, rubber, and any additional additives.
- 3.1.3. **Calibration.**
- 3.1.3.1. **Transverse Distribution.** Furnish a distributor test report, less than 1 yr. old, when tested in accordance with [Tex-922-K](#), Part III. The Department reserves the right to witness the calibration testing. Notify the Engineer 3 days before calibration testing.
- Include the following documentation in the test report:
- the serial number of the distributor,
  - a method that identifies the actual nozzle set used in the test, and
  - the fan width of the nozzle set at a 12-in. bar height.
- When a transverse variable rate is required, and a single spray bar is to be used, perform the test using the type and grade of asphalt material to be used on the project. The Engineer may verify the transverse rate and distribution at any time. If verification does not meet the requirements, correct deficiencies and furnish a new test report.
- 3.1.3.2. **Tank Volume.** Furnish a volumetric calibration and strap stick for the distributor tank in accordance with [Tex-922-K](#), Part I.
- Provide documentation of distributor calibration performed no more than 5 yr. before the date first used on the project. The Engineer may verify calibration accuracy in accordance with [Tex-922-K](#), Part II.
- 3.1.4. **Computerized Distributor.** When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.
- 3.2. **Aggregate Spreader.** Use a continuous-feed, self-propelled spreader to apply aggregate uniformly at the specified rate or as directed. If racked-in aggregate is shown on the plans, furnish a second aggregate spreader for the racked-in aggregate to apply aggregate uniformly at the specified rate.
- 3.3. **Rollers.** Unless otherwise shown on the plans, furnish light pneumatic-tire rollers in accordance with Item 210, "Rolling."
- 3.4. **Broom.** Furnish rotary, self-propelled brooms.
- 3.5. **Asphalt Storage and Handling Equipment.** When the plan or the Engineer allows storage tanks, furnish a thermometer in each tank to indicate the asphalt temperature continuously. Keep equipment clean and free of leaks. Keep asphalt material free of contamination.
- 3.6. **Aggregate Haul Trucks.** Unless otherwise approved, use trucks of uniform capacity to deliver the aggregate. Provide documentation showing measurements and calculation in cubic yards. Clearly mark the calibrated level. Truck size may be limited when shown on the plans.
- 3.7. **Digital Distance-Measuring Instrument.** Furnish a vehicle with a calibrated digital distance-measuring instrument accurate to  $\pm 6$  ft. per mile.

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## 4. CONSTRUCTION

- 4.1. **General.** Comply with the seal coat season as shown on the plans. Asphalt and aggregate rates shown on the plans are for estimating purposes only. Adjust the rates for existing conditions as directed.

- 4.2. **Temporary Aggregate Stockpiles.** The Engineer will approve the location of temporary aggregate stockpiles on the right of way before delivery. Place stockpiles in a manner that will not:
- obstruct traffic or sight distance,
  - interfere with the access from abutting property, or
  - interfere with roadway drainage.
- Locate stockpiles at least 30 ft. from roadway when possible. Sign and barricade as shown on the plans.
- 4.3. **Aggregate Furnished by the Department.** When shown on the plans, the Department will furnish aggregate to the Contractor without cost. Stockpile locations are shown on the plans.
- 4.4. **Adverse Weather Conditions.** Do not place surface treatments when, in the Engineer's opinion, general weather conditions are unsuitable. Meet the requirements for air and surface temperature shown below.
- 4.4.1. **Standard Temperature Limitations.** Apply seal coat when air temperature is above 50°F and rising. Do not apply seal coat when air temperature is 60°F and falling. In all cases, do not apply seal coat when surface temperature is below 60°F.
- 4.4.2. **Polymer-Modified Asphalt Cement Temperature Limitations.** When using materials described in Section 300.2.2., "Polymer-Modified Asphalt Cement," apply seal coat when air temperature is above 70°F and rising. Do not apply seal coat when air temperature is 80°F and falling. In all cases, do not apply seal coat when surface temperature is below 70°F.
- 4.4.3. **Asphalt-Rubber Temperature Limitations.** Do not place hot A-R seal coat when, in the Engineer's opinion, general weather conditions are unsuitable. Apply seal coat when the air temperature is 80°F and above, or above 70°F and rising. In all cases, do not apply seal coat when surface temperature is below 70°F.
- 4.4.4. **Cool Weather Night Air Temperature.** The Engineer reserves the right to review the National Oceanic and Atmospheric Administration (NOAA) weather forecast and determine whether the nightly air temperature is suitable for asphalt placement to prevent aggregate loss.
- 4.4.5. **Cold Weather Application.** When asphalt application is allowed outside the above temperature restrictions, the Engineer will approve the binder grade and the air and surface temperatures for asphalt material application. Apply seal coat at air and surface temperatures as directed.
- 4.5. **Mixing Hot A-R Binder.** If using A-R, mix in accordance with the approved blend design required in Section 316.2.1., "Asphalt."
- At the end of each shift, provide the Engineer with production documentation that includes the following:
- amount and temperature of asphalt cement before addition of rubber,
  - amount of rubber and any extender added,
  - viscosity of each hot A-R batch just before roadway placement, and
  - time of the rubber additions and viscosity tests.
- 4.6. **Surface Preparation.** Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove vegetation and blade pavement edges. When directed, apply a tack coat before applying the hot A-R treatment on an existing wearing surface in accordance with Section 341.4.7.2., "Tack Coat."

#### 4.7. **Rock Land and Shot.**

##### 4.7.1. **Definitions.**

- **Rock Land.** The area covered at the aggregate rate directed with one truckload of aggregate.
- **Shot.** The area covered by one distributor load of asphalt material.

4.7.2. **Setting Lengths.** Calculate the lengths of both rock land and shot. Adjust shot length to be an even multiple of the rock land. Verify that the distributor has enough asphalt material to complete the entire shot length. Mark shot length before applying asphalt. When directed, mark length of each rock land to verify the aggregate rate.

#### 4.8. **Asphalt Placement.**

4.8.1. **General.** The maximum shot width is the width of the current transverse distribution test required under Section 316.3.1.3.1., "Transverse Distribution," or the width of the aggregate spreader box, whichever is less. Adjust the shot width so operations do not encroach on traffic or interfere with the traffic control plan, as directed. Use paper or other approved material at the beginning and end of each shot to construct a straight transverse joint and to prevent overlapping of the asphalt. Unless otherwise approved, match longitudinal joints with the lane lines. The Engineer may require a string line if necessary to keep joints straight with no overlapping. Use enough pressure to flare the nozzles fully.

Select an application temperature, as approved, in accordance with Item 300. Uniformly apply the asphalt material at the rate directed, within 15°F of the approved temperature, and not above the maximum allowable temperature.

4.8.2. **Limitations.** Do not apply asphalt to the roadway until:

- traffic control methods and devices are in place as shown on the plans or as directed,
- the loaded aggregate spreader is in position and ready to begin,
- haul trucks are loaded with enough aggregate to cover the shot area and are in place behind the spreader box, and
- rollers are in place behind the haul trucks.

4.8.3. **Nonuniform Application.** Stop application if it is not uniform due to streaking, ridging, puddling, or flowing off the roadway surface. Verify equipment condition, operating procedures, application temperature, and material properties. Determine and correct the cause of nonuniform application. If the cause is high- or low-emulsion viscosity, replace emulsion with material that corrects the problem.

4.8.4. **Test Strips.** The Engineer may stop asphalt application and require construction of test strips at the Contractor's expense if any of the following occurs:

- nonuniformity of application continues after corrective action;
- on three consecutive shots, application rate differs by more than 0.03 gal. per square yard from the rate directed; or
- any shot differs by more than 0.05 gal. per square yard from the rate directed.

The Engineer will approve the test strip location. The Engineer may require additional test strips until surface treatment application meets specification requirements.

4.8.5. **Sampling.** Collect all samples in accordance with [Tex-500-C](#) from the distributor and with witness by the Engineer.

At least once per project, collect split samples of each binder grade and source used. The Engineer will submit one split sample to the Materials and Tests Division (MTD) for testing and retain the other split sample.

In addition, collect one sample of each binder grade and source used on the project for each production day. The Engineer will retain these samples.

The Engineer will keep all retained samples for 1 yr. for hot-applied binders and cutback asphalts, or for 2 mo. for emulsified asphalts. The Engineer may submit retained samples to MTD for testing as necessary or as requested by MTD.

The Department will furnish sampling containers in accordance with [Tex-500-C](#).

- 4.9. **Aggregate Placement.** As soon as possible, apply aggregate uniformly at the rate directed without causing the rock to roll over.
- 4.9.1. **Nonuniform Application.** Stop application if it is not uniform in the transverse direction. Verify equipment condition, operating procedures, and transverse application rate. The transverse application rate should be within 1 lb. Determine and correct the cause of nonuniform application.
- 4.10. **Rolling.** Start rolling operation on each shot as soon as aggregate is applied. Use enough rollers to cover the entire mat width in one pass; i.e., one direction. Roll in a staggered pattern. Unless otherwise shown on the plans, make at least:
- five passes or
  - three passes when the asphalt material is an emulsion.
- If rollers are unable to keep up with the spreader box, stop application until rollers have caught up, or furnish additional rollers. Keep roller tires asphalt-free.
- 4.11. **Patching.** Before rolling, repair spots where coverage is incomplete. Repair can be made by hand spotting or other approved method. When necessary, apply additional asphalt material to embed aggregate.
- 4.12. **Racked-In Aggregate.** If specified on the plans, apply racked-in aggregate after patching, uniformly at the rate directed. The racked-in aggregate must be applied before opening the roadway or intersection to traffic.
- 4.13. **Brooming.** After rolling, sweep as soon as aggregate has sufficiently bonded to remove excess. In areas of racked-in aggregate, sweep as directed.
- 4.14. **Final Acceptance.** Maintain seal coat until the Engineer accepts the work. Repair any surface failures. Before final project acceptance, remove all temporary stockpiles and restore the area to the original contour and grade.

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## 5. MEASUREMENT

- 5.1. **Asphalt Material.** Unless otherwise shown on the plans, asphalt material will be measured by one of the following methods.
- 5.1.1. **Volume.** Asphalt material, including all components, will be measured at the applied temperature by strapping the tank before and after road application. The distributor calibrated strap stick will be used for measuring the asphalt level in the distributor asphalt tank. The certified tank chart will be used to determine the beginning gallons and the final gallons in the distributor tank. The quantity to be measured for payment will be the difference between the beginning gallons and the final gallons.
- 5.1.2. **Weight.** Asphalt material will be measured in tons using certified scales meeting the requirements of Item 520, "Weighing and Measuring Equipment," unless otherwise approved. The transporting truck must have a seal attached to the draining device and other openings. Random checking on public scales at the Contractor's expense may be required to verify weight accuracy.

Upon work completion or temporary suspension, any remaining asphalt material will be weighed by a certified public weigher or measured by volume in a calibrated distributor or tank, and the quantity converted to tons at the measured temperature. The quantity to be measured will be the number of tons received minus the number of tons remaining after all directed work is complete and minus the amount used for other items.

- 5.1.3. **Quantity Adjustments.** When shown on the plans, the measured quantity will be adjusted to compensate for variation in required application or residual rates for different types of asphalt.
- 5.1.4. **Aggregate.** Unless otherwise shown on the plans, aggregate will be measured by the cubic yard in the trucks as applied on the road. Strike off the loaded aggregate for accurate measurement when directed.
- 5.2. **Loading, Hauling, and Distributing Aggregate.** When the Department furnishes the aggregate, the loading, hauling, and distributing will be measured by the cubic yard in the trucks as applied on the road.

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## 6. PAYMENT

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 "Asphalt"; "Aggregate"; and "Loading, Hauling, and Distributing Aggregate" of the types and grades shown on the plans. These prices are full compensation for surface preparation; furnishing, preparing, hauling, and placing materials; removing existing pavement markers and excess aggregate; rolling; cleaning up stockpiles; and equipment, labor, tools, and incidentals.

Hauling of any aggregate to consolidate stockpiles at the end of the project when directed by the Engineer will be paid by force account work.

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## Item 341

# Dense-Graded Hot-Mix Asphalt

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### 1. DESCRIPTION

Construct a hot-mix asphalt (HMA) pavement layer composed of a compacted, dense-graded mixture of aggregate, asphalt binder, and additives mixed hot in a mixing plant. Payment adjustments will apply to HMA placed under this Specification unless the HMA is deemed exempt in accordance with Section 341.4.9.4., "Exempt Production."

### 2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.

Notify the Engineer of all material sources and before changing any material source or formulation. The Engineer will verify that the specification requirements are met and document all material source changes when the Contractor makes a source or formulation change. The Engineer may sample and test project materials anytime during the project to verify specification compliance in accordance with Item 6, "Control of Materials."

#### 2.1. **Aggregate.** Furnish aggregates from sources that conform to the requirements shown in Table 1 and this Section.

Aggregate requirements in this Section, including those shown in Table 1, may be modified or eliminated when shown on the plans. Additional aggregate requirements may be specified when shown on the plans. Provide aggregate stockpiles that meet the definitions in this Section for coarse, intermediate, or fine aggregate. Aggregate from reclaimed asphalt pavement (RAP) is not required to meet Table 1 requirements unless otherwise shown on the plans. Supply aggregates that meet the definitions in [Tex-100-E](#) for crushed gravel or crushed stone. The Engineer will designate the plant or the quarry as the sampling location. Provide samples from materials produced for the project. The Engineer will establish the Surface Aggregate Classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests shown in Table 1. Document all test results in the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis in accordance with [Tex-200-F](#), Part II.

#### 2.1.1. **Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Aggregates from sources listed in the Department's *Bituminous Rated Source Quality Catalog* (BRSQC) are preapproved for use. Use only the rated values for HMA listed in the BRSQC. Rated values for surface treatment (ST) do not apply to coarse aggregate sources used in HMA.

For sources not listed in the Department's BRSQC:

- build an individual stockpile for each material;
- request the Department test the stockpile for specification compliance;
- allow 30 calendar days for the Engineer to sample, test, and report results;
- use only when tested and approved; and
- once approved, do not add additional material to the stockpile unless otherwise allowed by the Engineer.

Provide coarse aggregate with at least the minimum SAC shown on the plans. SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. The SAC for sources in the Department's *Aggregate Quality Monitoring Program (AQMP)* ([Tex-499-A](#)) is listed in the BRSQC.

- 2.1.1.1. **Blending Class A and Class B Aggregates.** Class B aggregate meeting all other requirements shown in Table 1 may be blended with a Class A aggregate to meet requirements for Class A materials, unless otherwise shown on the plans. When blending Class A and Class B aggregates to meet a Class A requirement, ensure that at least 50% by weight, or volume if required, of the material retained on the No. 4 sieve comes from the Class A aggregate source, unless otherwise shown on the plans. Blend by volume if the bulk specific gravities of the Class A and Class B aggregates differ by more than 0.300. Coarse aggregate from RAP and recycled asphalt shingles (RAS) will be considered as Class B aggregate for blending purposes.

The Engineer may perform tests anytime during production, when the Contractor blends Class A and Class B aggregates to meet a Class A requirement. The Engineer will use the Department's mix design template, when electing to verify conformance, to calculate the percent of Class A aggregate retained on the No. 4 sieve by inputting the bin percentages shown from readouts in the control room at the time of production and stockpile gradations measured at the time of production. The Engineer may determine the gradations based on either washed or dry sieve analysis from samples obtained from individual aggregate cold feed bins or aggregate stockpiles. The Engineer may perform spot checks to verify the percent of Class A aggregate retained on the No. 4 sieve. The Engineer will use the gradations supplied by the Contractor in the mixture design report as an input for the template. A failing spot check will require confirmation with a stockpile gradation determined by the Engineer.

- 2.1.1.2. **Micro-Deval Abrasion.** The Engineer will perform at least one Micro-Deval abrasion test in accordance with [Tex-461-A](#) for each coarse aggregate source used in the mixture design that has a rated source soundness magnesium (RSSM) loss value greater than 15 as listed in the BRSQC. The Engineer will perform testing before the start of production and may perform additional testing anytime during production. The Engineer may obtain the coarse aggregate samples from each coarse aggregate source or may require the Contractor to obtain the samples. The Engineer may waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

The Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source, when tested, using the following formula:

$$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$$

where:

$Mg_{est.}$  = magnesium sulfate soundness loss

$RSSM$  = rated source soundness magnesium

$MD_{act.}$  = actual Micro-Deval percent loss

$RSMD$  = rated source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved. The Engineer will consult the Materials and Tests Division, and additional testing may be required before granting approval.

- 2.1.2. **Intermediate Aggregate.** Aggregates not meeting the definition of coarse or fine aggregate will be defined as intermediate aggregate. Supply intermediate aggregates, when used, that are free of organic impurities. Supply intermediate aggregate from coarse aggregate sources, when used, that meet the requirements shown in Table 1, unless otherwise approved.

Test the stockpile if 10% or more of the stockpile is retained on the No. 4 sieve, and verify that it meets the requirements in Table 1 for crushed face count ([Tex-460-A](#)) and flat and elongated particles ([Tex-280-F](#)).

2.1.3. **Fine Aggregate.** Fine aggregates consist of manufactured sands, screenings, and field sands. Fine aggregate stockpiles must meet the fine aggregate properties in accordance with Table 1 and the gradation requirements in accordance with Table 2. Supply fine aggregates that are free of organic impurities. The Engineer may test the fine aggregate in accordance with [Tex-408-A](#) to verify the material is free of organic impurities. Unless otherwise shown on the plans, at most 10% of the total aggregate may be field sand or other uncrushed fine aggregate. Use fine aggregate, except field sand, from coarse aggregate sources that meet the requirements shown in Table 1, unless otherwise approved.

Test the stockpile if 10% or more of the stockpile is retained on the No. 4 sieve and verify that it meets the requirements in Table 1 for crushed face count ([Tex-460-A](#)) and flat and elongated particles ([Tex-280-F](#)).

**Table 1  
Aggregate Quality Requirements**

Property	Test Method	Requirement
<b>Coarse Aggregate</b>		
SAC	<a href="#">Tex-499-A</a> (AQMP)	As shown on the plans
Deleterious material, %, Max	<a href="#">Tex-217-F</a> , Part I	1.5
Decantation, %, Max	<a href="#">Tex-217-F</a> , Part II	1.5
Micro-Deval abrasion, %	<a href="#">Tex-461-A</a>	Note <sup>1</sup>
Los Angeles abrasion, %, Max	<a href="#">Tex-410-A</a>	40
Magnesium sulfate soundness, 5 cycles, %, Max	<a href="#">Tex-411-A</a>	30
Crushed face count, <sup>2</sup> %, Min	<a href="#">Tex-460-A</a> , Part I	85
Flat and elongated particles @ 5:1, %, Max	<a href="#">Tex-280-F</a>	10
<b>Fine Aggregate</b>		
Linear shrinkage, %, Max	<a href="#">Tex-107-E</a>	3
Sand equivalent, %, Min	<a href="#">Tex-203-F</a>	45 <sup>3</sup>
Organic impurities	<a href="#">Tex-408-A</a>	Note <sup>4</sup>

1. Used to estimate the magnesium sulfate soundness loss in accordance with Section 341.2.1.1.2., “Micro-Deval Abrasion.”
2. Only applies to crushed gravel.
3. The Department may perform [Tex-252-F](#) on fine aggregates not meeting this minimum requirement. Fine aggregates with a methylene blue value of 10.0 mg/g or less may be used.
4. Optional test.

**Table 2  
Gradation Requirements for Fine Aggregate**

Sieve Size	% Passing by Wt. Or Volume
3/8"	100
#8	70–100
#200	0–30

2.2. **Mineral Filler.** Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Use no more than 2% hydrated lime or fly ash, unless otherwise shown on the plans. Use no more than 1% hydrated lime if a substitute binder is used, unless otherwise shown on the plans or allowed. Test all mineral fillers except hydrated lime and fly ash in accordance with [Tex-107-E](#) to ensure specification compliance. The plans may require or disallow specific mineral fillers. Provide mineral filler, when used, that:

- is dry enough, free-flowing, and free of clumps and foreign matter as determined by the Engineer;
- does not exceed 3% linear shrinkage when tested in accordance with [Tex-107-E](#); and
- meets the gradation requirements shown in Table 3, unless otherwise shown on the plans.

**Table 3**  
**Gradation Requirements for Mineral Filler**

Sieve Size	% Passing by Wt. or Volume
#8	100
#200	55–100

- 2.3. **Baghouse Fines.** Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.
- 2.4. **Asphalt Binder.** Furnish the type and grade of performance-graded (PG) asphalt binder shown on the plans that meets the requirements of Item 300, “Asphalts, Oils, and Emulsions.”
- 2.5. **Tack Coat.** Furnish CSS-1H, SS-1H, EBL, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 300. Specialized tack coat materials on the MPL for *Tracking Resistant Asphalt Interlayer* (TRAIL) will be allowed or required when shown on the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use, unless required in conformance with the manufacturer’s recommendation for approved TRAIL products on the MPL.
- 2.6. **Additives.** Use the type of additive specified when shown on the plans. Use the rate of additive specified in conformance with the manufacturer’s recommendation. Additives that facilitate mixing and compaction or improve the quality of the mixture are allowed when approved. Provide the Engineer with documentation such as the bill of lading showing the quantity of additives used in the project unless otherwise directed.
- 2.6.1. **Lime and Liquid Antistripping Agent.** Lime or liquid antistripping agent is required when shown on the plans. When lime or a liquid antistripping agent is used, add in accordance with Item 301, “Asphalt Antistripping Agents.” Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum.
- 2.6.2. **Warm-Mix Asphalt (WMA).** WMA is defined as HMA that is produced within a target temperature discharge range of 215°F and 275°F using approved WMA additives or processes from the MPL.
- WMA is allowed for use on all projects and is required when shown on the plans. When WMA is required, the maximum placement or target discharge temperature for WMA will be set at a value at or below 275°F.
- Department-approved WMA additives or processes may be used to facilitate mixing and compaction of HMA produced at target discharge temperatures above 275°F; however, such mixtures will not be defined as WMA.
- 2.6.3. **Compaction Aid.** Compaction aid is defined as a Department-approved chemical warm-mix additive, denoted as “chemical additive” on the MPL, that is used to facilitate mixing and compaction of HMA at a discharge temperature greater than 275°F.
- Compaction aid is allowed for use on all projects. Compaction aid is required when shown on the plans or as required in Section 341.4.7.1., “Weather Conditions.”
- Warm-mix foaming processes, denoted as “foaming process” on the MPL, may be used to facilitate mixing and compaction of HMA at target discharge temperatures greater than 275°F; however, warm-mix foaming processes are not defined as a compaction aid.
- 2.7. **Recycled Materials.** Use of RAP and RAS is permitted unless otherwise shown on the plans. Use of RAS is restricted to only intermediate and base mixes unless otherwise shown on the plans. Do not exceed the maximum allowable percentages of RAP and RAS in accordance with Table 4. The allowable percentages in accordance with Table 4 may be decreased or increased when shown on the plans. Determine the asphalt binder content and gradation of the RAP and RAS stockpiles for mixture design purposes in accordance with [Tex-236-F](#), Part I. The Engineer may verify the asphalt binder content of the stockpiles anytime during

production. Perform other tests on RAP and RAS when shown on the plans. Asphalt binder from RAP and RAS is designated as recycled asphalt binder. Calculate and ensure that the ratio of the recycled asphalt binder to total binder does not exceed the percentages in accordance with Table 5 during mixture design and HMA production when RAP or RAS is used. Use a separate cold feed bin for each stockpile of RAP and RAS during HMA production. Surface, intermediate, and base mixes referenced in Table 4 and Table 5 are defined as follows, unless otherwise shown on the plans.

- **Surface.** The final HMA lift placed at the top of the pavement structure.
- **Intermediate.** Mixtures placed below an HMA surface mix and less than or equal to 8.0 in. below the riding surface.
- **Base.** Mixtures placed greater than 8.0 in. below the riding surface. Unless otherwise shown on the plans, mixtures used for bond breaker are defined as base mixtures.

2.7.1. **RAP.** RAP is salvaged, milled, pulverized, broken, or crushed asphalt pavement. Fractionated RAP is defined as a stockpile that contains RAP material with at least 95.0% passing the 1/2-in. sieve, before burning in the ignition oven, unless otherwise approved. The Engineer may allow the Contractor to use an alternate to the 1/2-in. screen to fractionate the RAP.

Use of Contractor-owned RAP, including HMA plant waste, is permitted unless otherwise shown on the plans. Department-owned RAP stockpiles are available for the Contractor’s use when the stockpile locations are shown on the plans. If Department-owned RAP is available for the Contractor’s use, the Contractor may use Contractor-owned fractionated RAP and replace it with an equal quantity of Department-owned RAP. Department-owned RAP generated by required work on the Contract is available for the Contractor’s use when shown on the plans. Perform any necessary tests to ensure Contractor- or Department-owned RAP is appropriate for use. The Department will not perform any tests or assume any liability for the quality of the Department-owned RAP unless otherwise shown on the plans. The Contractor will retain ownership of RAP generated on the project when shown on the plans.

Do not use Department- or Contractor-owned RAP contaminated with dirt or other objectionable materials. Do not use Department- or Contractor-owned RAP if the decantation value exceeds 5% and the plasticity index is greater than 8. Test the stockpiled RAP for decantation in accordance with [Tex-406-A](#), Part I. Determine the plasticity index in accordance with [Tex-106-E](#) if the decantation value exceeds 5%. The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction or ignition.

Do not intermingle Contractor-owned RAP stockpiles with Department-owned RAP stockpiles. Remove unused Contractor-owned RAP material from the project site upon completion of the project. Return unused Department-owned RAP to the designated stockpile location.

**Table 4**  
**Max Allowable Amounts of RAP<sup>1</sup>**

Max Allowable Fractionated RAP (%)		
Surface	Intermediate	Base
20.0	30.0	35.0

1. Must also meet the recycled binder to total binder ratio shown in Table 5.

2.7.2. **RAS.** RAS is defined as processed asphalt shingle material from manufacturing of asphalt roofing shingles or from re-roofing residential structures. Post-manufactured RAS is processed manufacturer’s shingle scrap byproduct. Post-consumer RAS is processed shingle scrap removed from residential structures. Use of post-manufactured RAS or post-consumer RAS (tear-offs) is not permitted in surface mixtures unless otherwise shown on the plans. RAS may be used in intermediate and base mixtures unless otherwise shown on the plans. Up to 3% RAS may be used separately or as a replacement for fractionated RAP in accordance with Table 4 and Table 5. RAS may be used separately or in conjunction with RAP. Comply with all regulatory requirements stipulated for RAS by TCEQ.

Process the RAS by ambient grinding or granulating such that 100% of the particles pass the 3/8-in. sieve when tested in accordance with [Tex-200-F](#), Part I. Perform a sieve analysis on processed RAS material before extraction (or ignition) of the asphalt binder.

Add sand meeting the requirements of Table 1 and Table 2, or fine RAP, to RAS stockpiles if needed to keep the processed material workable. Any stockpile that contains RAS will be considered a RAS stockpile and be limited to no more than 3.0% of the HMA mixture in accordance with Table 4.

Certify compliance of the RAS with [DMS-11000](#), "Evaluating and Using Nonhazardous Recyclable Materials Guidelines." Treat RAS as an established nonhazardous recyclable material if it has not come into contact with any hazardous materials. Use RAS from shingle sources on the MPL. Remove all materials that are not part of the shingle, such as wood, paper, metal, plastic, and felt paper, before use. Determine the deleterious content of RAS material for mixture design purposes in accordance with [Tex-217-F](#), Part III. Do not use RAS if deleterious materials are more than 0.5% of the stockpiled RAS, unless otherwise approved. Submit a sample for approval before submitting the mixture design. The Department will perform the testing for deleterious material of RAS to determine specification compliance.

- 2.8. **Substitute Binders.** No binder substitution will be allowed when shown on the plans. The Contractor may use a substitute PG binder shown in Table 5 instead of the PG binder originally specified, if using recycled materials, and if the substitute PG binder and mixture made with the substitute PG binder meet the following.
- The substitute binder meets the specification requirements for the substitute binder grade in accordance with Section 300.2.11., "Performance-Graded Binders."
  - The mixture has less than 10.0 mm of rutting on the Hamburg wheel test ([Tex-242-F](#)) after the number of passes required for the originally specified binder. Use of substitute PG binders may be allowed only at the discretion of the Engineer if the Hamburg wheel test results are between 10.0 mm and 12.5 mm.

**Table 5**  
**Allowable PG Binders and Max Recycled Binder Ratios**

Originally Specified PG Binder	Allowable Substitute PG Binder for Surface Mixes	Allowable Substitute PG Binder for Intermediate and Base Mixes	Maximum Ratio of Recycled Binder <sup>1</sup> to Total Binder (%)		
			Surface	Intermediate	Base
76-22	70-22	70-22	15.0	25.0	30.0
70-22	Note <sup>2</sup>	64-22	15.0	25.0	30.0
64-22	Note <sup>2</sup>	Note <sup>2</sup>	15.0	25.0	30.0
76-28	70-28	70-28	15.0	25.0	30.0
70-28	Note <sup>2</sup>	64-28	15.0	25.0	30.0
64-28	Note <sup>2</sup>	Note <sup>2</sup>	15.0	25.0	30.0

1. Combined recycled binder from RAP and RAS. RAS is not permitted in surface mixtures unless otherwise shown on the plans.
2. No binder substitution is allowed.

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### 3. EQUIPMENT

Provide required or necessary equipment in accordance with Item 320, "Equipment for Asphalt Concrete Pavement."

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### 4. CONSTRUCTION

Produce, haul, place, and compact the specified paving mixture. In addition to tests required in accordance with the Specification, the Contractor may perform other QC tests as necessary. Anytime during the project, the Engineer may perform production and placement tests as necessary in accordance with Item 5, "Control of the Work." Schedule and participate in a mandatory pre-paving meeting with the Engineer on or before the first day of paving unless otherwise shown on the plans.

- 4.1. **Certification.** Personnel certified by the Department-approved HMA certification program must conduct all mixture designs, sampling, and testing in accordance with Table 6. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made. Provide a mixture design developed and signed by a Level 2-certified specialist. Provide Level 1A-certified specialists at the plant during production operations. Provide Level 1B-certified specialists to conduct placement tests. Provide Level AGG101-certified specialists for aggregate testing.

**Table 6  
Test Methods, Test Responsibility, and Min Certification Levels**

Test Description	Test Method	Contractor	Engineer	Level <sup>1</sup>
<b>Aggregate and Recycled Material Testing</b>				
Sampling	<a href="#">Tex-221-F</a>	✓	✓	1A/AGG101
Dry sieve	<a href="#">Tex-200-F, Part I</a>	✓	✓	1A/AGG101
Washed sieve	<a href="#">Tex-200-F, Part II</a>	✓	✓	1A/AGG101
Deleterious material	<a href="#">Tex-217-F, Part I and Part III</a>	✓	✓	AGG101
Decantation	<a href="#">Tex-217-F, Part II</a>	✓	✓	AGG101
Los Angeles abrasion	<a href="#">Tex-410-A</a>	-	✓	Department
Magnesium sulfate soundness	<a href="#">Tex-411-A</a>	-	✓	Department
Micro-Deval abrasion	<a href="#">Tex-461-A</a>	-	✓	AGG101
Crushed face count	<a href="#">Tex-460-A</a>	✓	✓	AGG101
Flat and elongated particles	<a href="#">Tex-280-F</a>	✓	✓	AGG101
Linear shrinkage	<a href="#">Tex-107-E</a>	✓	✓	AGG101
Sand equivalent	<a href="#">Tex-203-F</a>	✓	✓	AGG101
Methylene blue test	<a href="#">Tex-252-F</a>	-	✓	Department
Bulk-specific gravity	<a href="#">Tex-201-F</a>	✓	✓	AGG101
Organic impurities	<a href="#">Tex-408-A</a>	✓	✓	AGG101
<b>Asphalt Binder and Tack Coat Sampling</b>				
Asphalt binder sampling	<a href="#">Tex-500-C, Part II</a>	✓	✓	1A/1B
Tack coat sampling	<a href="#">Tex-500-C, Part III</a>	✓	✓	1A/1B
<b>Mix Design and Verification</b>				
Design and job-mix formula (JMF) changes	<a href="#">Tex-204-F</a>	✓	✓	2
Mixing	<a href="#">Tex-205-F</a>	✓	✓	2
Molding (Superpave gyratory compactor [SGC])	<a href="#">Tex-241-F</a>	✓	✓	1A
Laboratory-molded density	<a href="#">Tex-207-F, Part I and Part VI</a>	✓	✓	1A
Rice gravity	<a href="#">Tex-227-F, Part II</a>	✓	✓	1A
Ignition oven correction factors <sup>2</sup>	<a href="#">Tex-236-F, Part II</a>	✓	✓	1A
Indirect tensile strength	<a href="#">Tex-226-F</a>	✓	✓	1A
Hamburg wheel test	<a href="#">Tex-242-F</a>	✓	✓	1A
Witnessing mixing of correction factors	<a href="#">Tex-236-F, Part III</a>	-	✓	Department
Boil test	<a href="#">Tex-530-C</a>	✓	✓	1A
<b>Production Testing</b>				
Selecting production random numbers	<a href="#">Tex-225-F, Part I</a>	-	✓	1A
Mixture sampling	<a href="#">Tex-222-F</a>	✓	✓	1A/1B
Molding (SGC)	<a href="#">Tex-241-F</a>	✓	✓	1A
Laboratory-molded density	<a href="#">Tex-207-F, Part I and Part VI</a>	✓	✓	1A
Rice gravity	<a href="#">Tex-227-F, Part II</a>	✓	✓	1A
Gradation and asphalt binder content <sup>2</sup>	<a href="#">Tex-236-F, Part I</a>	✓	✓	1A
Control charts	<a href="#">Tex-233-F</a>	✓	✓	1A
Moisture content	<a href="#">Tex-212-F, Part II</a>	✓	✓	1A/AGG101
Hamburg wheel test	<a href="#">Tex-242-F</a>	✓	✓	1A
Micro-Deval abrasion	<a href="#">Tex-461-A</a>	-	✓	AGG101
Boil test	<a href="#">Tex-530-C</a>	✓	✓	1A
Abson recovery	<a href="#">Tex-211-F</a>	-	✓	Department

Test Description	Test Method	Contractor	Engineer	Level <sup>1</sup>
<b>Placement Testing</b>				
Selecting placement random numbers	<a href="#">Tex-225-F</a> , Part II	-	✓	1B
Trimming roadway cores	<a href="#">Tex-251-F</a> , Part I and Part II	✓	✓	1A/1B
In-place air voids	<a href="#">Tex-207-F</a> , Part I and Part VI	✓	✓	1A
In-place density (nuclear method)	<a href="#">Tex-207-F</a> , Part III	✓	-	1B
Establish rolling pattern	<a href="#">Tex-207-F</a> , Part IV	✓	-	1B
Control charts	<a href="#">Tex-233-F</a>	✓	✓	1A
Ride quality measurement	<a href="#">Tex-1001-S</a>	✓	✓	Note <sup>3</sup>
Segregation (density profile)	<a href="#">Tex-207-F</a> , Part V	✓	✓	1B
Longitudinal joint density	<a href="#">Tex-207-F</a> , Part VII	✓	✓	1B
Thermal profile	<a href="#">Tex-244-F</a>	✓	-	1B
Shear bond strength test	<a href="#">Tex-249-F</a>	-	✓	Department

1. Levels 1A, 1B, AGG101, and 2 are certification levels provided by the Hot Mix Asphalt Center certification program.
2. Refer to Section 341.4.9.2.3., "Production Testing," for exceptions to using an ignition oven.
3. Profiler and operator are required to be certified at the Texas A&M Transportation Institute facility when surface test Type B is specified.

4.2. **Reporting and Responsibilities.** Use Department-provided templates to record and calculate all test data, including mixture design, production and placement QC and QA, control charts, thermal profiles, segregation density profiles, and longitudinal joint density. Obtain the current version of the templates from the Department’s website or from the Engineer. The Engineer and the Contractor will provide any available test results to the other party when requested. The maximum allowable time for the Contractor and Engineer to exchange test data is as shown in Table 7, unless otherwise approved. The Engineer and the Contractor will immediately report to the other party any test result that requires suspension of production or placement, or a payment adjustment less than 1.000, or that fails to meet the specification requirements. Record and electronically submit all test results and pertinent information on Department-provided templates.

Subsequent sublots placed after test results are available to the Contractor, which require suspension of operations, may be considered unauthorized work. Unauthorized work will be accepted or rejected at the discretion of the Engineer in accordance with Article 5.3., "Conformity with Plans, Specifications, and Special Provisions."

**Table 7  
Reporting Schedule**

Description	Reported By	Reported To	To Be Reported Within
<b>Production Quality Control</b>			
Gradation <sup>1</sup>	Contractor	Engineer	1 working day of completion of the subplot
Asphalt binder content <sup>1</sup>			
Laboratory-molded density <sup>2</sup>			
Moisture content <sup>3</sup>			
Boil test <sup>4</sup>			
<b>Production Quality Assurance</b>			
Gradation <sup>3</sup>	Engineer	Contractor	1 working day of completion of the subplot
Asphalt binder content <sup>3</sup>			
Laboratory-molded density <sup>1</sup>			
Hamburg wheel test <sup>5</sup>			
Boil test <sup>4</sup>			
Binder tests <sup>5</sup>			

Description	Reported By	Reported To	To Be Reported Within
<b>Placement Quality Control</b>			
In-place air voids <sup>2</sup>	Contractor	Engineer	1 working day of completion of the lot
Segregation <sup>1</sup>			
Longitudinal joint density <sup>1</sup>			
Thermal profile <sup>1</sup>			
<b>Placement Quality Assurance</b>			
In-place air voids <sup>1</sup>	Engineer	Contractor	1 working day after receiving the trimmed cores <sup>6</sup>
Segregation <sup>3</sup>			1 working day of completion of the lot
Longitudinal joint density <sup>3</sup>			
Thermal profile <sup>3</sup>			
Aging ratio <sup>5</sup>			
Shear bond strength test <sup>5</sup>	5 working days after receiving the cores		
Payment adjustment summary	Engineer	Contractor	2 working days of performing all required tests and receiving Contractor test data

1. These tests are required on every subplot.
2. Optional test. When performed on split samples, report the results as soon as they become available.
3. To be performed at the frequency shown in Table 16 or as shown on the plans.
4. When shown on the plans.
5. To be reported as soon as the results become available.
6. Two days are allowed if cores cannot be dried to constant weight within 1 day.

The Engineer will use the Department-provided template to calculate all payment adjustment factors for the lot. Sublot samples may be discarded after the Engineer and Contractor sign off on the payment adjustment summary documentation for the lot.

Use the procedures described in [Tex-233-F](#) to plot the results of all QC and QA testing. Update the control charts as soon as test results for each subplot become available. Make the control charts readily accessible at the field laboratory. The Engineer may suspend production for failure to update control charts.

- 4.3. **Quality Control Plan (QCP).** Develop and follow the QCP in detail. Obtain approval for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP before the mandatory pre-paving meeting. Receive approval of the QCP before beginning production. Include the following items in the QCP.

- 4.3.1. **Project Personnel.** For project personnel, include:
- a list of individuals responsible for QC with authority to take corrective action,
  - current contact information for each individual listed, and
  - current copies of certification documents for individuals performing specified QC functions.
- 4.3.2. **Material Delivery and Storage.** For material delivery and storage, include:
- the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
  - aggregate stockpiling procedures to avoid contamination and segregation;
  - frequency, type, and timing of aggregate stockpile testing to assure conformance with material requirements before mixture production; and
  - procedure for monitoring the quality and variability of asphalt binder.

4.3.3. **Production.** For production, include:

- loader operation procedures to avoid contamination in cold bins;
- procedures for calibrating and controlling cold feeds;
- procedures to eliminate debris or oversized material;
- procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, RAS, lime, liquid antistriper, compaction aid, foaming process, and WMA);
- procedures for reporting job control test results; and
- procedures to avoid segregation and drain-down in the silo.

4.3.4. **Loading and Transporting.** For loading and transporting, include:

- type and application method for release agents, and
- truck-loading procedures to avoid segregation.

4.3.5. **Placement and Compaction.** For placement and compaction, include:

- proposed agenda for mandatory pre-paving meeting, including date and location;
- proposed paving plan (e.g., production rate, paving widths, joint offsets, and lift thicknesses);
- type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- procedures for the transfer of mixture into the paver while avoiding physical and thermal segregation and preventing material spillage;
- process to balance production, delivery, paving, and compaction to achieve continuous placement operations and good ride quality;
- paver operations (e.g., speed, operation of wings, and height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- procedures to construct quality longitudinal and transverse joints.

4.4. **Mixture Design.**

4.4.1. **Design Requirements.** Use the dense-graded design procedure provided in [Tex-204-F](#), unless otherwise shown on the plans. Design the mixture to meet the requirements shown in Tables 1, 2, 3, 4, 5, 8, 9, and 10.

Design the mixture using an SGC, and 50 gyrations as the design number of gyrations ( $N_{design}$ ). Use a target laboratory-molded density of 96.0% to design the mixture; however, adjustments can be made to the  $N_{design}$  value as shown in Table 9. The  $N_{design}$  level may be reduced to at least 35 gyrations at the Contractor's discretion.

Use a Department-approved laboratory on the MPL to perform the Hamburg wheel test and provide results with the mixture design, or provide the laboratory mixture and request that the Department perform the Hamburg wheel test. Upon receiving the sample from the Contractor, the Engineer will be allowed 10 working days to provide the Contractor with Hamburg wheel test results on the laboratory mixture design.

The Engineer will provide the mixture design when shown on the plans. The Contractor may submit a new mixture design anytime during the project. The Engineer will verify and approve all mixture designs (JMF1) before the Contractor can begin production.

Provide the Engineer with a mixture design report using the Department-provided template. Include the following items in the report:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- the binder source and optimum design asphalt content;
- asphalt binder content and aggregate gradation of RAP and RAS stockpiles;
- the  $N_{design}$  level used on the SGC;

- results of all applicable tests;
- the mixing and molding temperatures;
- the signature of the Level 2 person or persons who performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

**Table 8**  
**Master Gradation Limits (% Passing by Wt. or Volume) and Void in Mineral Aggregate (VMA) Requirements**

Sieve Size	DG-B Fine Base	DG-C Coarse Surface	DG-D Fine Surface	DG-F Fine Mixture
2"	—	—	—	—
1-1/2"	100.0 <sup>1</sup>	—	—	—
1"	98.0–100.0	100.0 <sup>1</sup>	—	—
3/4"	84.0–98.0	95.0–100.0	100.0 <sup>1</sup>	—
1/2"	—	—	98.0–100.0	100.0 <sup>1</sup>
3/8"	60.0–80.0	70.0–85.0	85.0–100.0	98.0–100.0
#4	40.0–60.0	43.0–63.0	50.0–70.0	70.0–90.0
#8	29.0–43.0	32.0–44.0	35.0–46.0	38.0–48.0
#30	13.0–28.0	14.0–28.0	15.0–29.0	12.0–27.0
#50	6.0–20.0	7.0–21.0	7.0–20.0	6.0–19.0
#200	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0
<b>Design (VMA), % Min</b>				
—	13.0	14.0	15.0	16.0
<b>Production (Plant-Produced) (VMA), % Min</b>				
—	12.5	13.5	14.5	15.5

1. Defined as Max sieve size. No tolerance allowed.

**Table 9**  
**Laboratory Mixture Design Properties**

Mixture Property	Test Method	Requirement
Target laboratory-molded density, %	<a href="#">Tex-207-F</a>	96.0
Design gyrations (N <sub>design</sub> )	<a href="#">Tex-241-F</a>	50 <sup>1</sup>
Indirect tensile strength (dry), psi	<a href="#">Tex-226-F</a>	85–200 <sup>2</sup>
Boil test <sup>3</sup>	<a href="#">Tex-530-C</a>	—

1. Adjust within a range of 35–100 gyrations when shown on the plans, in accordance with the specification, or when mutually agreed between the Engineer and Contractor.
2. The Engineer may allow the indirect tensile test strength to exceed 200 psi if the corresponding Hamburg wheel rut depth is >2.5 mm and <12.5 mm.
3. When shown on the plans. Used to establish baseline for comparison to production results.

**Table 10**  
**Hamburg Wheel Test Requirements**

High-Temperature Binder Grade	Test Method	Min # of Passes at 12.5-mm <sup>1</sup> Rut Depth, Tested at 50°C
PG 64 or lower	<a href="#">Tex-242-F</a>	10,000 <sup>2</sup>
PG 70		15,000 <sup>3</sup>
PG 76 or higher		20,000

1. The Hamburg wheel test will have a minimum rut depth of 2.5 mm.
2. May be decreased to at least 5,000 passes when shown on the plans.
3. May be decreased to at least 10,000 passes when shown on the plans.

4.4.2. **Job-Mix Formula Approval.** The JMF is the combined aggregate gradation, N<sub>design</sub> level, and target asphalt percentage used to establish target values for hot-mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. When WMA is used, JMF1 may be designed and submitted to the

Engineer without including the WMA additive, foaming process, or compaction aid. When WMA or a compaction aid is used, document the additive or process used and recommended rate in the JMF1 submittal. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch, unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1. The Department may require the Contractor to reimburse the Department for verification tests if more than two trial batches per design are required.

4.4.2.1. **Contractor's Responsibilities.**

4.4.2.1.1. **Providing Superpave Gyrotory Compactor.** Provide an SGC in accordance with Item 504, "Field Office and Laboratory," and make the SGC available to the Engineer for use in molding production samples.

4.4.2.1.2. **Gyrotory Compactor Correlation Factors.** Use [Tex-206-F](#), Part II, to perform a gyrotory compactor correlation when the Engineer uses a different SGC. Apply the correlation factor to all subsequent production test results.

4.4.2.1.3. **Submitting JMF1.** Furnish a mix design report (JMF1) with representative samples of all component materials and request approval to produce the trial batch. Provide approximately 25 lb. of the design mixture if opting to have the Department perform the Hamburg wheel test on the laboratory mixture, and request that the Department perform the test.

4.4.2.1.4. **Supplying Aggregates.** Provide approximately 40 lb. of each aggregate stockpile unless otherwise directed.

4.4.2.1.5. **Supplying Asphalt.** Provide at least 1 gal. of the asphalt material and enough quantities of any additives proposed for use.

4.4.2.1.6. **Ignition Oven Correction Factors.** Notify the Engineer before performing [Tex-236-F](#), Part II. Allow the Engineer to witness the mixing of ignition oven correction factor sample. Determine the aggregate and asphalt correction factors from the ignition oven in accordance with [Tex-236-F](#), Part II.

If the Engineer witnesses the mixing of the ignition oven correction factor samples, provide the Engineer with identically prepared samples of the mixtures before the trial batch production, including all additives (except water), and blank samples used to determine the correction factors for the ignition oven used for QA testing during production.

Correction factors established from a previously approved mixture design may be used for the current mixture design if the mixture design and ignition oven are the same as previously used, unless otherwise directed. Correction factors must be performed every 12 mo.

4.4.2.1.7. **Boil Test.** When shown on the plans, perform the test and retain the tested sample from [Tex-530-C](#) until completion of the project or as directed. Use this sample for comparison purposes during production.

4.4.2.1.8. **Trial Batch Production.** Provide a plant-produced trial batch upon receiving conditional approval of JMF1 and authorization to produce a trial batch. If applicable, include the WMA additive, foaming process, or compaction aid for verification testing of JMF1 and development of JMF2. Produce a trial batch mixture that meets the requirements shown in Tables 4, 5, and 11. The Engineer may accept test results from recent production of the same mixture instead of a new trial batch.

4.4.2.1.9. **Trial Batch Production Equipment.** Use only equipment and materials proposed for use on the project to produce the trial batch.

4.4.2.1.10. **Trial Batch Quantity.** Produce enough quantity of the trial batch to ensure that the mixture meets the specification requirements.

- 4.4.2.1.11. **Number of Trial Batches.** Produce trial batches as necessary to obtain a mixture that meets the specification requirements.
- 4.4.2.1.12. **Trial Batch Sampling.** Obtain a representative sample of the trial batch and split it into three equal portions in accordance with [Tex-222-F](#). Label these portions as “Contractor,” “Engineer,” and “Referee.” Deliver samples to the appropriate laboratory as directed.
- 4.4.2.1.13. **Trial Batch Testing.** Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the mixture requirements shown in Table 11. Ensure the trial batch mixture is also in compliance with the Hamburg wheel requirement shown in Table 10. Use a Department-approved laboratory listed on the MPL to perform the Hamburg wheel test on the trial batch mixture, or request that the Department perform the Hamburg wheel test. Provide approximately 25 lb. of the trial batch mixture if opting to have the Department perform the Hamburg wheel test, and request that the Department perform the test. Upon receiving the sample from the Contractor, the Engineer will be allowed 10 working days to provide the Contractor with Hamburg wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.
- 4.4.2.1.14. **Development of JMF2.** After the Engineer grants full approval of JMF1, evaluate the trial batch test results, determine the optimum mixture proportions, and submit as JMF2. Adjust the asphalt binder content or gradation to achieve the specified target laboratory-molded density. The asphalt binder content established for JMF2 is not required to be within any tolerance of the optimum asphalt binder content established for JMF1; however, mixture produced using JMF2 must meet the VMA requirements for production shown in Table 8. If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform [Tex-226-F](#) on Lot 1 production to confirm the indirect tensile strength does not exceed 200 psi. Verify that JMF2 meets the mixture requirements shown in Table 4 and Table 5.
- 4.4.2.1.15. **Mixture Production.** Use JMF2 to produce Lot 1 in accordance with Section 341.4.9.3.1.1., “Lot 1 Placement,” after receiving approval for JMF2 and a passing Hamburg wheel result on the trial batch from a laboratory listed on the MPL. Once JMF2 is approved, and without receiving the results from the Department’s Hamburg wheel test on the trial batch, the Contractor may proceed to Lot 1 production at their own risk.
- Notify the Engineer if electing to proceed without Hamburg wheel test results from the trial batch. Note that the Engineer may require up to the entire subplot of any mixture failing the Hamburg wheel test to be removed and replaced at the Contractor’s expense.
- 4.4.2.1.16. **Development of JMF3.** Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.
- 4.4.2.1.17. **JMF Adjustments.** If JMF adjustments are necessary to achieve the specified requirements, make the adjustments before beginning a new lot. The adjusted JMF must:
- be provided to the Engineer in writing before the start of a new lot,
  - be numbered in sequence to the previous JMF,
  - meet the mixture requirements in accordance with Table 4 and Table 5,
  - meet the master gradation limits in accordance with Table 8, and
  - be within the operational tolerances of JMF2 in accordance with Table 11.
- 4.4.2.1.18. **Requesting Referee Testing.** Use referee testing, if needed, in accordance with Section 341.4.9.1., “Referee Testing,” to resolve testing differences with the Engineer.

**Table 11**  
**Operational Tolerances**

Description	Test Method	Allowable Difference Between JMF2 and JMF1 Target <sup>1</sup>	Allowable Difference Between Current JMF and JMF2 <sup>2</sup>	Allowable Difference Between Contractor and Engineer <sup>3</sup>
Individual % retained on #8 sieve and larger	<a href="#">Tex-200-F</a> or <a href="#">Tex-236-F</a>	Must be Within Master Gradation Limits in Table 8	±5.04	±5.0
Individual % retained on sieves smaller than #8 and larger than #200			±3.04	±3.0
% passing the #200 sieve			±2.04	±1.6
Asphalt binder content, %	<a href="#">Tex-236-F</a>	±0.5	±0.3	±0.3
Laboratory-molded density, %	<a href="#">Tex-207-F</a>	±1.0	±1.0	±1.0
In-place air voids, %		–	–	±1.0
Laboratory-molded bulk specific gravity		–	–	±0.020
VMA, %, Min	<a href="#">Tex-204-F</a>	Note <sup>5</sup>	Note <sup>5</sup>	–
Theoretical maximum specific (Rice) gravity	<a href="#">Tex-227-F</a>	–	–	±0.020

- JMF1 is the approved laboratory mixture design used for producing the trial batch. JMF2 is the approved mixture design developed from the trial batch used to produce Lot 1.
- Current JMF is JMF3 or higher. JMF3 is the approved mixture design used to produce Lot 2.
- Contractor may request referee testing when values exceed these tolerances.
- When within these tolerances, mixture production gradations may fall outside the master gradation limits; however, the % passing the #200 will be considered out of tolerance when outside the master gradation limits.
- Verify that Table 8 requirements are met for VMA.

#### 4.4.2.2. Engineer's Responsibilities.

4.4.2.2.1. **Superpave Gyrotory Compactor.** The Engineer will use a Department SGC, calibrated in accordance with [Tex-241-F](#), to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location.

4.4.2.2.2. **Conditional Approval of JMF1 and Authorizing Trial Batch.** The Engineer will review and verify conformance with the following information within 2 working days of receipt:

- the Contractor's mix design report (JMF1);
- the Contractor-provided Hamburg wheel test results;
- all required materials including aggregates, asphalt, additives, and recycled materials; and
- the mixture specifications.

The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates that the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg wheel test results with laboratory mixture design, 10 working days are allowed for conditional approval of JMF1. The Engineer will base full approval of JMF1 on the test results on mixture from the trial batch.

Unless waived, the Engineer will determine the Micro-Deval abrasion loss in accordance with Section 341.2.1.1.2., "Micro-Deval Abrasion." If the Engineer's test results are pending after 2 working days, conditional approval of JMF1 will still be granted within 2 working days of receiving JMF1. When the Engineer's test results become available, they will be used for specification compliance.

The Contractor is authorized to produce a trial batch after the Engineer grants conditional approval of JMF1.

4.4.2.2.3. **Hamburg Wheel Testing of JMF1.** If the Contractor requests the option to have the Department perform the Hamburg wheel test on the laboratory mixture, the Engineer will mold samples in accordance with [Tex-242-F](#) to verify compliance with the Hamburg wheel test requirement shown in Table 10. Upon receiving the sample from the Contractor, the Engineer will be allowed 10 working days to provide the Contractor with Hamburg wheel test results on the laboratory mixture design.

- 4.4.2.2.4. **Ignition Oven Correction Factors.** The Engineer will determine ignition oven correction factors by one of the following options.
- Witness the mixing of ignition oven correction factor samples by the Contractor in accordance with [Tex-236-F](#), Part III. The Engineer will use the identically prepared samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven in accordance with [Tex-236-F](#), Part II.
  - If the Engineer does not witness the mixing of ignition oven correction factor samples, the Engineer will prepare the samples to determine the aggregate and asphalt correction factors for the ignition oven in accordance with [Tex-236-F](#), Part II. Notify the Contractor before performing [Tex-236-F](#), Part II. Allow the Contractor to witness the Engineer performing [Tex-236-F](#), Part II.

Correction factors must be performed every 12 mo. to be used for QA testing during production.

- 4.4.2.2.5. **Testing the Trial Batch.** Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the mixture meets the requirements shown in Table 11. If the Contractor requests the option to have the Department perform the Hamburg wheel test on the trial batch mixture, the Engineer will mold samples in accordance with [Tex-242-F](#) to verify compliance with the Hamburg wheel test requirement shown in Table 10.

The Engineer will have the option to perform the following tests on the trial batch.

- [Tex-226-F](#), to verify that the indirect tensile strength meets the requirement shown in Table 9.
  - [Tex-530-C](#), to retain and use for comparison purposes during production.
- 4.4.2.2.6. **Full Approval of JMF1.** The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for the trial batch meet the requirements shown in Tables 8, 9, and 10. The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet these requirements.
- 4.4.2.2.7. **Approval of JMF2.** The Engineer will approve JMF2 within 1 working day if the mixture meets the requirements shown in Table 5 and Table 8. The asphalt binder content established for JMF2 is not required to be within any tolerance of the optimum asphalt binder content established for JMF1; however, mixture produced using JMF2 must meet the VMA requirements shown in Table 8. If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform [Tex-226-F](#) on Lot 1 production to confirm the indirect tensile strength does not exceed 200 psi.
- 4.4.2.2.8. **Approval of Lot 1 Production.** The Engineer will authorize the Contractor to proceed with JMF2 for Lot 1 production after a passing Hamburg wheel test result on the trial batch is achieved from a laboratory listed on the MPL. The Contractor may proceed at their own risk with Lot 1 production without the results from the Hamburg wheel test on the trial batch.

If the Department-approved laboratory's sample from the trial batch fails the Hamburg wheel test, the Engineer will suspend production until further Hamburg wheel tests meet the specified values. The Engineer may require up to the entire subplot of any mixture failing the Hamburg wheel test be removed and replaced at the Contractor's expense.

- 4.4.2.2.9. **Approval of JMF3 and Subsequent JMF Changes.** JMF3 and subsequent JMF changes are approved if they meet the mixture requirements shown in Table 4 and Table 5, and the master gradation limits shown in Table 8, and they are within the operational tolerances of JMF2 shown in Table 11. The addition of a WMA additive to facilitate mixing or as a compaction aid does not require a new laboratory mixture design or trial batch. Current JMF changes that exceed the operational tolerances of JMF2 in accordance with Table 11 may require a new laboratory mixture design, trial batch, or both.

- 4.5. **Production Operations.** Perform a new trial batch when the plant or plant location is changed. All source changes for asphalt will require a passing Hamburg wheel test result from a laboratory listed on the MPL. The Contractor may proceed at their own risk with Lot 1 production without the results from the Hamburg wheel test on the trial batch. All aggregate source changes will require a new laboratory mixture design and trial batch. Take corrective action and receive approval to proceed after any production suspension for noncompliance with the specification. Submit a new mix design and perform a new trial batch when the asphalt binder content of:
- any RAP stockpile used in the mix is more than 0.5% higher than the value shown in the mixture design report, or
  - RAS stockpile used in the mix is more than 2.0% higher than the value shown in the mixture design report.

- 4.5.1. **Storage and Heating of Materials.** Do not heat the asphalt binder above the temperatures specified in Item 300, or outside the manufacturer’s recommended values. Provide the Engineer with daily records of asphalt binder and HMA discharge temperatures (in legible and discernible increments) in accordance with Item 320, unless otherwise directed. Do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr. unless otherwise approved.

- 4.5.2. **Mixing and Discharge of Materials.** Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed the maximum production temperatures shown in Table 12. The Department will not pay for or allow placement of any mixture produced above the maximum production temperatures shown in Table 12.

**Table 12**  
**Max Production Temperature**

High-Temperature Binder Grade <sup>1</sup>	Max Production Temperature (°F)
PG 64	325 <sup>2</sup>
PG 70	335 <sup>2</sup>
PG 76	345 <sup>2</sup>

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The Max production temperature of WMA is 275°F.

Produce WMA within the target discharge temperature range of 215–275°F when WMA is required. Take corrective action anytime the discharge temperature of the WMA exceeds the target discharge range. The Engineer may suspend production operations if the Contractor’s corrective action is not successful at controlling the production temperature within the target discharge range. Note that when WMA is produced, it may be necessary to adjust burners to ensure complete combustion such that no burner fuel residue remains in the mixture.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. Determine the moisture content, if requested, by oven-drying in accordance with [Tex-212-F](#), Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck and perform the test promptly.

- 4.6. **Hauling Operations.** Clean all truck beds before use to ensure that mixture is not contaminated. Use a release agent listed on the MPL to coat the inside bed of the truck when necessary. Do not use diesel or any release agent not listed on the MPL.

Use equipment for hauling as defined in Section 341.4.7.3.3., “Hauling Equipment.” Use other hauling equipment only when allowed.

4.7. **Placement Operations.** Collect haul tickets from each load of mixture delivered to the project and provide the Department’s copy to the Engineer approximately every hour, or as directed. Use a handheld thermal camera or infrared thermometer, when a thermal imaging system is not used, to measure and record the internal temperature of the mixture as discharged from the truck or material transfer device (MTD) before or as the mix enters the paver. Measure the mixture temperature at a minimum frequency of one per ten trucks, or as approved. Include an approximate station number or Global Positioning System coordinates of the location where the temperature was taken on each ticket. Ensure the mixture meets the temperature requirements shown in Table 12. Calculate the daily yield and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day unless otherwise directed. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 in. Place mixture so that longitudinal joints on the surface course coincide within 6 in. of lane lines, are not placed in the wheel path, or will not be covered with pavement markings, or as directed. Ensure that all finished surfaces will drain properly. Place the mixture at the rate or thickness shown on the plans. The Engineer will use the guidelines shown in Table 13 to determine the compacted lift thickness of each layer when multiple lifts are required. The thickness determined is based on the rate of 110 lb. per square yard for each inch of pavement, unless otherwise shown on the plans.

**Table 13  
Compacted Lift Thickness and Required Core Height**

Mixture Type	Compacted Lift Thickness Guidelines		Min Untrimmed Core Height Eligible for Testing (in.)
	Min (in.)	Max (in.)	
DG-B	2.50	5.00	1.75
DG-C	2.00	4.00	1.50
DG-D	1.50	3.00	1.25
DG-F	1.25	2.50	1.25

4.7.1. **Weather Conditions.**

4.7.1.1. **When Using a Thermal Imaging System.** Place mixture when the roadway surface is dry and the roadway surface temperature is at or above the temperatures shown in Table 14A, unless otherwise approved or as shown on the plans. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. Provide output data from the thermal imaging system to demonstrate to the Engineer that no recurring severe thermal segregation exists in accordance with Section 341.4.7.3.1.2., “Thermal Imaging System.”

**Table 14A  
Min Pavement Surface Temperatures**

High-Temperature Binder Grade <sup>1</sup>	Min Pavement Surface Temperatures (°F)	
	Subsurface Layers	Surface Layers
PG 64	35	40
PG 70	45 <sup>2</sup>	50 <sup>2</sup>
PG 76	45 <sup>2</sup>	50 <sup>2</sup>

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The Contractor may pave at temperatures 10°F lower than these values when a chemical WMA additive is used as a compaction aid in the mixture or when using WMA.

4.7.1.2. **When Not Using a Thermal Imaging System.** When using a thermal camera instead of the thermal imaging system, place mixture when the roadway surface temperature is at or above the temperatures shown in

Table 14B, unless otherwise approved or as shown on the plans. Measure the roadway surface temperature using a handheld thermal camera or infrared thermometer. The Engineer may allow mixture placement to begin before the roadway surface reaches the required temperature if conditions are such that the roadway surface will reach the required temperature within 2 hr. of beginning placement operations. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer.

**Table 14B**  
**Min Pavement Surface Temperatures**

High-Temperature Binder Grade <sup>1</sup>	Min Pavement Surface Temperatures (°F)	
	Subsurface Layers	Surface Layers
PG 64	45	50
PG 70	55 <sup>2</sup>	60 <sup>2</sup>
PG 76	60 <sup>2</sup>	60 <sup>2</sup>

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The Contractor may pave at temperatures 10°F lower than these values when a chemical WMA additive is used as a compaction aid in the mixture, when using WMA, or when using a paving process with equipment that eliminates thermal segregation. In such cases, for each subplot and in the presence of the Engineer, use a handheld thermal camera operated in accordance with [Tex-244-F](#) to demonstrate to the satisfaction of the Engineer that the uncompacted mat has no more than 10°F of thermal segregation.

#### 4.7.2. Tack Coat.

4.7.2.1. **Application.** Clean the surface before placing the tack coat. The Engineer will set the rate between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area. Apply a uniform tack coat at the specified rate unless otherwise directed. Apply the tack coat in a uniform manner to avoid streaks and other irregular patterns. Apply the tack coat to all surfaces that will come in contact with the subsequent HMA placement, unless otherwise directed. Apply adequate overlap of the tack coat in the longitudinal direction during placement of the mat to ensure bond of adjacent mats, unless otherwise directed. Allow adequate time for emulsion to break completely before placing any material. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use, unless required in conformance with the manufacturer's recommendation for approved TRAIL product use, or when shown on the plans.

4.7.2.2. **Sampling.** The Engineer will obtain at least one sample of the tack coat binder per project per source in accordance with [Tex-500-C](#), Part III, and test it to verify compliance with Item 300. The Engineer will notify the Contractor when the sampling will occur and will witness the collection of the sample from the asphalt distributor immediately before use. Label the can with the corresponding lot and subplot numbers, producer, producer facility location, grade, district, date sampled, all applicable bills of lading (if available), and project information, including highway and control-section-job (CSJ) number. For emulsions, the Engineer may test as often as necessary to ensure the residual of the emulsion is greater than or equal to the specification requirement in Item 300.

4.7.3. **Lay-Down Operations.** Use the placement temperatures shown in Table 15 to establish the minimum placement temperature of the mixture delivered to the paving operation.

**Table 15**  
**Min Mixture Placement Temperature**

High-Temperature Binder Grade <sup>1</sup>	Min Placement Temperature <sup>2,3,4</sup> (°F)
PG 64	260
PG 70	270
PG 76	280

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The mixture temperature must be measured using a handheld thermal camera or infrared thermometer immediately before entering MTD or paver.
3. Min placement temperatures may be reduced 20°F if using a chemical WMA additive as a compaction aid, MTD with remixing capabilities, or paver hopper insert with remixing capabilities.
4. When using WMA, the minimum placement temperature is 215°F.

4.7.3.1. **Thermal Profile.** Use a handheld thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with [Tex-244-F](#). Thermal profiles are not applicable in areas described in Section 341.4.9.3.1.4., “Miscellaneous Areas.”

4.7.3.1.1. **Thermal Segregation.**

4.7.3.1.1.1. **Moderate.** Any areas that have a temperature differential greater than 25°F, but not exceeding 50°F.

4.7.3.1.1.2. **Severe.** Any areas that have a temperature differential greater than 50°F.

4.7.3.1.2. **Thermal Imaging System.** Review the output results when a thermal imaging system is used, and provide the automated report described in [Tex-244-F](#) to the Engineer daily, unless otherwise directed. Modify the paving process as necessary to eliminate any recurring (moderate or severe) thermal segregation identified by the thermal imaging system.

The Engineer may suspend paving operations if the Contractor cannot successfully modify the paving process to eliminate recurring severe thermal segregation. Density profiles are not required and not applicable when using a thermal imaging system.

Provide the Engineer with electronic copies of all daily data files that can be used with the thermal imaging system software to generate temperature profile plots daily or as requested.

4.7.3.1.3. **Thermal Camera.** Provide the Engineer with the thermal profile of every subplot within 1 working day of the completion of each lot. When requested by the Engineer, provide the thermal images generated using the thermal camera. Report the results of each thermal profile in accordance with Section 341.4.2., “Reporting and Responsibilities.” The Engineer will use a handheld thermal camera to obtain a thermal profile at least once per project.

Take immediate corrective action to eliminate recurring moderate thermal segregation when a handheld thermal camera is used.

Suspend operations and take immediate corrective action to eliminate severe thermal segregation unless otherwise directed. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Section. No production or placement payment adjustments greater than 1.000 will be paid for any subplot that contains severe thermal segregation. Evaluate areas with severe thermal segregation by performing density profiles in accordance with Section 341.4.9.3.3.3., “Segregation (Density Profile).” Remove and replace the material in any areas that have severe thermal segregation and a failing result for segregation (density profile), unless otherwise directed. The subplot in question may receive a production and placement payment adjustment greater than 1.000, if applicable, when the defective material is successfully removed and replaced.

- 4.7.3.2. **Windrow Operations.** Operate windrow pickup equipment so that when hot mix is placed in windrows, substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.
- 4.7.3.3. **Hauling Equipment.** Use belly dump, live-bottom, or end dump trucks to haul and transfer mixture. Except for paving miscellaneous areas, end dump trucks are allowed only when used in conjunction with an MTD with remixing capability or when a thermal imaging system is used, unless otherwise approved.
- 4.7.3.4. **Screed Heaters.** Turn off screed heaters to prevent overheating of the mat if the paver stops for more than 5 min. The Engineer may evaluate the suspect area in accordance with Section 341.4.9.3.3.5., "Recovered Asphalt Dynamic Shear Rheometer (DSR)," if the screed heater remains on for more than 5 min. while the paver is stopped.
- 4.8. **Compaction.** Compact the pavement uniformly to contain between 3.8% and 8.5% in-place air voids. Take immediate corrective action to bring the operation within 3.8% and 8.5% when the in-place air voids exceed the range of these tolerances. The Engineer will allow paving to resume when the proposed corrective action is likely to yield between 3.8% and 8.5% in-place air voids.
- Obtain cores in areas placed under exempt production, as directed, at locations determined by the Engineer. The Engineer may test these cores and suspend operations or require removal and replacement if the in-place air voids are less than 2.7% or more than 9.9%. Areas defined in Section 341.4.9.3.1.4., "Miscellaneous Areas," are not subject to in-place air void determination.
- Furnish the type, size, and number of rollers necessary to ensure desired compaction. Use additional rollers as required to remove any roller marks. Use only water or an approved release agent on rollers, tamps, and other compaction equipment unless otherwise directed.
- Use the control strip method shown in [Tex-207-E](#), Part IV, on the first day of production to establish the rolling pattern that will produce the desired in-place air voids, unless otherwise directed.
- Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction using rollers. The Engineer may require rolling using a trench roller on widened areas, in trenches, and in other limited areas.
- Complete all compaction operations using breakdown rollers before the pavement temperature drops below 180°F, unless otherwise allowed. Compaction using a pneumatic or light finish roller operated in static mode is allowed for pavement temperatures above 160°F.
- Allow the compacted pavement to cool to 160°F or lower before opening to traffic, unless otherwise directed. Sprinkle the finished mat with water or limewater, when directed, to expedite opening the roadway to traffic.
- 4.9. **Acceptance Plan.** Payment adjustments for the material will be in accordance with Article 341.6., "Payment."
- Sample and test the hot mix on a lot and subplot basis. Suspend production if the production payment factor shown in Section 341.6.1., "Production Payment Adjustment Factors," or the placement payment factor shown in Section 341.6.2., "Placement Payment Adjustment Factors," for two consecutive lots is below 1.000. Resume production once test results or other information indicates to the satisfaction of the Engineer that the next material produced or placed will result in payment factors of at least 1.000.
- 4.9.1. **Referee Testing.** The Materials and Tests Division is the referee laboratory. The Contractor may request referee testing if a "remove and replace" condition is determined based on the Engineer's test results, or if the differences between Contractor and Engineer test results exceed the maximum allowable difference in accordance with Table 11 and the differences cannot be resolved. The Contractor may also request referee testing if the Engineer's test results require suspension of production and the Contractor's test results are within specification limits. Make the request within 5 working days after receiving test results and cores from the Engineer. Referee tests will be performed only on the subplot in question and only for the tests in question.

Allow 10 working days from the time the referee laboratory receives the samples for test results to be reported. The Department may require the Contractor to reimburse the Department for referee tests if more than three referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.

The Materials and Tests Division will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample. The in-place air voids will be determined based on the bulk specific gravity of the cores, as determined by the referee laboratory, and the Engineer's average maximum theoretical specific gravity for the lot. Except for "remove and replace" conditions, referee test results are final and will establish payment adjustment factors for the subplot in question. The Contractor may decline referee testing and accept the Engineer's test results when the placement payment adjustment factor for any subplot results in a "remove and replace" condition. Placement sublots subject to be removed and replaced will be further evaluated in accordance with Section 341.6.2.2., "Placement Sublots Subject to Removal and Replacement."

#### 4.9.2. **Production Acceptance.**

4.9.2.1. **Production Lot.** A production lot consists of four equal sublots. The default quantity for Lot 1 is 1,000 ton; however, when requested by the Contractor, the Engineer may increase the quantity for Lot 1 to no more than 4,000 ton. The Engineer will select subsequent lot sizes based on the anticipated daily production such that approximately three–four sublots are produced each day. The lot size will be between 1,000 ton and 4,000 ton. The Engineer may change the lot size before the Contractor begins any lot.

If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform [Tex-226-F](#) on Lot 1 to confirm the indirect tensile strength does not exceed 200 psi. Take corrective action to bring the mixture within specification compliance if the indirect tensile strength exceeds 200 psi, unless otherwise directed.

4.9.2.1.1. **Incomplete Production Lots.** If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Adjust the payment for the incomplete lot in accordance with Section 341.6.1., "Production Payment Adjustment Factors." Close all lots within 5 working days unless otherwise allowed.

#### 4.9.2.2. **Production Sampling.**

4.9.2.2.1. **Mixture Sampling.** The Engineer will perform or witness the sampling of production sublots from trucks at the plant in accordance with [Tex-222-F](#). The sampler will split each sample into three equal portions in accordance with [Tex-200-F](#) and label these portions as "Contractor," "Engineer," and "Referee." The Engineer will perform or witness the sample splitting and take immediate possession of the samples labeled "Engineer" and "Referee." The Engineer will maintain the custody of the samples labeled "Engineer" and "Referee" until the Department's testing is completed.

4.9.2.2.1.1. **Random Sample.** At the beginning of the project, the Engineer will select random numbers for all production sublots. Determine sample locations in accordance with [Tex-225-F](#). Take one sample for each subplot at the randomly selected location. The Engineer will perform or witness the sampling of production sublots.

4.9.2.2.1.2. **Blind Sample.** For one subplot per lot, the Engineer will sample, split, and test a "blind" production sample instead of the random sample collected by the Contractor. The location of the Engineer's "blind" sample will not be disclosed to the Contractor before sampling. The Engineer's "blind" sample may be randomly selected in accordance with [Tex-225-F](#) for any subplot or selected at the discretion of the Engineer. The Engineer may sample and test an additional blind sample when the random sampling process does not result in obtaining a sample.

For one subplot per lot, the Contractor must obtain from the Engineer a "blind" production sample collected by the Engineer. If desired, the Contractor may witness the collection of blind samples. Test either the "blind" or

the random sample; however, referee testing for the subplot (if applicable) will be based on a comparison of results from the “blind” sample.

- 4.9.2.2.2. **Asphalt Binder Sampling.** The Engineer will witness the Contractor obtain a 1-qt. sample of the asphalt binder for each lot of mixture produced. The Contractor will notify the Engineer when the sampling will occur. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill and upstream from the introduction of any additives in accordance with [Tex-500-C](#), Part II. Label the can with the corresponding lot and subplot numbers, producer name, producer facility, grade, District, date sampled, all applicable bills of lading (if available), and project information, including highway and CSJ number. The Engineer will retain these samples for 1 yr. The Engineer may also obtain independent samples. If obtaining an independent asphalt binder sample and upon request of the Contractor, the Engineer will split a sample of the asphalt binder with the Contractor.

At least once per project, the Engineer will collect split samples of each binder grade and source used. The Engineer will submit one split sample to the Materials and Tests Division to verify compliance with Item 300, and will retain the other split sample for 1 yr.

- 4.9.2.3. **Production Testing.** The Contractor and Engineer must perform production tests shown in Table 16. The Contractor has the option to verify the Engineer’s test results on split samples provided by the Engineer. Determine compliance with operational tolerances shown in Table 11 for all sublots.

Take immediate corrective action if the Engineer’s laboratory-molded density on any subplot is less than 95.0% or greater than 97.0% to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor’s corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

The Engineer may allow alternate methods for determining the asphalt binder content and aggregate gradation if the aggregate mineralogy is such that [Tex-236-F](#), Part I does not yield reliable results. Provide evidence that results from [Tex-236-F](#), Part I are not reliable before requesting permission to use an alternate method unless otherwise directed. Use the applicable test procedure as directed if an alternate test method is allowed.

**Table 16  
Production and Placement Testing Frequency**

Description	Test Method	Min Contractor Testing Frequency	Min Engineer Testing Frequency
Individual % retained on #8 sieve and larger	<a href="#">Tex-200-F</a> or <a href="#">Tex-236-F</a>	1 per subplot	1 per 12 sublots <sup>1</sup>
Individual % retained on sieves smaller than #8 and larger than #200			
% passing #200 sieve			
Laboratory-molded density	<a href="#">Tex-207-F</a>	-	1 per subplot <sup>1</sup>
Laboratory-molded bulk specific gravity			
In-place air voids			
VMA	<a href="#">Tex-204-F</a>		
Segregation (density profile)	<a href="#">Tex-207-F</a> , Part V	1 per subplot <sup>2</sup>	1 per project
Longitudinal joint density	<a href="#">Tex-207-F</a> , Part VII	1 per subplot <sup>3</sup>	1 per project
Moisture content	<a href="#">Tex-212-F</a> , Part II	When directed	1 per project
Theoretical maximum specific (Rice) gravity	<a href="#">Tex-227-F</a>	-	1 per subplot <sup>1</sup>
Asphalt binder content	<a href="#">Tex-236-F</a>	1 per subplot	1 per lot <sup>1</sup>
Thermal profile	<a href="#">Tex-244-F</a>	1 per subplot <sup>2</sup>	1 per project
Hamburg wheel test	<a href="#">Tex-242-F</a>	-	
Deleterious in RAS <sup>4</sup>	<a href="#">Tex-217-F</a> , Part III	-	
Asphalt binder sampling and testing <sup>4,5</sup>	<a href="#">Tex-500-C</a> , Part II	-	
Tack coat sampling and testing	<a href="#">Tex-500-C</a> , Part III	-	
Boil test <sup>6</sup>	<a href="#">Tex-530-C</a>	1 per lot	
Shear bond strength test <sup>7</sup>	<a href="#">Tex-249-F</a>	-	

1. For production defined in Section 341.4.9.4., "Exempt Production," the Engineer will perform one test per day if 100 ton or more is produced. For exempt production, no testing is required when < 100 ton is produced.
2. To be performed in the presence of the Engineer when not using the thermal imaging system, unless otherwise approved.
3. To be performed in the presence of the Engineer.
4. Testing performed by the Materials and Tests Division or designated laboratory.
5. Sampling performed by the Contractor. The Engineer will witness sampling and retain the samples for 1 yr.
6. When shown on the plans.
7. Testing performed by the Materials and Tests Division or District for informational purposes on a sample obtained by the Contractor within the first four lots of the project.

4.9.2.4. **Operational Tolerances.** Control the production process within the operational tolerances shown in Table 11. When production is suspended, the Engineer will allow production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.

4.9.2.4.1. **Gradation.** Suspend operation and take corrective action if any aggregate is retained on the maximum sieve size shown in Table 8. A subplot is defined as out of tolerance if either the Engineer's or the Contractor's test results are out of operational tolerance. Suspend production when test results for gradation exceed the operational tolerances shown in Table 11 for three consecutive sublots on the same sieve or four consecutive sublots on any sieve, unless otherwise directed. The consecutive sublots may be from more than one lot.

4.9.2.4.2. **Asphalt Binder Content.** A subplot is defined as out of operational tolerance if either the Engineer's or the Contractor's test results exceed the values shown in Table 11. No production or placement payment adjustments greater than 1.000 will be paid for any subplot that is out of operational tolerance for asphalt binder content. Suspend production and shipment of the mixture if the Engineer's or the Contractor's asphalt binder content deviates from the current JMF by more than 0.5% for any subplot.

4.9.2.4.3. **VMAs.** The Engineer will determine the VMA for every subplot. For sublots when the Engineer does not determine asphalt binder content, the Engineer will use the asphalt binder content results from QC testing performed by the Contractor to determine VMA.

Take immediate corrective action if the VMA value for any subplot is less than the minimum VMA requirement for production shown in Table 8. Suspend production and shipment of the mixture if the Engineer's VMA results on two consecutive sublots are below the minimum VMA requirement for production shown in Table 8. No production or placement payment adjustments greater than 1.000 will be paid for any subplot that does not meet the minimum VMA requirement for production shown in Table 8 based on the Engineer's VMA determination.

Suspend production and shipment of the mixture if the Engineer's VMA result is more than 0.5% below the minimum VMA requirement for production shown in Table 8. In addition to suspending production, the Engineer may require removal and replacement or may allow the subplot to be left in place without payment.

- 4.9.2.4.4. **Hamburg Wheel Test.** The Engineer may perform a Hamburg wheel test on plant-produced mixture anytime during production. Suspend production until further Hamburg wheel tests meet the specified values when the production samples fail the Hamburg wheel test criteria shown in Table 10. The Engineer may require up to the entire subplot of any mixture failing the Hamburg wheel test to be removed and replaced at the Contractor's expense.

If the Department-approved laboratory's Hamburg wheel test on plant-produced mixture results in a "remove and replace" condition, the Contractor may request that the Materials and Tests Division determine the final disposition of the material in question by re-testing the failing material.

- 4.9.2.5. **Individual Loads of Hot Mix.** The Engineer may reject individual truckloads of hot mix. When a load of hot mix is rejected for reasons other than temperature, contamination, or excessive uncoated particles, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 11, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load.

4.9.3. **Placement Acceptance.**

- 4.9.3.1. **Placement Lot.** A placement lot consists of four placement sublots. A placement subplot consists of the area placed during a production subplot.

- 4.9.3.1.1. **Lot 1 Placement.** Placement payment adjustments greater than 1.000 for Lot 1 will be in accordance with Section 341.6.2., "Placement Payment Adjustment Factors"; however, no placement adjustment less than 1.000 will be assessed for any subplot placed in Lot 1 when the in-place air voids are greater than or equal to 2.7% and less than or equal to 9.9%. Remove and replace any subplot with in-place air voids less than 2.7% or greater than 9.9%.

- 4.9.3.1.2. **Incomplete Placement Lots.** An incomplete placement lot consists of the area placed as described in Section 341.4.9.2.1.1., "Incomplete Production Lots," excluding areas defined in Section 341.4.9.3.1.4., "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production subplot.

- 4.9.3.1.3. **Shoulders, Ramps, Etc.** Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are subject to in-place air void determination and payment adjustments unless shown on the plans as not eligible for in-place air void determination. Intersections may be considered miscellaneous areas when determined by the Engineer.

- 4.9.3.1.4. **Miscellaneous Areas.** Miscellaneous areas include areas that typically involve significant handwork or discontinuous paving operations, such as temporary detours, driveways, mailbox turnouts, crossovers, gores, spot level-up areas, pavement repair sections less than 300 ft., and other similar areas. Temporary detours are subject to in-place air void determination when shown on the plans. Miscellaneous areas also include level-ups and thin overlays when the layer thickness shown on the plans is less than the minimum untrimmed core height eligible for testing in accordance with Table 13. The specified layer thickness is based

on the rate of 110 lb. per square yard for each inch of pavement unless another rate is shown on the plans. When "Level Up" is listed as part of the bid item description, a payment adjustment factor of 1.000 will be assigned for all placement sublots as described in Article 341.6., "Payment." Miscellaneous areas are not eligible for random placement sampling locations. Compact miscellaneous areas in accordance with Section 341.4.8., "Compaction." Miscellaneous areas are not subject to in-place air void determination, thermal profiles testing, segregation (density profiles), or longitudinal joint density evaluations.

- 4.9.3.2. **Placement Sampling.** The Engineer will select random numbers for all placement sublots at the beginning of the project. The Engineer will provide the Contractor with the placement random numbers only immediately after the subplot is completed. Mark the roadway location at the completion of each subplot and record the station number. Determine one random sample location for each placement subplot in accordance with [Tex-225-F](#). Adjust the random sample location by no more than necessary to achieve a 2-ft. clearance if the location is within 2 ft. of a joint or pavement edge.

Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are always eligible for selection as a random sample location; however, if a random sample location falls on one of these areas and the area is shown on the plans as not subject to in-place air void determination, cores will not be taken for the subplot and a 1.000 pay factor will be assigned to that subplot.

Provide the equipment and means to obtain and trim roadway cores onsite. Onsite is defined as in close proximity to where the cores are taken. Obtain the cores within 1 working day of the time the placement subplot is completed, unless otherwise approved. Obtain two 6-in. diameter cores side-by-side from within 1 ft. of the random location provided for the placement subplot. Mark the cores for identification, measure and record the untrimmed core height, and provide the information to the Engineer. The Engineer will witness the coring operation and measurement of the core thickness. Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. Take corrective action if an adequate bond does not exist between the current and underlying layer to ensure that an adequate bond will be achieved during subsequent placement operations.

Trim the cores immediately after obtaining them from the roadway in accordance with [Tex-251-F](#) if the core heights meet the minimum untrimmed value in accordance with Table 13. Trim the cores onsite in the presence of the Engineer. Use a permanent marker or paint pen to record the lot and subplot numbers on each core, as well as the designation as Core A or Core B. The Engineer may require additional information to be marked on the core and may choose to sign or initial the core. The Engineer will take custody of the cores immediately after witnessing the trimming of the cores and will retain custody of the cores until the Department's testing is completed. Before turning the trimmed cores over to the Engineer, the Contractor may wrap the trimmed cores or secure them in a manner that will reduce the risk of possible damage occurring during transport by the Engineer. After testing, the Engineer will return the cores to the Contractor.

The Engineer may have the cores transported back to the Department's laboratory at the HMA plant via the Contractor's haul truck or other designated vehicle. In such cases where the cores will be out of the Engineer's possession during transport, the Engineer will use Department-provided security bags and the Protocol for Roadway Core Custody located on the Department's website to provide a secure means and process that protect the integrity of the cores during transport.

Decide whether to include the pair of cores in the air void determination for that subplot if the core height before trimming is less than the minimum untrimmed value shown in Table 13. Trim the cores in accordance with [Tex-251-F](#) before delivering to the Engineer if electing to have the cores included in the air void determination. If electing to not have the cores included in air void determination, inform the Engineer of the decision, and deliver untrimmed cores to the Engineer. The placement pay factor for the subplot will be 1.000 if cores will not be included in air void determination.

Instead of the Contractor trimming the cores onsite immediately after coring, the Engineer and the Contractor may mutually agree to have the trimming operations performed at an alternate location, such as a field laboratory or other similar location. In such cases, the Engineer will take possession of the cores immediately

after they are obtained from the roadway and will retain custody of the cores until testing is completed. Either the Department or Contractor representative may perform trimming of the cores. The Engineer will witness all trimming operations in cases where the Contractor representative performs the trimming operation.

Dry the core holes and tack the sides and bottom immediately after obtaining the cores. Fill the hole with the same type of mixture and properly compact the mixture. Repair core holes using other methods when approved.

4.9.3.3. **Placement Testing.** Perform placement tests in accordance with Table 16. After the Engineer returns the cores, the Contractor may test the cores to verify the Engineer's test results for in-place air voids. The allowable differences between the Contractor's and Engineer's test results are shown in Table 11.

4.9.3.3.1. **In-Place Air Voids.** The Engineer will measure in-place air voids in accordance with [Tex-207-F](#) and [Tex-227-F](#). Before drying to a constant weight, cores may be pre-dried using a CoreDry or similar vacuum device to remove excess moisture. The Engineer will average the values obtained for all sublots in the production lot to determine the theoretical maximum specific gravity. The Engineer will use the average air void content for in-place air voids.

The Engineer will use the vacuum method to seal the core if required in accordance with [Tex-207-F](#). The Engineer will use the test results from the unsealed core to determine the placement payment adjustment factor if the sealed core yields a higher specific gravity than the unsealed core. After determining the in-place air void content, the Engineer will return the cores and provide test results to the Contractor.

4.9.3.3.2. **Informational Shear Bond Strength Testing.** The Engineer will select one random subplot within the first four lots of the project for shear bond strength testing. Obtain full-depth cores in accordance with [Tex-249-F](#) unless the HMA is being placed directly on concrete pavement. Label the cores with lot and subplot numbers and provide to the Engineer. Inspector must use pertinent Department form to document the CSJ number, producer of the tack coat, mix type, and shot rate. The Engineer will ship the cores to the Materials and Tests Division or District laboratory for shear bond strength testing. Results from these tests will not be used for specification compliance.

4.9.3.3.3. **Segregation (Density Profile).** Test for segregation using density profiles in accordance with [Tex-207-F](#), Part V. Density profiles are not required and are not applicable when using a thermal imaging system. Density profiles are not applicable in areas described in Section 341.4.9.3.1.4., "Miscellaneous Areas."

Perform at least one density profile per subplot. Perform additional density profiles when any of the following conditions occur, unless otherwise approved:

- areas that are identified by either the Contractor or the Engineer with severe thermal segregation,
- any visibly segregated areas that exist,
- the paver stops due to lack of material being delivered to the paving operations and the temperature of the uncompacted mat before the initial breakdown rolling is less than the temperatures shown in Table 17.

**Table 17  
Min Uncompacted Mat Temperature Requiring Segregation Profile<sup>1</sup>**

High-Temperature Binder Grade <sup>2</sup>	Min Temperature of Uncompacted Mat Allowed Before Initial Breakdown Rolling <sup>3,4,5</sup> (°F)
PG 64	<250
PG 70	<260
PG 76	<270

1. Applicable only to paver stops that occur due to lack of material being delivered to the paving operations and when not using a thermal imaging system.
2. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
3. The surface of the uncompacted mat must be measured using a handheld thermal camera or infrared thermometer.
4. Min uncompacted mat temperature requiring a segregation profile may be reduced 20°F if using a chemical WMA additive as a compaction aid, MTD with remixing capabilities, or paver hopper insert with remixing capabilities.
5. When using WMA, the Min uncompacted mat temperature requiring a segregation profile is 215°F.

Provide the Engineer with the density profile of every subplot in the lot within 1 working day of the completion of each lot. Report the results of each density profile in accordance with Section 341.4.2., "Reporting and Responsibilities."

The density profile is considered failing if it exceeds the tolerances shown in Table 18. When a thermal imaging system is not used, the Engineer will measure the density profile at least once per project. The Engineer's density profile results will be used when available. The Engineer may require the Contractor to remove and replace the area in question if the area fails the density profile and has surface irregularities as defined in Section 341.4.9.3.3.6., "Irregularities." The subplot in question may receive a production and placement payment adjustment greater than 1.000, if applicable, when the defective material is successfully removed and replaced.

Investigate density profile failures and take corrective actions during production and placement to eliminate the segregation. Suspend production if two consecutive density profiles fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

**Table 18  
Segregation (Density Profile) Acceptance Criteria**

Mixture Type	Max Allowable Density Range (highest to lowest, pcf)	Max Allowable Density Range (average to lowest, pcf)
DG-B	8.0	5.0
DG-C, DG-D, and DG-F	6.0	3.0

4.9.3.3.4. **Longitudinal Joint Density.**

4.9.3.3.4.1. **Informational Tests.** Perform joint density evaluations while establishing the rolling pattern and verify that the joint density is no more than 3.0 pcf below the density taken at or near the center of the mat. Adjust the rolling pattern, if needed, to achieve the desired joint density. Perform additional joint density evaluations, at least once per subplot, unless otherwise directed.

4.9.3.3.4.2. **Record Tests.** Perform a joint density evaluation for each subplot at each pavement edge that is or will become a longitudinal joint. Joint density evaluations are not applicable in areas described in Section 341.4.9.3.1.4., "Miscellaneous Areas." Determine the joint density in accordance with [Tex-207-F](#), Part VII. Record the joint density information and submit results on Department forms to the Engineer. The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and

the correlated joint density is less than 90.0%. The Engineer will make independent joint density verification at least once per project and may make independent joint density verifications at the random sample locations. The Engineer's joint density test results will be used when available.

Provide the Engineer with the joint density of every subplot in the lot within 1 working day of the completion of each lot. Report the results of each joint density in accordance with Section 341.4.2., "Reporting and Responsibilities."

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if the evaluations on two consecutive sublots fail, unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

4.9.3.3.5. **Recovered Asphalt Dynamic Shear Rheometer (DSR).** The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Materials and Tests Division. The aging ratio is the DSR value of the extracted binder divided by the DSR value of the original unaged binder. Obtain DSR values in accordance with AASHTO T 315 at the specified high-temperature PG of the asphalt. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores in accordance with [Tex-211-F](#).

4.9.3.3.6. **Irregularities.** Identify and correct irregularities, including segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, tears, gouges, streaks, uncoated aggregate particles, or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. If the Engineer determines that the irregularity will adversely affect pavement performance, the Engineer may require the Contractor to remove and replace (at the Contractor's expense) areas of the pavement that contain irregularities. The Engineer may also require the Contractor to remove and replace (at the Contractor's expense) areas where the mixture does not bond to the existing pavement.

If irregularities are detected, the Engineer may require the Contractor to immediately suspend operations or may allow the Contractor to continue operations for no more than 1 day while the Contractor is taking appropriate corrective action.

4.9.4. **Exempt Production.** The mixture may be deemed as exempt production when mutually agreed upon between the Engineer and the Contractor, or when shown on the plans. Exempt production may be used for the following conditions.

- Anticipated daily production is less than 500 ton.
- Total production for the project is less than 5,000 ton.
- Pavement repair sections are equal to or greater than 300 ft. For pavement repair sections less than 300 ft., refer to Section 341.4.9.3.1.4., "Miscellaneous Areas."

Exempt production is not eligible for referee testing. For exempt production, the Contractor is relieved of all production and placement QC and QA sampling and testing requirements, except for coring operations when required by the Engineer. When mutually agreed upon between the Engineer and the Contractor, production sampling will be allowed at the point of delivery. When 100 ton or more per day is produced, the Engineer must perform acceptance tests for production and placement in accordance with Table 16. If the specification requirements listed below are met, the production and placement pay factors are 1.000:

- produce, haul, place, and compact the mixture in compliance with the specification and as directed;
- control mixture production to yield a laboratory-molded density that is within  $\pm 1.0\%$  of the target laboratory-molded density as tested by the Engineer;
- compact the mixture in accordance with Section 341.4.8., "Compaction;"

- when a thermal imaging system is not used, the Engineer may perform segregation (density profiles) and thermal profiles in accordance with the specification; and
- all other specification requirements.

4.9.5. **Ride Quality.** Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

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## 5. MEASUREMENT

5.1. **Dense-Graded HMA.** Hot mix will be measured by the ton of composite hot mix, which includes asphalt, aggregate, and additives. Measure the weight on scales in accordance with Item 520, "Weighing and Measuring Equipment."

5.2. **Tack Coat.** Tack coat will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the calibrated distributor. The Engineer will witness all strapping operations for volume determination. All tack, including emulsions, will be measured by the gallon applied.

The Engineer may allow the use of a metering device to determine asphalt volume used and application rate if the device is accurate within 1.5% of the strapped volume.

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## 6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under Section 341.5.1., "Dense-Graded HMA," will be paid for at the unit price bid for "Dense-Graded Hot-Mix Asphalt" of the mixture type, SAC, and binder specified. These prices are full compensation for surface preparation, materials, placement, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under Section 341.5.2., "Tack Coat," will be paid for at the unit price bid for "Tack Coat" of the tack coat provided. These prices are full compensation for materials, placement, equipment, labor, tools, and incidentals. Payment adjustments will be applied as determined in accordance with this Item; however, a payment adjustment factor of 1.000 will be assigned for all placement sublots for level-ups only when "Level Up" is listed as part of the bid item description. A payment adjustment factor of 1.000 will be assigned to all production and placement sublots when "Exempt" is listed as part of the bid item description, and all testing requirements are met.

Payment for each subplot, including applicable payment adjustments greater than 1.000, will be paid only for sublots when the Contractor supplies the Engineer with the required documentation for production and placement QC and QA, thermal profiles, segregation density profiles, and longitudinal joint densities in accordance with Section 341.4.2., "Reporting and Responsibilities." When a thermal imaging system is used, documentation is not required for segregation density profiles on individual sublots; however, the thermal imaging system automated reports described in [Tex-244-F](#) are required.

Trial batches will not be paid for unless they are included in pavement work approved by the Department.

Payment adjustment for ride quality will be determined in accordance with Item 585.

6.1. **Production Payment Adjustment Factors.** The production payment adjustment factor is based on the laboratory-molded density using the Engineer's test results. The bulk specific gravities of the samples from each subplot will be divided by the Engineer's maximum theoretical specific gravity for the subplot. The individual sample densities for the subplot will be averaged to determine the production payment adjustment factor in accordance with Table 19 for each subplot, using the deviation from the target laboratory-molded

density in accordance with Table 9. The production payment adjustment factor for completed lots will be the average of the payment adjustment factors for the four sublots sampled within that lot.

**Table 19**  
**Production Payment Adjustment Factors for Laboratory-Molded Density<sup>1</sup>**

Absolute Deviation from Target Laboratory-Molded Density	Production Payment Adjustment Factor (Target Laboratory-Molded Density)
0.0	1.050
0.1	1.050
0.2	1.050
0.3	1.044
0.4	1.038
0.5	1.031
0.6	1.025
0.7	1.019
0.8	1.013
0.9	1.006
1.0	1.000
1.1	0.965
1.2	0.930
1.3	0.895
1.4	0.860
1.5	0.825
1.6	0.790
1.7	0.755
1.8	0.720
>1.8	Remove and replace

1. If the Engineer’s laboratory-molded density on any subplot is <95.0% or >97.0%, take immediate corrective action to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor’s corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

6.1.1. **Payment for Incomplete Production Lots.** Production payment adjustments for incomplete lots, described under Section 341.4.9.2.1.1., “Incomplete Production Lots,” will be calculated using the average production payment factors from all sublots sampled.

A production payment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any samples within the first subplot.

6.1.2. **Production Sublots Subject to Removal and Replacement.** If after referee testing the laboratory-molded density for any subplot results in a “remove and replace” condition as shown in Table 19, the Engineer may require removal and replacement or may allow the subplot to be left in place without payment. The Engineer may also accept the subplot in accordance with Section 5.3.1., “Acceptance of Defective or Unauthorized Work.” Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

6.2. **Placement Payment Adjustment Factors.** The placement payment adjustment factor is based on in-place air voids using the Engineer’s test results. The bulk specific gravities of the cores from each subplot will be divided by the Engineer’s average maximum theoretical specific gravity for the lot. The individual core densities for the subplot will be averaged to determine the placement payment adjustment factor in accordance with Table 20 for each subplot that requires in-place air void measurement. A placement payment adjustment factor of 1.000 will be assigned to the entire subplot when the random sample location falls in an area shown on the plans as not subject to in-place air void determination. A placement payment adjustment factor of 1.000 will be assigned to quantities placed in areas described in Section 341.4.9.3.1.4., “Miscellaneous Areas.” The placement payment adjustment factor for completed lots will be the average of the placement payment adjustment factors for up to four sublots within that lot.

**Table 20**  
**Placement Payment Adjustment Factors for In-Place Air Voids**

In-Place Air Voids	Placement Pay Adjustment Factor	In-Place Air Voids	Placement Payment Adjustment Factor
<2.7	Remove and replace	6.4	1.042
2.7	0.710	6.5	1.040
2.8	0.740	6.6	1.038
2.9	0.770	6.7	1.036
3.0	0.800	6.8	1.034
3.1	0.830	6.9	1.032
3.2	0.860	7.0	1.030
3.3	0.890	7.1	1.028
3.4	0.920	7.2	1.026
3.5	0.950	7.3	1.024
3.6	0.980	7.4	1.022
3.7	0.998	7.5	1.020
3.8	1.002	7.6	1.018
3.9	1.006	7.7	1.016
4.0	1.010	7.8	1.014
4.1	1.014	7.9	1.012
4.2	1.018	8.0	1.010
4.3	1.022	8.1	1.008
4.4	1.026	8.2	1.006
4.5	1.030	8.3	1.004
4.6	1.034	8.4	1.002
4.7	1.038	8.5	1.000
4.8	1.042	8.6	0.998
4.9	1.046	8.7	0.996
5.0	1.050	8.8	0.994
5.1	1.050	8.9	0.992
5.2	1.050	9.0	0.990
5.3	1.050	9.1	0.960
5.4	1.050	9.2	0.930
5.5	1.050	9.3	0.900
5.6	1.050	9.4	0.870
5.7	1.050	9.5	0.840
5.8	1.050	9.6	0.810
5.9	1.050	9.7	0.780
6.0	1.050	9.8	0.750
6.1	1.048	9.9	0.720
6.2	1.046	>9.9	Remove and replace
6.3	1.044	-	-

6.2.1. **Payment for Incomplete Placement Lots.** Payment adjustments for incomplete placement lots described under Section 341.4.9.3.1.2., “Incomplete Placement Lots,” will be calculated using the average of the placement payment factors from all sublots sampled and sublots where the random location falls in an area shown on the plans as not eligible for in-place air void determination.

If the random sampling plan results in production samples, but not in placement samples, the random core location and placement adjustment factor for the sublot will be determined by applying the placement random number to the length of the sublot placed.

If the random sampling plan results in placement samples, but not in production samples, no placement adjustment factor will apply for that sublot placed.

A placement payment adjustment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any production samples.

- 6.2.2. **Placement Sublots Subject to Removal and Replacement.** If after referee testing the placement payment adjustment factor for any subplot results in a “remove and replace” condition as shown in Table 20, the Engineer will choose the location of two cores to be taken within 3 ft. of the original failing core location. The Contractor must obtain the cores in the presence of the Engineer. The Engineer will take immediate possession of the untrimmed cores and submit the untrimmed cores to the Materials and Tests Division, where they will be trimmed, if necessary, and tested for bulk specific gravity within 10 working days of receipt.

The bulk specific gravity of each core from each subplot will be divided by the Engineer’s average maximum theoretical specific gravity for the lot. The individual core densities for the subplot will be averaged to determine the new payment adjustment factor of the subplot in question. If the new payment adjustment factor is 0.720 or greater, the new payment adjustment factor will apply to that subplot. If the new payment adjustment factor is less than 0.720, no payment will be made for the subplot. Remove and replace the failing subplot, or the Engineer may allow the subplot to be left in place without payment. The Engineer may also accept the subplot in accordance with Section 5.3.1., “Acceptance of Defective or Unauthorized Work.” Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

- 6.3. **Total Adjusted Pay (TAP) Calculation.** TAP will be based on the applicable payment adjustment factors for production and placement for each lot.

$$TAP = (A+B)/2$$

where:

$A = \text{Bid price} \times \text{production lot quantity} \times \text{average payment adjustment factor for the production lot}$

$B = \text{Bid price} \times \text{placement lot quantity} \times \text{average payment adjustment factor for the placement lot} + (\text{bid price} \times \text{quantity placed in miscellaneous areas} \times 1.000)$

$\text{Production lot quantity} = \text{Quantity actually placed} - \text{quantity left in place without payment}$

$\text{Placement lot quantity} = \text{Quantity actually placed} - \text{quantity left in place without payment} - \text{quantity placed in miscellaneous areas}$

# Item 400

## Excavation and Backfill for Structures



### 1. DESCRIPTION

Excavate for placement and construction of structures and backfill structures. Cut and restore pavement.

### 2. MATERIALS

Use materials that meet the requirements of the following.

- Item 401, "Flowable Backfill"
- Item 421, "Hydraulic Cement Concrete"
- [DMS-4600](#), "Hydraulic Cement"

### 3. CONSTRUCTION

#### 3.1. Excavation.

- 3.1.1. **General.** Excavate to the lines and grades shown on the plans or as directed. Provide slopes, benching, sheeting, bracing, pumping, and bailing as necessary to maintain the stability and safety of excavations up to 5 ft. deep. Excavation protection for excavations deeper than 5 ft. is governed by Item 402, "Trench Excavation Protection," and Item 403, "Temporary Special Shoring." Use satisfactory excavated material as backfill or as embankment fill in accordance with Item 132, "Embankment." Dispose of material not incorporated into the final project off the right of way in conformance with federal, state, and local regulations.

Keep any topsoil that has been removed separate, and replace it, as nearly as feasible, in its original position when excavating for installation of structures across private property or beyond the limits of the embankment. Restore the area to an acceptable condition.

Excavate drilled shafts in accordance with Item 416, "Drilled Shaft Foundations."

- 3.1.1.1. **Obstructions.** Remove obstructions to the proposed construction, including trees and other vegetation, debris, and structures, over the width of the excavation to a depth of 1 ft. below the bottom of excavation. Remove as required to clear the new structure and plug in an approved manner if abandoned storm drains, sewers, or other drainage systems are encountered. Restore the bottom of the excavation to grade by backfilling after removing obstructions in accordance with this Item. Dispose of surplus materials in conformance with federal, state, and local regulations.

- 3.1.1.2. **Excavation in Streets.** Cut pavement and base to neat lines when structures are installed in streets, highways, or other paved areas. Restore pavement structure after completion of excavation and backfilling.

Maintain and control traffic in accordance with the approved traffic control plan and the TMUTCD.

- 3.1.1.3. **Utilities.** Comply with the requirements of Article 7.15., "Responsibility for Damage Claims." Conduct work with minimum disturbance of existing utilities, and coordinate work in or near utilities with the utility owners. Inform utility owners before work begins, allowing them enough time to identify, locate, reroute, or make other adjustments to utility lines.

Avoid cutting or damaging underground utility lines that are to remain in place. Promptly notify the utility company if damage occurs. Provide temporary flumes across the excavation while open if an active sanitary

sewer line is damaged during excavation and restore the lines when backfilling has progressed to the original bedding lines of the cut sewer.

- 3.1.1.4. **De-Watering.** Construct or place structures in the presence of water only if approved. Place precast members, pipe, and concrete only on a dry, firm surface. Remove water by bailing, pumping, well point installation, deep wells, underdrains, or other approved method.

Remove standing water in a manner that does not allow water movement through or alongside concrete being placed if structures are approved for placement in the presence of water. Pump or bail only from a suitable sump separated from the concrete work while placing structural concrete or for a period of at least 36 hr. thereafter. Pump or bail during placement of seal concrete only to the extent necessary to maintain a static head of water within the cofferdam. Pump or bail to de-water inside a sealed cofferdam only after the seal has aged at least 36 hr.

Place a stabilizing material in the bottom of the excavation if the bottom cannot be de-watered to the point the subgrade is free of mud or it is difficult to keep reinforcing steel clean. Use flexible base, cement-stabilized base or backfill, lean concrete, or other approved stabilizing material. Provide concrete with at least 275 lb. of cement per cubic yard, if lean concrete is used, and place to a minimum depth of 3 in. Stabilizing material placed for the convenience of the Contractor will be at the Contractor's expense.

- 3.1.2. **Bridge Foundations and Retaining Walls.** Do not disturb material below the bottom of footing grade. Do not backfill to compensate for excavation that has extended below grade. Fill the area with concrete at the time the footing is placed if excavation occurs below the proposed footing grade. Additional concrete placed will be at the Contractor's expense.

Take core samples to determine the character of the supporting materials if requested. Provide an intact sample adequate to judge the character of the founding material. Take these cores when the excavation is close to completion. Cores should be approximately 5 ft. deeper than the proposed founding grade.

Remove loose material if the founding stratum is rock or other hard material, and clean and cut it to a firm surface that is level, stepped, or serrated, as directed. Clean out soft seams, and fill with concrete when the footing is placed.

Place the foundation once the Engineer has inspected the excavation and authorized changes have been made to provide a uniform bearing condition if the material at the footing grade of a retaining wall, bridge bent, or pier is a mixture of compressible and incompressible material.

- 3.1.3. **Cofferdams.** The term "cofferdam" designates any temporary or removable structure constructed to hold surrounding earth, water, or both out of the excavation whether the structure is formed of soil, timber, steel, concrete, or a combination of these. Use pumping wells or well points for de-watering cofferdams if required.

Submit details and design calculations for sheet pile or other types of cofferdams requiring structural members bearing the seal, signature, and date of a licensed professional engineer for review before constructing the cofferdam. The Department reserves the right to reject designs. Design structural systems to comply with the AASHTO *Standard Specifications for Highway Bridges* or AASHTO *LRFD Bridge Design Specifications*. Interior dimensions of cofferdams must provide enough clearance for the construction, inspection, and removal of required forms and, if necessary, enough room to allow pumping outside the forms. Extend sheet pile cofferdams well below the bottom of the footings and make concrete seals as well-braced and watertight as practicable.

Use Class E concrete for foundation seals unless otherwise specified. Place concrete foundation seals in accordance with Item 420, "Concrete Substructures." Seals placed for the convenience of the Contractor will be at the Contractor's expense.

Make the excavation deep enough to allow for swelling of the material at the base of the excavation during pile-driving operations when the Engineer judges it to be impractical to de-water inside a cofferdam and a concrete seal is to be placed around piling driven within the cofferdam. Remove swelling material to the

bottom of the seal grade after driving the piling. Remove the foundation material to exact footing grades where it is possible to de-water inside the cofferdam without placing a seal after driving piling. Do not backfill a foundation to compensate for excavation that has been extended below grade; fill such areas below grade with concrete at the time the seals or footings are placed.

Remove cofferdams after completing the substructure without disturbing or damaging the structure unless otherwise provided.

- 3.1.4. **Culverts and Storm Drains.** When the design requires special bedding conditions for culverts or storm drains, an excavation diagram will be shown on the plans. Do not exceed these limits of excavation.

Construct pipe structures in an open cut with vertical sides extending to a point 1 ft. above the pipe unless otherwise shown on the plans. When site conditions or the plans do not prohibit sloping the cut, the excavation may be stepped or laid back to a stable slope beginning 1 ft. above the pipe. Maintain the stability of the excavation throughout the construction period.

Construct the embankment for pipe to be installed in fill above natural ground to an elevation at least 1 ft. above the top of the pipe, and then excavate for the pipe.

- 3.1.4.1. **Unstable Material.** Remove the material to a depth of no more than 2 ft. below the grade of the structure when unstable soil is encountered at established footing grade, unless the Engineer authorizes additional depth. Replace soil removed with stable material in uniform layers no greater than 8 in. deep (loose measurement). Each layer must have enough moisture to be compacted by rolling or tamping as required to provide a stable foundation for the structure.

Use special materials such as flexible base, cement-stabilized base, cement-stabilized backfill, or other approved material when it is not feasible to construct a stable foundation as outlined above.

- 3.1.4.2. **Incompressible Material.** Remove the incompressible material to 6 in. below the footing grade, backfill with an approved compressible material, and compact in accordance with Section 400.3.3., "Backfill," if rock, part rock, or other incompressible material is encountered at established footing grade while placing prefabricated elements.

- 3.2. **Shaping and Bedding.**

- 3.2.1. **General.** Place at least 2 in. of fine granular material for precast box sections on the base of the excavation before placing the box sections. Use bedding as shown in Figure 1 for pipe installations. Use Class C bedding unless otherwise shown on the plans. The Engineer may require the use of a template to secure reasonably accurate shaping of the foundation material. Undercut the excavation at least 4 in. where cement-stabilized backfill is shown on the plans and backfill with stabilized material to support the pipe or box at the required grade.

$B_c$  - Outside diameter or horizontal dimension  
 $D$  - Inside diameter of pipe  
 $d$  - Min. bedding material below pipe

D	d
≤ 27"	3"
30" to 60"	4"
≥ 66"	6"

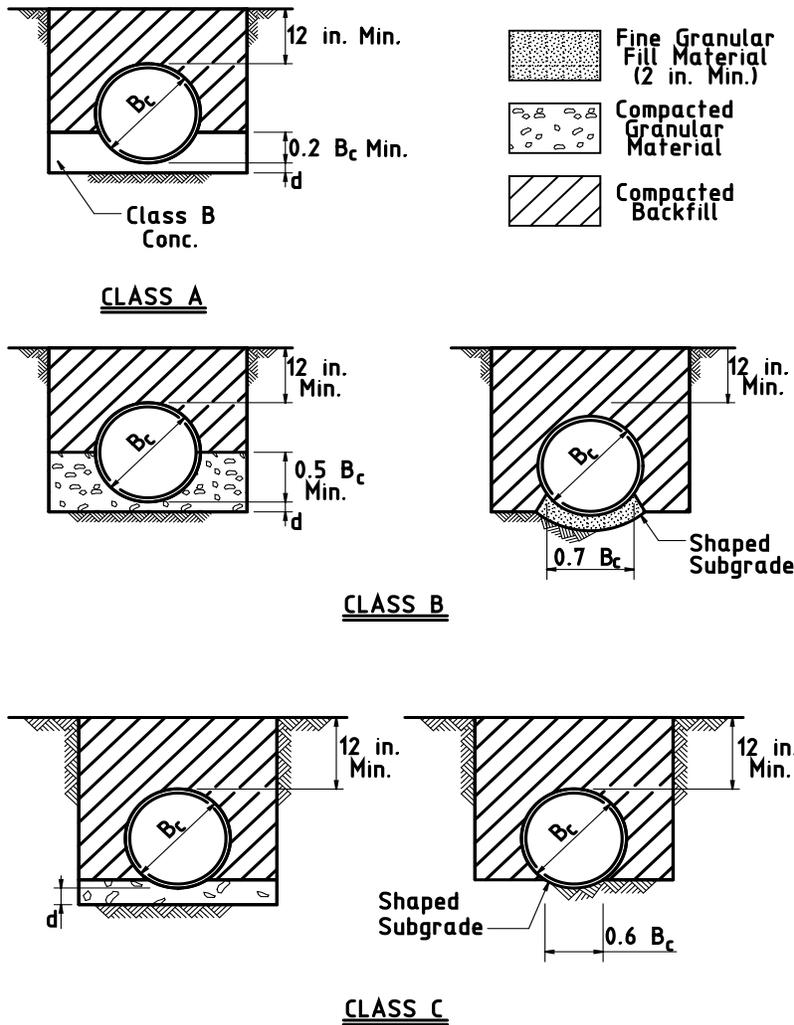


Figure 1  
 Bedding Diagrams

3.2.2. **Optional Shaping and Bedding for Precast Concrete Pipe.** For precast concrete pipe, the beddings in accordance with ASTM C1479 are permissible.

3.3. **Backfill.**

3.3.1. **General.** Backfill the excavation after placement of the permanent structure as soon as practical. Use backfill free of stones large enough to interfere with compaction; large or frozen lumps that will not break down readily under compaction; and wood or other extraneous material. Obtain backfill material from excavation or from other sources.

Place backfill in layers no greater than 10 in. deep (loose measurement) in areas not supporting a completed roadbed, retaining wall, or embankment. Place backfill in uniform layers no greater than 8 in. deep (loose measurement) in areas supporting a portion of a roadbed, retaining wall, or embankment. Compact each

layer to meet the density requirements of the roadbed, retaining wall, or embankment material, or as shown on the plans.

Bring each layer of backfill material to the moisture content needed to obtain the required density. Use mechanical tamps or rammers to compact the backfill. Rollers may be used to compact backfill if feasible.

Cohesionless materials may be used for backfilling. Use cohesionless materials that conform to the requirements shown in Table 1.

**Table 1**  
**Cohesionless Material Gradation Limits**

Sieve Size	Percent Retained
3"	0
#10	Note 1
#200	90-100

1. No. 10 sieve requirements are 0-30% retained when used as aggregate for cement-stabilized backfill.

Compact cohesionless materials using vibratory equipment, water ponding, or a combination of both.

3.3.2. **Bridge Foundations, Retaining Walls, Manholes and Inlets, and Box Culverts.** Place backfill against the structure only after the concrete has reached the design strength required in Item 421.

Backfill retaining walls with material meeting the requirements of Item 423, "Retaining Walls." Backfill around bridge foundations, manholes and inlets, and culverts using material with particles no more than 4 in. in greatest dimension and a gradation that permits thorough compaction. Use rock or gravel mixed with soil if the percentage of fines is enough to fill all voids and ensure a uniform and thoroughly compacted mass of proper density.

Use mechanical tamps and rammers to avoid damage to the structure where backfill material is being placed too close to the structure to permit compaction with blading and rolling equipment.

Avoid wedging action of backfill against structures. Step or serrate slopes bounding the excavation to prevent such action. Place backfill uniformly around bridge foundations. Place backfill equally and in uniform layers along both sides of manholes and inlets and culverts.

The Engineer may require backfilling of structures excavated into hard, erosion-resistant material, and subject to erosive forces, with stone or lean concrete.

Box culverts may be opened to traffic as soon as enough backfill and embankment have been placed over the top to protect culverts against damage from heavy construction equipment. Repair damage to culvert caused by construction traffic at no additional expense to the Department.

3.3.3. **Pipe.** Bring backfill material to the proper moisture condition after installing bedding and pipe as required and place it equally along both sides of the pipe in uniform layers no greater than 8 in. deep (loose measurement). Compact each lift mechanically. Thoroughly compact materials placed under the haunches of the pipe to prevent damage or displacement of the pipe. Place backfill in this manner to the top-of-pipe elevation. Place and compact backfill above the top of the pipe in accordance with Section 400.3.3.1., "General."

The Engineer may reject backfill material containing more than 20% by weight of material retained on a 3-in. sieve with large lumps not easily broken down or that cannot be spread in loose layers. Material excavated by trenching machine must generally meet the requirements of this Section as long as large stones are not present.

Place and compact additional material where pipe extends beyond the toe of slope of the embankment and the depth of cover provided by backfill to the original ground level is less than the minimum required by the specifications for the type of pipe involved, until the minimum cover has been provided.

- 3.3.4. **Cement-Stabilized Backfill.** Backfill the excavation to the elevations shown with cement-stabilized backfill when shown on the plans. Use cement-stabilized backfill that contains aggregate conforming to the gradation limits shown in Table 1, water, and at least 7% hydraulic cement based on the dry weight of the aggregate, in accordance with [Tex-120-E](#).

Place cement-stabilized backfill equally along the sides of structures to prevent strain on or displacement of the structure. Fill voids when placing cement-stabilized backfill. Use hand-operated tampers, if necessary, to fill voids. Compact the mixture using density control unless otherwise shown on the plans. Place and compact the backfill within 2 hr. of mixing.

- 3.3.5. **Flowable Backfill.** Backfill the excavation with flowable backfill to the elevations indicated when shown on the plans. Prevent the structure from being displaced during the placement of the flowable fill, and prevent flowable fill from entering manholes and inlets, culverts, and drainage structures.

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## 4. MEASUREMENT

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

- 4.1. **Structural Excavation.** Unless shown on the plans as a pay item, structural excavation quantities shown are for information purposes only.

When structural excavation is specified as a pay item, structural excavation for pipe headwalls, inlets, manholes, culvert or storm drain extensions less than 15 ft. long, bridge abutments, retaining walls, and side road and private entrance pipe culverts will not be measured. No allowance will be made for variance from plans quantity incurred by an alternate bid.

When specified as a pay item, structural excavation will be measured by the cubic yard as computed by the average end areas method or as shown on the plans. Excavation diagrams shown on the plans take precedence over the provisions of this Article.

- 4.1.1. **Boundaries of Measurement.**

- 4.1.1.1. **Pipe.**

- 4.1.1.1.1. **Pipe up to 42 Inches.** For pipe up to 42 in. nominal or equivalent diameter, no material outside vertical planes 1 ft. beyond and parallel to the horizontal projection of the outside surfaces of the pipe will be included.

- 4.1.1.1.2. **Pipe Larger than 42 Inches.** For pipes larger than 42 in. nominal or equivalent diameter, no material outside vertical planes located 2 ft. beyond and parallel to the horizontal projection of the outside surfaces of the pipe will be included.

Quantities for excavation in fill above natural ground include 1 ft. above the top of the pipe regardless of the height of completed fill. Excavation for pipe will be measured between the extreme ends of the completed structure, including end appurtenances as shown on the plans and from centerline to centerline of structures such as inlets and manholes.

- 4.1.1.2. **Footings, Walls, Boxes, and Other Excavation.** No material outside vertical planes 1 ft. beyond and parallel to the edges of the footings or outside walls will be included, whether a cofferdam or shoring is used. When plans provide the option of cast-in-place or precast boxes, measurement will be based on the cast-in-place option.

Where excavation in addition to that allowed for the footings is required for other portions of the structure, measurement for the additional excavation will be limited laterally by vertical planes 1 ft. beyond the face of the member and parallel to it, and vertically to a depth of 1 ft. below the bottom of the member.

- 4.1.1.3. **Excavation near Roadways and Channels.** At structure sites other than culverts and pipe excavations, the measurement of structural excavation will include only material below or outside the limits of the completed road or channel excavation. Roadway and channel excavation will be paid under Item 110, "Excavation." For culverts except side road and private entrance culverts, excavation within the limits of the structure and below or outside the limits of the completed roadway excavation will be measured as structural excavation.
- 4.1.2. **Falsework.** No measurement will be made for excavation necessary for placing forms or falsework that exceed the limits given in Section 400.4.1.1., "Boundaries of Measurement."
- 4.1.3. **Swelling.** Measurement will not include materials removed below footing grades to compensate for anticipated swelling due to pile driving, nor will it include material required to be removed due to swelling beyond the specified limits during pile-driving operations.
- 4.1.4. **Cave-Ins.** Measurement will not include additional volume caused by slips, slides, cave-ins, silting, or fill material resulting from the action of the elements or the Contractor's operation.
- 4.1.5. **Undercut.** Where rock or other incompressible or unstable material is undercut to provide a suitable foundation for pipe or box sections, such material below grade directed to be removed will be measured for payment.
- 4.1.6. **Grade Change.** Additional measurement will be made of the volume of excavation involved in the lowering or raising of the elevation of a footing, foundation, or structure unit, when such grade change is authorized.
- 4.2. **Cement-Stabilized Backfill.** Cement-stabilized backfill will be measured by the cubic yard as shown on the plans.
- 4.3. **Cutting and Restoring Pavement.** Cutting and restoring pavement will be measured by the square yard as shown on the plans. Excavation below pavement or base will be measured as structural excavation of the pertinent type.

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## 5. PAYMENT

- 5.1. **Structural Excavation.** Unless specified as a pay item, structural excavation and backfill performed, and material furnished in accordance with this Item will not be paid for directly, but will be subsidiary to pertinent Items.

When structural excavation is specified as a pay item, the excavation and backfill work performed, and materials furnished will be paid for at the unit price bid for "Structural Excavation," "Structural Excavation (Box)," "Structural Excavation (Pipe)," and "Structural Excavation (Bridge)." This price includes concrete to compensate for excavation that has extended below grade for bridge foundations and retaining walls, and backfilling and compacting areas that were removed as part of structural excavation.

Cofferdams or other measures necessary for supporting excavations less than 5 ft. deep will not be measured or paid for directly, but will be subsidiary to the Contract.

Foundation seal concrete for cofferdams, when required, will be paid for as provided in the pertinent Items. If no direct method of payment is provided in the Contract, the work will be measured and paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Seal placed for the convenience of the Contractor will not be paid for.

Unless otherwise provided, stone or lean concrete backfill around structures as provided for in Section 400.3.3.2., "Bridge Foundations, Retaining Walls, Manholes and Inlets, and Box Culverts," will be measured and paid for as extra work in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

When structural excavation is specified as a pay item, a partial payment of 50% of the bid price will be made for structural excavation completed to the satisfaction of the Engineer but not backfilled. The remaining

amount will be paid upon completion of backfilling. When the Contractor elects to excavate beyond plan requirements, no measurement will be made of the additional volume.

5.2. **Removal and Replacement of Unsuitable or Incompressible Material.** Removal and replacement of material will be paid for if directed. Removal and replacement of material or placement of special material made necessary by the softening of founding material due to the Contractor’s sequence of work or operation will be at the Contractor’s expense. Special material used or additional excavation made for the Contractor’s convenience will not be paid for.

5.2.1. **Structural Excavation as a Pay Item.** Where special materials are not required or specified, payment for the removal and replacement of unstable or incompressible material will be made at a price equal to 200% of the unit price bid per cubic yard for “Structural Excavation.” When the Contractor elects to remove and replace material deeper than directed, no measurement will be made on that portion below the directed elevation. This price is full compensation for removing the unstable or incompressible material; furnishing, hauling, placing, and compacting suitable replacement material; and equipment, labor, tools, and incidentals.

When shown on the plans or when directed, for the use of special materials such as flexible base, cement-stabilized base, cement-stabilized backfill, or other special material, payment for excavation below footing grades will be made at the unit price bid for “Structural Excavation.” Payment for furnishing, hauling, placing, and compacting the flexible base, cement-stabilized base, cement-stabilized backfill, or other special materials will be made at the unit price bid for these items in the Contract, or, if the required material is not a bid item, in accordance with Article 9.7., “Payment for Extra Work and Force Account Method.”

5.2.2. **Structural Excavation Not a Pay Item.** Where special materials for backfill are not required or specified, payment for the authorized removal and replacement of unstable or incompressible material will be measured and paid for at \$18 per cubic yard of material removed. This price is full compensation for removing the unstable or incompressible material; furnishing, hauling, placing, and compacting suitable replacement material; and equipment, labor, tools, and incidentals.

When shown on the plans or when directed, for the use of special materials such as flexible base, cement-stabilized base, cement-stabilized backfill, or other special material, excavation below the footing grades will be paid for at \$12 per cubic yard. Payment for furnishing, hauling, placing, and compacting the flexible base, cement-stabilized base, cement-stabilized backfill, or other special materials will be made at the unit price bid for these items, or, if the required material is not a bid item, in accordance with Article 9.7., “Payment for Extra Work and Force Account Method.”

5.3. **Lowering of a Structure Foundation.** If the Engineer requires a structure foundation to be lowered to an elevation below the grade shown on the plans, overexcavation will be paid for in accordance with Table 2.

**Table 2  
Payment for Required Overexcavation**

Variance of Revised Footing Grade from Plan Grade	Payment Terms	Variance of Revised Footing Grade from Plan Grade
	“Structural Excavation” is a Bid Item	“Structural Excavation” is Not a Bid Item
Up to and including 5 ft.	Unit price equal to 115% of unit price bid for “Structural Excavation”	\$12 per cubic yard
Over 5 ft. up to 10 ft.	Unit price equal to 125% of unit price bid for “Structural Excavation”	\$15 per cubic yard
Over 10 ft.	In accordance with Article 9.7., “Payment for Extra Work and Force Account Method.”	

5.4. **Cement-Stabilized Backfill.** Cement-stabilized backfill will be paid for at the unit price bid for “Cement-Stabilized Backfill.”

5.5. **Cutting and Restoring Pavement.** Cutting and restoring pavement will be paid for at the unit price bid for “Cutting and Restoring Pavement” of the type specified.

Work done to repair damage to base or pavement incurred outside the limits shown on the plans, or the limits authorized, will not be measured for payment.

The unit prices bid are full compensation for excavation, including removing obstructions and plugging drainage systems; bedding and backfilling, including placing, sprinkling, and compaction of material; soundings; cleaning and filling seams; constructing and removing cofferdams; de-watering, sheeting, or bracing excavations up to and including 5 ft. deep; pumps; drills; explosives; disposition of surplus material; cutting pavement and base to neat lines; and materials, hauling, equipment, labor, tools, and incidentals.

Flowable backfill will be paid for in accordance with Item 401. Protection methods for open excavations deeper than 5 ft. will be measured and paid for as required in accordance with Item 402 or Item 403.

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# Item 402

## Trench Excavation Protection

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### 1. DESCRIPTION

Furnish and place excavation protection for trenches 5 ft. or greater in depth for pipe, box culvert, electrical or telephone conduit, duct, or other utility installation.

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### 2. CONSTRUCTION

Provide vertical or sloped cuts, benches, shields, support systems, or other systems providing the necessary protection in accordance with OSHA Standards and Interpretations, 29 CFR Part 1926, Subpart P, "Excavations."

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### 3. MEASUREMENT

This Item will be measured by the foot along the long axis of the trench where the depth of trench exceeds 5 ft. This measurement includes all required trench protection, including trench ends.

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### 4. PAYMENT

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 "Trench Excavation Protection." This price is full compensation for excavation and backfill required for excavation protection; furnishing, placing, and removing shoring, sheeting, or bracing; de-watering or diversion of water; jacking and jack removal; and equipment, labor, materials, tools, and incidentals.

# Item 421

## Hydraulic Cement Concrete



### 1. DESCRIPTION

Furnish hydraulic cement concrete for concrete pavements, concrete structures, and other concrete construction.

### 2. MATERIALS

Use materials from prequalified sources listed on the Department website. Provide aggregates from sources listed in the Department's Concrete Rated Source Quality Catalog (CRSQC). Use materials from non-listed sources only when tested and approved before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources. Do not combine approved material with unapproved material.

2.1. **Cement.** Furnish cement in accordance with [DMS-4600](#), "Hydraulic Cement."

2.2. **Supplementary Cementitious Materials (SCMs).**

- **Coal Ash.** Furnish sources of fly ash, modified fly ash (MFA), harvested coal ash (HCA), and ground bottom ash (GBA) in accordance with [DMS-4610](#), "Coal Ash."
- **Slag Cement.** Furnish slag cement in accordance with [DMS-4620](#), "Slag Cement."
- **Silica Fume.** Furnish silica fume in accordance with [DMS-4630](#), "Silica Fume."
- **Natural Pozzolans.** Furnish natural pozzolans in accordance with [DMS-4635](#), "Natural Pozzolans."

2.3. **Cementitious Material.** Cementitious materials are the cement and SCMs used in concrete.

2.4. **Chemical Admixtures.** Furnish admixtures in accordance with [DMS-4640](#), "Chemical Admixtures for Concrete."

2.5. **Water.** Furnish mixing and curing water that is free of oils, acids, organic matter, or other deleterious substances. Water from municipal supplies approved by the Texas Department of Health will not require testing. Provide test reports showing compliance with Table 1 before use when using water from other sources.

Water that is a blend of concrete wash water and other acceptable water sources, certified by the concrete producer as complying with the requirements shown in Table 1 and Table 2, may be used as mix water. Test the blended water weekly for 4 weeks for compliance with Table 1 and Table 2 or provide previous test results. Then test every month for compliance. Provide water test results upon request.

Do not use mix water that has an adverse effect on the air-entraining agent, on any other chemical admixture, or on strength or time of set of the concrete. Use mixing and curing water free of iron and other impurities that may cause staining or discoloration when using white hydraulic cement.

**Table 1**  
**Chemical Limits for Mix Water**

Contaminant	Test Method	Max Concentration (ppm or mg/L)
Chloride (Cl)	ASTM C114 <sup>1</sup>	
Prestressed concrete		500
Bridge decks & superstructure		500
All other concrete		1,000
Sulfate (SO <sub>4</sub> )	ASTM C114 <sup>1</sup>	2,000
Alkalis (Na <sub>2</sub> O + 0.658K <sub>2</sub> O)	ASTM C114 <sup>1</sup>	600
Total solids	ASTM C1603	50,000

1. ASTM C114 includes reference and alternative test methods to measure the concentration of chlorides, sulfates, and alkalis in solutions prepared from dissolving cementitious materials. Use the applicable Test Methods in C114 to measure these constituents. The laboratory performing these tests is not required to conform to the method qualification requirements of Test Methods C114. Alternative instrumental and wet chemistry methods not listed in Test Methods C114 that measure the concentration of these chemical species in solution are permitted. When alternative methods are used, the test method used will be included in the report.

**Table 2**  
**Acceptance Criteria for Questionable Water Supplies**

Property	Test Method	Limits
Compressive strength, Min % control at 7 days	ASTM C31, ASTM C39 <sup>1,2</sup>	90
Time of set, deviation from control, h:min.	ASTM C403	From 1:00 early to 1:30 later

1. Base comparisons on fixed proportions and the same volume of test water compared to the control mix using 100% potable water or distilled water.
2. Base comparisons on sets consisting of at least two standard specimens made from a composite sample.

2.6. **Aggregate.**

2.6.1. **Coarse Aggregate.** Provide coarse aggregate consisting of durable particles of gravel, crushed blast furnace slag, recycled crushed hydraulic cement concrete, crushed stone, or combinations that are free of frozen material and injurious amounts of salt, alkali, vegetable matter, or other objectionable material, either free or as an adherent coating. Provide coarse aggregate of uniform quality throughout.

Provide coarse aggregate with the requirements shown in Table 3 unless otherwise shown on the plans.

**Table 3**  
**Coarse Aggregate Requirements**

Description	Test Method	Limit
Weight of clay lumps, % Max	<a href="#">Tex-413-A</a>	0.25
Weight of shale, % Max		1.0
Weight of laminate and friable particle, % Max		5.0
L.A. abrasion wear, % Max	<a href="#">Tex-410-A</a>	40
5-cycle magnesium sulfate soundness, <sup>1,2</sup> non-air-entrained concrete, % Max	<a href="#">Tex-411-A</a>	25
5-cycle magnesium sulfate soundness, <sup>1,3</sup> air-entrained concrete, % Max		18
Loss by decantation, % Max	<a href="#">Tex-406-A</a>	1.5

1. Recycled crushed hydraulic cement concrete is not subject to 5-cycle magnesium sulfate soundness requirements.
2. Allowed when air-entrained concrete is used at the Contractor's option.
3. Only when air-entrained concrete is required by the plans.

Increase the loss by decantation limit to 3.0% for all classes of concrete and 5.0% for Class A, B, and P if the material finer than the No. 200 sieve is determined to be at least 85% calcium carbonate in accordance with [Tex-406-A](#), Part III, in the case of coarse aggregates made primarily from crushing stone, unless otherwise shown on the plans. Provide test results upon request.

Provide coarse aggregate or combination of aggregates conforming to the gradation requirements shown in Table 4 when tested in accordance with [Tex-401-A](#) unless otherwise specified.

**Table 4  
Coarse Aggregate Gradation Chart**

Aggregate Grade No. <sup>1</sup>	Maximum Nominal Size	Percent Passing on Each Sieve								
		2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	#4	#8
1	2"	100	80-100	50-85	-	20-40	-	-	0-10	-
2	1-1/2"	-	100	95-100	-	35-70	-	10-30	0-10	-
3	1-1/2"	-	100	95-100	-	60-90	25-60	-	0-10	-
4 (57)	1"	-	-	100	95-100	-	25-60	-	0-10	0-5
5 (67)	3/4"	-	-	-	100	90-100	-	20-55	0-10	0-5
6 (7)	1/2"	-	-	-	-	100	90-100	40-70	0-15	0-5
7	3/8"	-	-	-	-	-	100	70-95	0-25	-
8	3/8"	-	-	-	-	-	100	95-100	20-65	0-10

1. Corresponding ASTM C33 gradation shown in parentheses.

2.6.2.

**Fine Aggregate.** Provide fine aggregate consisting of clean, hard, durable particles of natural, manufactured sand; recycled crushed hydraulic cement concrete; slag; lightweight aggregate; or a combination thereof. Provide fine aggregate free of frozen material and injurious amounts of salt, alkali, vegetable matter, or other objectionable material.

Provide fine aggregates in accordance with Table 5 unless otherwise shown on the plans.

**Table 5  
Fine Aggregate Requirements**

Description	Test Method	Limit
Weight of clay lumps, % Max	<a href="#">Tex-413-A</a>	0.50
Organic impurities <sup>1</sup>	<a href="#">Tex-408-A</a>	Color not darker than standard
Sand equivalent, Min	<a href="#">Tex-203-F</a>	80
Fineness modulus	<a href="#">Tex-402-A</a>	2.3-3.1

1. Only when air-entrained concrete is specified.

Provide fine aggregate or combinations of aggregates conforming to the gradation requirements shown in Table 6 when tested in accordance with [Tex-401-A](#) unless otherwise specified.

**Table 6  
Fine Aggregate Gradation Chart (Grade 1)**

Sieve Size	% Passing
3/8"	100
#4	95-100
#8	80-100
#16	50-85
#30	25-65
#50	10-35 <sup>1</sup>
#100	0-10
#200	0-3 <sup>2</sup>

1. 6-35 when sand equivalent value is greater than 85.
2. 0-6 for manufactured sand.

2.6.3.

**Intermediate Aggregate.** Provide intermediate aggregate consisting of clean, hard, durable particles of natural, manufactured sand; slag; recycled crushed hydraulic cement concrete; lightweight aggregate; or a combination thereof when optimized aggregate gradation (OAG) concrete is specified or when used at the Contractor's option. Provide intermediate aggregate free of frozen material and injurious amounts of salt, alkali, vegetable matter, or other objectionable material.

Provide intermediate aggregate in accordance with Table 7.

**Table 7**  
**Intermediate Aggregate Requirements**

Description	Test Method	Limit
Weight of clay lumps, % Max	<a href="#">Tex-413-A</a>	0.50
L.A. abrasion wear, <sup>1</sup> % Max	<a href="#">Tex-410-A</a>	40
5-cycle magnesium sulfate soundness, <sup>1,2,3</sup> non-air-entrained concrete, % Max	<a href="#">Tex-411-A</a>	25
5-cycle magnesium sulfate soundness, <sup>1,2,4</sup> air-entrained concrete, % Max		18
Organic impurities <sup>5</sup>	<a href="#">Tex-408-A</a>	Color not darker than standard
Loss by decantation, <sup>1</sup> % Max	<a href="#">Tex-406-A</a>	1.5

1. Applies only to the portion retained on the No. 4 sieve, if more than 30% of the intermediate aggregate is retained on the No. 4 sieve.
2. Recycled crushed hydraulic cement concrete is not subject to 5-cycle magnesium sulfate soundness requirements.
3. Allowed when air-entrained concrete is used at the Contractor's option.
4. Only when air-entrained concrete is required by the plans.
5. Applies only to the portion passing the 3/8-in. sieve, if more than 30% of the intermediate aggregate is passing the 3/8-in. sieve.

For the portion retained on the No. 4 sieve, if more than 30% of the intermediate aggregate is retained on the No. 4 sieve, and in the case of aggregates made mainly from crushing stone, unless otherwise shown on the plans, the loss by decantation may be increased to 3.0% for all classes of concrete and 5.0% for Class A, B, and P if the material finer than the No. 200 sieve is determined to be at least 85% calcium carbonate in accordance with [Tex-406-A](#), Part III. Provide test results upon request.

- 2.7. **Mortar and Grout.** Furnish pre-packaged grouts in accordance with [DMS-4675](#), "Cementitious Grouts and Mortars for Miscellaneous Applications," when specified for applications other than post-tension grouting.

When grouting or mortaring stone riprap is shown on the plans, provide mortar and grout consisting of one part hydraulic cement, two parts sand, and sufficient water to provide the desired consistency. Other mix proportions allowed as approved. Provide mortar with a consistency such that the mortar can be easily handled and spread by trowel. Provide grout of a consistency that will flow into and completely fill all voids.

Section 421.4.2.6., "Mix Design Options," does not apply for mortar and grout.

- 2.8. **Storage of Materials.**

- 2.8.1. **Cement and Supplementary Cementitious Materials.** Store all cement and supplementary cementitious materials in weatherproof enclosures that will protect the materials from dampness or absorption of moisture.

When permitted, small quantities of packaged cementitious material may be stored in the open, on a raised platform, and under waterproof covering for up to 48 hr.

- 2.8.2. **Aggregates.** Handle and store concrete aggregates in a manner that prevents contamination by foreign materials. Clear and level the sites for the stockpiles of all vegetation if the aggregates are stored on the ground, and do not use the bottom 6-in. layer of aggregate without cleaning the aggregate before use.

Maintain separate stockpiles and prevent intermixing when conditions require the use of two or more grades of coarse aggregates. Separate the stockpiles using physical barriers where space is limited. Store aggregates from different sources in different stockpiles unless the Engineer authorizes pre-blending of the aggregates. Minimize segregation in stockpiles. Remix and test stockpiles when segregation is apparent.

Sprinkle stockpiles to control moisture and temperature as necessary. Maintain reasonably uniform moisture content in aggregate stockpiles.

- 2.8.3. **Chemical Admixtures.** Store admixtures in conformance with manufacturer's recommendations in tanks that are clearly labeled and prevent admixtures from freezing.

### 3. EQUIPMENT

- 3.1. **Concrete Plants and Mixing Equipment.** Except for volumetric stationary plant or truck (auger) mixers, each plant and truck mixer must be certified by NRMCA or have an inspection report signed and sealed by a licensed professional engineer showing concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a licensed professional engineer's inspection require re-inspection every 2 yr. Provide a copy of the certification or the signed and sealed inspection report to the Engineer. Remove equipment or facilities from service until corrected when they fail to meet specification requirements.

When allowed as shown on the plans or by the Engineer, for concrete classes not identified as structural concrete in Table 8 or for Class C concrete not used for bridge-class structures, the Engineer may inspect and approve all plants and trucks instead of NRMCA or non-Department engineer-sealed certifications. The criteria and frequency of Engineer approval of plants and trucks are the same used for NRMCA certification.

Inspect and furnish inspection reports of the condition of blades and fins and their percent wear from the original manufacturer's design for all mixing and agitating equipment annually. Repair mixing equipment exhibiting 10% or more wear before use. If an inspection within 12 mo. is not practical, a 2-mo. grace period (for a maximum of 14 mo. between inspections) is permitted.

- 3.1.1. **Scales.** Check all scales before beginning of operations, after each move, or whenever their accuracy or adequacy is questioned, and at least once every 6 mo. Immediately correct deficiencies, and recalibrate. Provide a record of calibration showing scales in compliance with ASTM C94 requirements. Check batching accuracy of volumetric water batching devices at least every 90 days. Check batching accuracy of chemical admixture dispensing devices at least every 6 mo. Perform daily checks as necessary to ensure measuring accuracy. Check electronic aggregate moisture probes at least every 90 days in accordance with [Tex-409-A](#), and be accurate to within 1.0% of the actual moisture content.

- 3.1.2. **Volumetric Mixers.** Provide volumetric mixers with rating plates defining the capacity and the performance of the mixer in accordance with the Volumetric Mixer Manufacturers Bureau or equivalent. Provide volumetric mixers that comply with ASTM C685. Provide test data showing mixers meet the uniformity test requirements in accordance with [Tex-472-A](#).

Unless allowed on the plans or by the Engineer, volumetric truck (auger) mixers may not supply classes of concrete identified as structural concrete in Table 8.

- 3.1.3. **Agitators and Truck and Stationary Mixers.** Provide stationary and truck mixers capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and capable of discharging the concrete so that the requirements of [Tex-472-A](#) are met.

Perform concrete uniformity tests on mixers or agitators in accordance with [Tex-472-A](#) as directed, to resolve issues of mix uniformity and mixer performance.

Perform the mixer or agitator uniformity test at the full rated capacity of the equipment. Remove all equipment that fails the uniformity test from service.

Inspect and maintain mixers and agitators. Keep them free of concrete buildup, and repair or replace worn or damaged blades or fins.

Ensure all mixers have a plate affixed showing manufacturer's recommended operating speed and rated capacity for mixing and agitating.

Truck mixers with automated water and chemical admixture measurement and slump and slump flow monitoring equipment meeting the requirement of ASTM C94 will be allowed. Provide data every 6 mo. substantiating the accuracy of slump, slump flow, temperature, water, and chemical admixture measurements. The slump measured by the automated system must be within 1 in. of the slump measured in accordance with [Tex-415-A](#). The concrete temperature measured by the automated system must be within

1°F of concrete temperature measured in accordance with [Tex-422-A](#). The Engineer will not use the automated measurements for acceptance.

- 3.2. **Hauling Equipment.** Provide hauling equipment capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and discharging the concrete with a satisfactory degree of uniformity.

Provide equipment with smooth, mortar-tight metal containers equipped with gates that prevent accidental discharge of the concrete when using non-agitating equipment for transporting concrete.

Maintain hauling equipment clean and free of built-up concrete.

- 3.3. **Testing Equipment.** Provide strength-testing equipment when required in accordance with the Contract controlling test unless shown otherwise. Provide calibration records of strength-testing equipment to the Engineer within 1 week after each calibration. Furnish and maintain the following in conformance with the pertinent test procedure unless otherwise shown on the plans or specified.

- Test molds
- Curing facilities
- Maturity meters if used
- Wheelbarrow or other container acceptable for the sampling of the concrete

#### 4. CONSTRUCTION

- 4.1. **Classification of Concrete Mix Designs.** Provide classes of concrete meeting the requirements shown in Table 8.

A higher-strength class of concrete with equal or lower water-to-cementitious material (w/cm) ratio may be substituted for the specified class of concrete when approved.

- 4.2. **Mix Design Proportioning.** Furnish mix designs using ACI 211, [Tex-470-A](#), or other approved procedures for the classes of concrete shown in Table 8 unless a design method is shown on the plans. Perform mix design proportioning by absolute volume method unless otherwise approved. Perform cement replacement using equivalent weight method unless otherwise approved.

Do not exceed the maximum w/cm ratio shown in Table 8 when designing the mixture.

- 4.2.1. **Cementitious Materials.** Do not exceed 700 lb. of cementitious material per cubic yard of concrete unless otherwise specified or approved.

- Use cement of the same type and from the same source for monolithic placements, unless otherwise approved.
- Do not use SCMs when white hydraulic cement is specified.

- 4.2.2. **Aggregates.** Recycled crushed hydraulic cement concrete may be used as a coarse or fine aggregate in Class A, B, E, and P concrete. Limit recycled crushed concrete fine aggregate to at most 20% of the fine aggregate.

Use light-colored aggregates when white hydraulic cement is specified.

**Table 8  
Concrete Classes**

Class of Concrete	Design Strength <sup>1</sup> , Min f <sub>c</sub> (psi)	Max w/cm Ratio	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Use <sup>2</sup>
A	3,000	0.60	I, II, I/II, IL, IP, IS, IT, V	1, 2, 4, and 7	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan listed in the MPL may be used at a cement replacement of 20%–50%.  Limit the alkali loading to 4.0 lb./cu. yd. or less when using Option 7.	Curb, gutter, curb and gutter, concrete retards, sidewalks, driveways, backup walls, anchors, non-reinforced drilled shafts
B	2,000	0.60				Riprap, traffic signal controller foundations, small roadside signs, anchors
C <sup>3</sup>	3,600	0.45	I, II, I/II, IP, IL, IS, IT, V	1–8	N/A	Drilled shafts, bridge substructure, traffic rail, culverts except top slab of direct traffic culverts, headwalls, wing walls, inlets, manholes, traffic barrier
E	3,000	0.50	I, II, I/II, IP, IL, IS, IT, V	1–8	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan listed on the MPLs may be used at a cement replacement of 20%–50%.  Limit the alkali loading to 4.0 lb./cu. yd. or less when using Option 7.	Seal concrete
F <sup>3</sup>	Note <sup>4</sup>	0.45				I, II, I/II, IP, IL, IS, IT, V
H <sup>3</sup>	Note <sup>4</sup>	0.45	I, II, I/II, III, IP, IL, IS, IT, V	1–4, 8	Mix design Options 1–8 allowed for cast-in-place concrete and the following precast elements unless otherwise shown on the plans. <ul style="list-style-type: none"> <li>■ Bridge deck panels</li> <li>■ Retaining wall systems</li> <li>■ Coping</li> <li>■ Sound walls</li> <li>■ Wall columns</li> <li>■ Traffic rail</li> <li>■ Traffic barrier</li> <li>■ Long/arch-span culverts</li> <li>■ Precast concrete products in accordance with Item 462, 464, and 465</li> </ul> Do not use Type III cement in mass placement concrete.	Precast concrete, post-tension members
S <sup>3</sup>	4,000	0.45				I, II, I/II, IP, IL, IS, IT, V
P	See Item 360, "Concrete Pavement."	0.50	I, II, I/II, IL, IP, IS, IT, V	1–8	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan on the MPLs may be used at a cement replacement of 20%–50%.	Concrete pavement
CO <sup>3</sup>	4,600	0.40	I, II, I/II, IP, IL,	1–8	N/A	Bridge deck concrete overlay
LMC <sup>3</sup>	4,000	0.40				Latex-modified concrete overlay

Class of Concrete	Design Strength <sup>1</sup> , Min f <sub>c</sub> (psi)	Max w/cm Ratio	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Use <sup>2</sup>
SS <sup>3</sup>	3,600	0.45		1-8	Use a minimum cementitious material content of 658 lb./cu. yd. of concrete.  Limit the alkali loading to 4.0 lb. per cubic yard or less when using Option 7.	Slurry displacement shafts, underwater drilled shafts
K <sup>3</sup>	Note <sup>4</sup>	0.40	I, II, I/II, III, IP, IL, IS, IT, V	1-8	N/A	Bridge repair
HES	Note <sup>4</sup>	0.45	I, IL, II, I/II, III	N/A	Mix design options do not apply.  Limit of 700 lb. of cementitious material per cubic yard is not pertinent.	Concrete pavement, concrete pavement repair
"X" (HPC) <sup>3,5,6</sup>	Note <sup>7</sup>	0.45	I, II, I/II, III, IP, IL, IS, IT, V	1-4, and 8	N/A	N/A
"X" (SRC) <sup>3,5,6</sup>	Note <sup>7</sup>	0.45	I/II, II, IP, IL (MS or HS), IS, IT (MS or HS), V	1-4, and 7	When using coal ash, use only coal ashes allowed for SRC in accordance with the coal ash MPL.  Type III-MS may be used where allowed.  Type I, Type IL, and Type III cements may be used when natural pozzolans are used or when coal ashes allowed for SRC in accordance with the coal ash MPL are used, and with a Max w/cm of 0.40.  Use Option 7 for precast concrete where allowed.	N/A

1. Design strength must be attained within 56 days.
2. For information only.
3. Structural concrete classes.
4. As shown on the plans or specified.
5. "X" denotes class of concrete as shown on the plans or specified.
6. (HPC): High Performance Concrete, (SRC): Sulfate Resistant Concrete.
7. Same as class of concrete as shown on the plans.

4.2.2.1. **Coarse Aggregate.** Use Grade 2 or 3 coarse aggregate for Class P concrete. Use Grade 8 aggregate in extruded curbs unless otherwise approved. Unless otherwise specified, do not use Grade 1 aggregate in drilled shafts. Use coarse aggregate grades for all other classes of concrete with a maximum nominal size no larger than:

- 1/5 the narrowest dimension between sides of forms;
- 1/3 the depth of slabs;
- 2/3 the minimum clear spacing between individual reinforcing bars or wire, bundles of bars, individual tendons, bundles of tendons, or ducts for cast-in-place concrete; or
- 3/4 the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, individual tendons, bundled tendons, or ducts for precast concrete.

4.2.2.2. **Fine Aggregate.** Use fine aggregate with an acid insoluble residue of at least 60% by weight when tested in accordance with [Tex-612-J](#) in all concrete subject to direct traffic.

Use the following equation to determine whether the aggregate combination meets the acid insoluble residue requirement when blending fine aggregate or using an intermediate aggregate.

$$\frac{(A_1 \times P_1) + (A_2 \times P_2) + (A_{ia} \times P_{ia})}{100} \geq 60\%$$

where:

$A_1$  = acid insoluble (%) of fine aggregate 1

$A_2$  = acid insoluble (%) of fine aggregate 2

$A_{ia}$  = acid insoluble (%) of intermediate aggregate passing the 3/8 in. sieve

$P_1$  = percent by weight of fine aggregate 1 of the fine aggregate blend

$P_2$  = percent by weight of fine aggregate 2 of the fine aggregate blend

$P_{ia}$  = percent by weight of intermediate aggregate passing the 3/8-in. sieve

Alternatively to the above equation, blend fine aggregate with a Micro-Deval loss of less than 12%, when tested in accordance with [Tex-461-A](#), with at least 40% of a fine aggregate with an acid insoluble residue of at least 60%.

Use the following equation to determine whether the aggregate combination meets the sand equivalency requirement when blending fine aggregate or using an intermediate aggregate.

$$\frac{(SE_1 \times P_1) + (SE_2 \times P_2) + (SE_{ia} \times P_{ia})}{100} \geq 80\%$$

where:

$SE_1$  = sand equivalency (%) of fine aggregate 1

$SE_2$  = sand equivalency (%) of fine aggregate 2

$SE_{ia}$  = sand equivalency (%) of intermediate aggregate passing the 3/8 in. sieve

$P_1$  = percent by weight of fine aggregate 1 of the fine aggregate blend

$P_2$  = percent by weight of fine aggregate 2 of the fine aggregate blend

$P_{ia}$  = percent by weight of intermediate aggregate passing the 3/8-in. sieve

- 4.2.3. **Chemical Admixtures.** Do not use Type C, E, F, or G admixtures in Class S bridge deck concrete. Do not use chemical admixtures containing calcium chloride in any concrete.

Use a 30% calcium nitrite solution when a corrosion-inhibiting admixture is required. Dose the admixture at the rate of gallons of admixture per cubic yard of concrete shown on the plans. Use set retarding admixtures, as needed, to control setting time to ensure concrete containing corrosion inhibiting admixtures remains workable for the entire duration of the concrete placement. Perform setting time testing and slump loss tests during trial batch testing.

- 4.2.4. **Air Entrainment.** When air-entrained concrete is shown on the plans, target an entrained air content of 4.0% for Class P concrete and 5.5% for all other classes of concrete. Use an approved air-entraining admixture when air-entrained concrete is specified, or when an air-entraining admixture is used at the Contractor's option. Unless otherwise shown on the plans, acceptance of concrete loads will be based on a tolerance of  $\pm 1.5\%$  from the target air content. If the air content is more than 1.5 but less than 3.0% above the target air, the concrete may be accepted based on strength tests. For specified concrete strengths above 5,000 psi, a reduction of 1% entrained air content is permitted.

- 4.2.5. **Slump.** Provide concrete with a slump in accordance with Table 9 unless otherwise specified. When approved, the slump of a given concrete mix may be increased above the values shown in Table 9 using chemical admixtures, provided the admixture-treated concrete has the same or lower w/cm ratio and does not exhibit segregation or excessive bleeding. Request approval to exceed the slump limits shown in Table 9 sufficiently in advance for proper evaluation by the Engineer.

**Table 9  
Placement Slump Requirements**

General Use	Placement Slump Range (in.)
Walls (>9 in. thick), caps, columns, piers	3–7
Bridge slabs, top slabs of direct traffic culverts, approach slabs, concrete overlays	3–6
Latex-modified concrete for bridge deck overlays	3–8
Inlets, manholes, walls (<9 in. thick), bridge railing, culverts, concrete traffic barrier, concrete pavement (formed)	4–6
Precast concrete	4–9
Underwater concrete placements	6–8-1/2
Drilled shafts, slurry displaced, underwater drilled shafts	See Item 416, “Drilled Shaft Foundations”
Curb, gutter, curb and gutter, concrete retards, sidewalk, driveways, seal concrete, anchors, riprap, small roadside sign foundations, concrete pavement repair, concrete repair	As approved

4.2.6. **Mix Design Options.**

4.2.6.1. **Option 1.** Replace cement with at least the minimum dosage listed on the MPL for the coal ash or natural pozzolan used in the mixture. Conduct Option 8 testing to determine the minimum replacement dosage as listed on the MPL. Do not replace more than 50% of the cement. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

4.2.6.2. **Option 2.** Replace 35–50% of the cement with slag cement. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

4.2.6.3. **Option 3.** Replace 35–50% of the cement with a combination of coal ash, slag cement, MFA, natural pozzolan, or at least 3% silica fume; however, no more than 10% may be silica fume. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

4.2.6.4. **Option 4.** Use Type IP, IS, or IT cement as allowed in Table 8 for each class of concrete. When replacing blended cements with additional SCMs, the replacement limits in Option 3 will apply to the final cementitious mixture. When using fly ash or natural pozzolans not having a minimum dosage listed on the MPL in the final cementitious mixture, perform Option 8 testing.

4.2.6.5. **Option 5.** Option 5 is left intentionally blank.

4.2.6.6. **Option 6.** Use a lithium nitrate admixture at a minimum dosage determined by testing conducted in accordance with [Tex-471-A](#). Before use of the mix, provide an annual certified test report signed and sealed by a licensed professional engineer, from a laboratory on the MPL, certified by the Materials and Tests Division (MTD) as being capable of testing in accordance with [Tex-471-A](#).

4.2.6.7. **Option 7.** Ensure the total alkali contribution from the cement in the concrete does not exceed 3.5 lb. per cubic yard of concrete when using hydraulic cement not containing SCMs calculated as follows.

$$\text{lb. alkali per cu. yd.} = \frac{(\text{lb. cement per cu. yd.}) \times (\% \text{ Na}_2\text{O equivalent in cement})}{100}$$

In the above calculation, use the maximum cement alkali content reported on the cement mill certificate.

4.2.6.8. **Option 8.** Use Table 10 when deviating from Options 1–3 or when required by the coal ash MPL. Perform required testing annually and submit results to the Engineer. Laboratories performing ASTM C1260, C1567, and C1293 testing must be listed on the Department’s MPL. Before use of the mix, provide a certified test report signed and sealed by a licensed professional engineer demonstrating the proposed mixture conforms to the requirements of Table 10.

Provide a certified test report signed and sealed by a licensed professional engineer, when high-performance concrete (HPC) is required, and less than 20% of the cement is replaced with SCMs, demonstrating ASTM C1202 test results indicate the permeability of the concrete is less than 1,500 coulombs tested immediately after either of the following curing schedules.

- Moisture cure specimens 56 days at 73°F.
- Moisture cure specimens 7 days at 73°F followed by 21 days at 100°F.

**Table 10**  
**Option 8 Testing and Mix Design Requirements**

Scenario	ASTM C1260 Result		Testing Requirements for Mix Design Materials or Prescriptive Mix Design Options <sup>1</sup>
	Mix Design Fine Aggregate	Mix Design Coarse Aggregate	
A	>0.10%	>0.10%	Determine the dosage of SCMs needed to limit the 14-day expansion of each aggregate <sup>1</sup> to <0.10% when tested individually in accordance with ASTM C1567.
B	≤0.10%	≤0.10%	Use the minimum replacement listed in the coal ash MPL, or When Option 8 is listed on the MPL, use at least 40% coal ash with a maximum CaO <sup>2</sup> content of 25%, or Use any ternary combination that replaces 35–50% of cement.
	≤0.10%	ASTM C1293 1 yr. Expansion ≤0.04%	Use a minimum of 20% of any coal ash; or Use any ternary combination that replaces 20–50% of cement.
C	≤0.10%	>0.10%	Determine the dosage of SCMs needed to limit the 14-day expansion of course and intermediate <sup>1</sup> aggregate to <0.10% when tested individually in accordance with ASTM C1567.
D	>0.10%	≤0.10%	Use the minimum replacement listed in the coal ash MPL, or When Option 8 is listed in the MPL, use a minimum of 40% coal ash with a maximum CaO <sup>2</sup> content of 25%, or Use any ternary combination that replaces 35% to 50% of cement.
	>0.10%	ASTM C1293 1 yr. Expansion ≤0.04%	Determine the dosage of SCMs needed to limit the 14-day expansion of each fine aggregate to <0.10% when individually tested in accordance with ASTM C1567.

1. Intermediate size aggregates will fall under the requirements of mix design coarse aggregate.
2. Average the CaO content from the previous ten values as listed on the test certificate.

4.2.7. **Optimized Aggregate Gradation (OAG) Concrete.** The gradation requirements shown in Table 4 and Table 6 do not apply when OAG concrete is specified or used by the Contractor, unless otherwise shown on the plans.

The fineness modulus for fine aggregate shown in Table 5 does not apply when OAG concrete is used. Establish the optimized aggregate gradation in accordance with [Tex-470-A](#). Use at least 420 lb. per cubic yard of cementitious material when OAG concrete is used unless otherwise approved.

Make necessary adjustments to individual aggregate stockpile proportions during OAG concrete production when the gradation deviates more than 2% from the optimized gradation requirements.

4.2.8. **Self-Consolidating Concrete (SCC).** Provide SCC meeting the requirements shown in Table 11 when approved for use in precast concrete. Use concrete with a slump flow that can be placed without vibration and will not segregate or excessively bleed.

Request approval to exceed the slump flow limits sufficiently in advance for proper evaluation by the Engineer.

**Table 11**  
**Mix Design Requirements for SCC**

Tests	Test Method	Acceptable Limits
Slump flow for precast concrete	ASTM C1611	22–27 <sup>1</sup>
T <sub>50</sub> , sec.	ASTM C1611	2–7
VSI rating	ASTM C1611	0 or 1
Passing ability, in.	ASTM C1621	≤2
Segregation column, %	ASTM C1610	≤10
Bleeding, %	ASTM C232	≤2.5

1. These slump flow limits are generally acceptable for most applications. However, slump flow limits may be adjusted during mix design approval process and when approved.

- 4.3. **Concrete Trial Batches.** Perform trial batches when required by the plans, or when previous satisfactory field data is not available. Submit previous satisfactory field data to the Engineer showing the proposed mix design conforms to specification requirements when trial batches are not required and before concrete is placed. Trial batch test results will be reported to the Contractor and the concrete supplier. Trial batches are not required for Class A, B, or E concrete unless establishing target values as described below.

Perform trial batches for all self-consolidating concrete mix designs.

Make all trial batches using the proposed ingredients in a mixer that is representative of the mixers to be used on the project when required. Make the batch size at least 50% of the mixer's rated capacity. Alternatively, use an AASHTO-accredited laboratory to perform laboratory trial batches using all the proposed ingredients. Perform fresh concrete tests for air content and slump, and make, cure, and test strength specimens for compliance with specification requirements. Test at least one set of design strength specimens, consisting of two specimens per set, at 7-day, 28-day, and at least one additional age unless otherwise directed. Before placing, provide the Engineer the option of witnessing trial batches, including the testing of the concrete. If not provided this option, the Engineer may require additional trial batches, including testing, before the concrete is placed.

Trial batches for precast concrete will be performed in accordance with [Tex-703-I](#) to show proposed mix design meets the requirements of the pertinent class of concrete, or Table 11 when SCC is used.

Establish a compressive strength target value in accordance with [Tex-427-A](#) for each Class A, B, and E concrete.

When changes are made to the type, brand, or source of aggregates, cement, SCM, water, or chemical admixtures, submit previous satisfactory field data, data from a new trial batch, or other evidence showing the change will not adversely affect the relevant properties of the concrete. Submit the data for approval before making changes to the mix design. A change in vendor does not necessarily constitute a change in materials or source. The Engineer may waive new trial batches when there is a prior record of satisfactory performance with the ingredients. During concrete production, dosage changes of chemical admixtures used in the trial batches will not require a re-evaluation of the mix design.

The Contractor has the option of performing trial batches in conjunction with concrete placements except for SCC mixtures, when new trial batches are required during the course of the project. If the concrete fails to meet any requirement, the Engineer will determine acceptability and payment adjustments. Establishing target strength for Class A, B, and E concrete may be conducted during these placements.

Establish the strength–maturity relationship in accordance with [Tex-426-A](#) when the maturity method is specified or permitted. When using the maturity method, any changes in any of the ingredients, including changes in proportions, will require the development of a new strength–maturity relationship for the mix.

- 4.3.1. **Mix Design of Record.** Once a trial batch or previously satisfactory field data substantiates the mix design, the proportions and mixing methods used become the mix design of record. Do not exceed mix design w/cm ratio.

4.4. **Production Testing.**

- 4.4.1. **Aggregate Moisture Testing.** Determine moisture content in accordance with [Tex-409-A](#) or [Tex-425-A](#) for coarse, intermediate, and fine aggregates at least twice per week, when there is an apparent change, or for new shipments of aggregate. When aggregate hoppers or storage bins are equipped with properly maintained electronic moisture probes for continuous moisture determination, moisture tests in accordance with [Tex-409-A](#) or [Tex-425-A](#) are not required.

When producing SCC, and when aggregate hoppers or storage bins are not equipped with electronic moisture probes, determine the moisture content of the aggregates before producing the first concrete batch each day. Thereafter, determine the moisture content every 4 hr. or when there is an apparent change while SCC is being produced.

- 4.4.2. **Aggregate Gradation Testing.** Perform a sieve analysis in accordance with [Tex-401-A](#) on each stockpile used in the blend at least 1 day before producing OAG concrete. Perform sieve analysis on each stockpile after every 10,000 cu. yd. of Class P OAG concrete produced, and every 1,000 cu. yd. for all other structural-class concrete. Provide sieve analysis data to the Engineer.

4.5. **Measurement of Materials.**

- 4.5.1. **Non-Volumetric Mixers.** Measure aggregates by weight. Correct batch weight measurements for aggregate moisture content. Measure mixing water, consisting of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures, by volume or weight. Measure ice by weight. Measure cement and SCMs in a hopper and on a separate scale from those used for other materials. When measuring by cumulative weight, measure the cement first and ensure the cement meets the cement tolerance shown in Table 12 before measuring the SCMs. Measure concrete chemical admixtures by weight or volume. Measure batch materials within the tolerances shown in Table 12.

**Table 12**  
**Mix Design Batching Tolerances—Non-Volumetric Mixers**

Material	Tolerance (%)
Cement, wt.	-1 to +3
SCM, wt.	-1 to +3
Cement + SCM (cumulative weighing), wt.	-1 to +3
Water, wt. or volume	$\pm 3^1$
Fine aggregate, wt.	$\pm 2$
Coarse aggregate, wt.	$\pm 2$
Fine + coarse aggregate (cumulative weighing), wt.	$\pm 1$
Chemical admixtures, wt. or volume	$\pm 3$

1. Allowable deviation from target weight, not including water withheld or moisture in the aggregate. The Engineer will verify the w/cm ratio is within specified limits.

Ensure the quantity measured, when measuring cementitious materials at less than 30% of scale capacity, is accurate to no less than the required amount and no more than 4% in excess. Ensure the cumulative quantity, when measuring aggregates in a cumulative weigh batcher at less than 30% of the scale capacity, is measured accurately to  $\pm 0.3\%$  of scale capacity or  $\pm 3\%$  of the required cumulative weight, whichever is less.

Measure cement in number of bags under special circumstances when approved. Use the weights specified on the packaging. Weighing bags of cement is not required. Ensure fractional bags are not used except for small hand-mixed batches of approximately 5 cu. ft. or less and when an approved method of volumetric or weight measurement is used.

- 4.5.2. **Volumetric Mixers.** Provide an accurate method of measuring all ingredients by volume and calibrate equipment to assure correct measurement of materials within the specified tolerances. Base tolerances on volume-weight relationship established by calibration and measure the various ingredients within the tolerances shown in Table 13. Correct batch measurements for aggregate moisture content.

**Table 13**  
**Mix Design Batching Tolerances—Volumetric Mixers**

Material	Tolerance
Cement, wt. %	0 to +4
SCM, wt. %	0 to +4
Fine aggregate, wt. %	±2
Coarse aggregate, wt. %	±2
Admixtures, wt. or volume %	±3
Water, wt. or volume %	±1

4.6. **Mixing and Delivering Concrete.**

- 4.6.1. **Mixing Concrete.** Operate mixers and agitators within the limits of the rated capacity and speed of rotation for mixing and agitation as designated by the manufacturer of the equipment. Provide concrete in a thoroughly mixed and uniform mass with a satisfactory degree of uniformity when tested in accordance with [Tex-472-A](#).

Do not top-load new concrete onto returned concrete.

Adjust mixing times and batching operations as necessary when the concrete contains silica fume to ensure the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix will be verified by MTD using cylinders made from trial batches. Make necessary changes to the batching operations, if uniform dispersion is not achieved, until uniform and complete dispersion of the silica fume is achieved.

Mix concrete by hand methods or in a small motor-driven mixer when permitted, for small placements of less than 2 cu. yd. For such placements, proportion the mix by volume or weight.

- 4.6.2. **Delivering Concrete.** Deliver concrete to the project in a thoroughly mixed and uniform mass, and discharge the concrete with a satisfactory degree of uniformity. Conduct testing in accordance with [Tex-472-A](#) when there is a reason to suspect the uniformity of concrete and as directed.

Maintain concrete delivery and placement rates sufficient to prevent cold joints.

Adding chemical admixtures or the portion of water withheld is permitted only at the jobsite, under the supervision of the Engineer, to adjust the slump or slump flow of the concrete. Do not add water or chemical admixtures to the batch after more than an amount needed to conduct slump testing has been discharged. Turn the drum or blades at least 30 additional revolutions at mixing speed to ensure thorough and uniform mixing of the concrete. When this water is added, do not exceed the approved mix design w/cm ratio.

When truck mixers are equipped with automated water or chemical admixture measurement and slump or slump flow monitoring equipment, the addition of water or chemical admixtures during transit is allowed. Reports generated by this equipment must be submitted to the Engineer daily.

Before unloading, furnish the delivery ticket for the batch of concrete containing the information required in accordance with ASTM C94. The Engineer will verify all required information is provided on the delivery tickets. The Engineer may suspend concrete operations until the corrective actions are implemented if delivery tickets do not provide the required information. The Engineer will verify the design w/cm ratio is not exceeded.

An electronic ticket delivery system (e-ticketing) may be used instead of printed tickets. The use of e-ticketing will require written approval. At minimum, the system will:

- provide electronic, real-time e-tickets meeting the requirements above;
- automatically generate e-tickets using software and hardware fully integrated with the batch plant scales used to weigh the material;
- be able to record all water and chemical admixture additions performed at the jobsite or in transit when allowed;

- provide the ability to associate fresh concrete test results with each e-ticket;
- be designed in such a way that data input cannot be altered by the Contractor or the Engineer;
- provide the Engineer access to the e-ticketing data in real-time using a web-based or app-based system compatible with iOS; and
- provide offline capabilities to prevent data loss if power or connectivity is lost.

The Engineer may discontinue use of the e-ticketing and require printed tickets as needed if the e-ticketing system fails to meet the above requirements.

Begin the discharge of concrete delivered in truck mixers within the times shown in Table 14. Concrete delivered after these times and concrete that has not begun to discharge within these times will be rejected. The discharge times shown in Table 14 may be extended provided slump loss testing is conducted in accordance with [Tex-430-A](#) to show concrete will maintain the minimum required slump for the requested discharge time extension. Extended discharge times will be allowed when the concrete temperature at time of discharge is no more than 10°F higher than the slump loss test concrete temperature.

**Table 14  
Concrete Discharge Times for Truck Mixers**

Fresh Concrete Temperature, °F	Max Time After Batching for Concrete Not Containing Type B or D Admixtures, min.	Max Time After Batching for Concrete Containing Type B or D Admixtures, <sup>1</sup> min.
90 and above	45	75
75 ≤ T < 90	60	90
T < 75	90	120

1. Concrete must contain at least the minimum manufacturer's recommended dosage of Type B or D admixture.

- 4.7. **Placing, Finishing, and Curing Concrete.** Place, finish, and cure concrete in conformance with the pertinent Items.
- 4.8. **Sampling and Testing of Concrete.** Unless otherwise specified, all fresh and hardened concrete is subject to testing as follows.
- 4.8.1. **Certification of Testing Personnel.** Contractor personnel performing testing must be either ACI-certified or qualified by a Department-recognized equivalent written and performance testing program for the tests being performed. Personnel performing these tests are subject to Department approval. Use of a commercial laboratory is permitted at the Contractor's option.
- 4.8.2. **Fresh Concrete.** Provide safe access and assistance to the Engineer during sampling. Fresh concrete will be sampled for testing at the point of discharge from the delivery equipment or end of belt conveyors.
- 4.8.3. **Testing Concrete.** The Engineer, unless specified in other Items or shown on the plans, will test the fresh and hardened concrete in accordance with the following methods.
- **Slump.** [Tex-415-A](#)
  - **Air Content.** [Tex-414-A](#) or [Tex-416-A](#), only when air-entrained concrete is shown on the plans
  - **Temperature.** [Tex-422-A](#)
  - **Making and Curing Strength Specimens.** [Tex-447-A](#)
  - **Compressive Strength.** [Tex-418-A](#)
  - **Flexural Strength.** [Tex-448-A](#)
  - **Maturity.** [Tex-426-A](#)

Flexural strength and maturity specimens will not be made unless specified in other Items or shown on the plans.

Concrete with slump less than minimum required after all addition of water withheld will be rejected, unless otherwise allowed by the Engineer. Concrete with slump exceeding maximum allowed may be used at the

Contractor's option. If used, Engineer will make, test, and evaluate strength specimens in accordance with Article 421.5., "Acceptance of Concrete." Acceptance of concrete not meeting air content or temperature requirements will be determined by Engineer. Fresh concrete exhibiting segregation and excessive bleeding will be rejected.

- 4.8.3.1. **Strength Specimen Handling.** After strength test specimens are molded, protect and cure in conformance with pertinent test methods. When necessary, deliver Contractor-molded specimens to curing facilities, remove specimens from their molds, and place specimens in curing tanks within 24–48 hr. after molding, in conformance with pertinent test methods. The Engineer will deliver Department-molded specimens to curing facilities, remove specimens from their molds, and place specimens in curing tanks within 24–48 hr. after molding, in conformance with pertinent test methods.

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## 5. ACCEPTANCE OF CONCRETE

The Engineer will sample and test the fresh and hardened concrete for acceptance. The test results will be reported to the Contractor and the concrete supplier. Investigate the quality of the materials, the concrete production operations, and other possible problem areas to determine the cause for any concrete that fails to meet the required strengths as specified below. Take necessary actions to correct the problem, including redesign of the concrete mix. The Engineer may suspend all concrete operations under the pertinent Items if the Contractor is unable to identify, document, and correct the cause of the low strengths in a timely manner. Resume concrete operations only after obtaining approval for any proposed corrective actions. Concrete failing to meet the required strength as specified below will be evaluated in accordance with Article 421.6., "Measurement and Payment."

- 5.1. **Structural Class of Concrete.** For concrete classes identified as structural concrete shown in Table 8, the Engineer will make and test 7-day and 28-day specimens, and, if necessary, 56-day specimens. The Engineer will base acceptance on attaining the design strength shown in Table 8 or design strength shown on the plans.
- 5.2. **Class P and Class High Early Strength (HES).** The Engineer will base acceptance in accordance with Item 360 and Item 361, "Repair of Concrete Pavement."
- 5.3. **All Other Classes of Concrete.** For concrete classes not identified as structural concrete in Table 8, the Engineer will make and test 7-day specimens. The Engineer will base acceptance on attaining design strength or attaining the 7-day target value established in accordance with [Tex-427-A](#).

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## 6. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

The following procedure will be used to evaluate concrete where one or more project acceptance test specimens fail to meet the required design strength specified in this Item or shown on the plans.

- The concrete for a given placement will be considered structurally adequate and accepted at full price if the average of 28-day or 56-day set of specimens made at the time of placement meets the required design strength, provided no single specimen test result is less than 85% of the required design strength.
- The Engineer will perform a structural review of the concrete to determine its adequacy to remain in service if the average 28-day or 56-day set of specimens made at the time of placement is less than the required design strength or if any single specimen test result is less than 85% of the required design strength. If the concrete is determined to be structurally adequate, the Engineer will determine the limits of the payment adjustment using the formula below.
- If the in situ concrete strength is needed for the structural review, take cores at locations designated by the Engineer in accordance with [Tex-424-A](#). The Engineer will test the cores. The coring and testing will be at the Contractor's expense.

- If all the tested cores meet the required design strength, the concrete will be paid for at full price.
- If any of the tested cores do not meet the required design strength, but the average strength attained is determined to be structurally adequate, the Engineer will determine the limits of the payment adjustment using the following formula.

$$A = B_p \left[ -5.37 \left( \frac{S_a}{S_s} \right)^2 + 11.69 \left( \frac{S_a}{S_s} \right) - 5.32 \right]$$

where:

$A$  = Amount to be paid per unit of measure for the entire placement in question.

$S_a$  = Actual average strength from cylinders or cores. Use values from cores, if taken.

$S_s$  = Minimum required strength (specified).

$B_p$  = Unit bid price.

- If the structural review determines the concrete is not adequate to remain in service, the Engineer will determine the limits of the concrete to be removed.
- The decision to reject structurally inadequate concrete or to apply the payment adjustment factor will be made no later than 7 days after 28-day or 56-day design strength specimens, or cores, if taken, are tested.

# Item 460

## Corrugated Metal Pipe



### 1. DESCRIPTION

Furnish and install corrugated metal pipes, materials for constructing corrugated metal pipe culverts, or corrugated metal storm drain mains, laterals, stubs, and inlet leads.

### 2. MATERIALS

2.1. **Fabrication.** Furnish corrugated metal pipe in accordance with Table 1.

**Table 1**  
**Specifications for Corrugated Metal Pipe**

Pipe Type	AASHTO Specification
Galvanized steel and aluminized steel	M 36
Aluminized Type 2	M 36
Polymer coated	M 245
Asphalt coated	M 190
Aluminum	M 196

The pipe types and corresponding AASHTO designations are shown in Table 2.

**Table 2**  
**Corrugated Metal Pipe Types**

Pipe Type	AASHTO Classification
Circular	Type I
Circular, smooth-lined	Type IA
Circular, spiral rib	Type IR
Arch	Type II
Arch, smooth-lined	Type IIA
Arch, spiral rib	Type IIR

Provide corrugated metal pipe of all types with annular corrugations, helical corrugations, or spiral ribs (corrugations) projecting outward. Provide pipe with helical end corrugations only when necessary to join new pipe to existing pipe with helical end corrugations.

Provide a minimum polymer coating thickness of 10 mils on each side for pre-coated galvanized steel pipe. Galvanized metal sheets and coils used for galvanized corrugated metal pipe may be sampled and tested in accordance with [Tex-708-I](#).

Repair damaged galvanized coating in accordance with Section 445.3.4., "Repairs." Repair damaged aluminized or polymer coating in accordance with AASHTO M 36 and AASHTO M 245, respectively.

2.2. **Protective Coating.** Furnish bituminous coating, when required, that meets AASHTO M 190, that tightly adheres to the metal, does not chip off in handling, and protects the pipe from deterioration.

Coat the pipe uniformly inside and out to a minimum thickness of 0.05 in. measured on the crests of the corrugations. Coat the pipe with additional material applied to the full inner circumference to form a smooth inside lining with a minimum thickness of 1/8 in. above the crest of the corrugations when smooth lining is specified.

2.3. **Design.** The diameter, permissible corrugations, and required gauges for full-circle pipe must be shown. The design size and permissible corrugations for pipe arch must be shown. The required gauges of the shell and

the liner for smooth lined pipe must also be shown. Furnish the shape and minimum gauge for steel pipe arch in accordance with Tables 3, 4, 5, or 6 for the specified design size and corrugation. Use Table 7 or Table 8 for aluminum pipe arch. Refer to U.S. Standard Gauge for uncoated sheets where reference is made to gauge of metal.

Measure dimensions from the inside crests of the corrugations. A tolerance of ±1 in. or 2% of the equivalent circular diameter, whichever is greater, is allowed for span and rise.

**Table 3**  
**Steel Pipe Arch**  
**2-2/3 × 1/2-in. Corrugations**

Design Size	Span (in.)	Rise (in.)	Min Cover (in.)	Min Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
1	17	13	12	16	0.064	15
2	21	15	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	28	20	12	16	0.064	24
4	35	24	12	16	0.064	30
5	42	29	12	14	0.079	36
6	49	33	12	14	0.079	42
7	57	38	12	12	0.109	48
8	64	43	12	12	0.109	54
9	71	47	12	10	0.138	60

**Table 4**  
**Steel Pipe Arch**  
**3 × 1-in. Corrugations**

Design Size	Span (in.)	Rise (in.)	Min Cover (in.)	Min Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
7	53	41	12	14	0.079	48
8	60	46	12	14	0.079	54
9	66	51	12	14	0.079	60
10	73	55	12	14	0.079	66
11	81	59	12	14	0.079	72
12	87	63	12	14	0.079	78
13	95	67	12	12	0.109	84
14	103	71	18	12	0.109	90
15	112	75	18	12	0.109	96
16	117	79	18	12	0.109	102
17	128	83	24	10	0.138	108
18	137	87	24	10	0.138	114
19	142	91	24	10	0.138	120

**Table 5**  
**Steel Pipe Arch**  
**5 × 1-in. Corrugations**

Design Size	Span (in.)	Rise (in.)	Min Cover (in.)	Min Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
11	81	59	12	12	0.109	72
12	87	63	12	12	0.109	78
13	95	67	12	12	0.109	84
14	103	71	18	12	0.109	90
15	112	75	18	12	0.109	96
16	117	79	18	12	0.109	102
17	128	83	24	10	0.138	108
18	137	87	24	10	0.138	114
19	142	91	24	10	0.138	120

**Table 6**  
**Steel Pipe Arch, Spiral Rib**  
**7-1/2 × 3/4 × 3/4-in. Corrugations**

Design Size	Span (in.)	Rise (in.)	Min Cover (in.)	Min Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
2	20	16	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	27	21	12	16	0.064	24
4	33	26	12	16	0.064	30
5	40	31	12	14	0.064	36
6	46	36	12	12	0.064	42
7	53	41	12	12	0.079	48
8	60	46	12	12	0.079	54
9	66	51	15	12	0.079	60

**Table 7**  
**Aluminum Pipe Arch**  
**2-2/3 × 1/2-in. Corrugations**

Design Size	Span (in.)	Rise (in.)	Min Cover (in.)	Min Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
1	17	13	12	16	0.060	15
2	21	15	12	16	0.060	18
2A	23	19	12	16	0.060	21
3	28	20	12	14	0.075	24
4	35	24	12	14	0.075	30
5	42	29	18	12	0.105	36
6	49	33	18	12	0.105	42
7	57	38	18	10	0.135	48
8	64	43	18	10	0.135	54
9	71	47	18	8	0.164	60

**Table 8**  
**Aluminum Pipe Arch, Spiral Rib**  
**7-1/2 × 3/4 × 3/4-in. Corrugations**

Design Size	Span (in.)	Rise (in.)	Min Cover (in.)	Min Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
2	20	16	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	27	21	15	16	0.064	24
4	33	26	18	16	0.064	30
5	40	31	18	14	0.075	36
6	46	36	18	12	0.105	42
7	53	41	21	12	0.105	48
8	60	46	18	10	0.135	54
9	66	51	21	10	0.135	60

- 2.4. **Coupling Bands.** Furnish coupling bands and other hardware for galvanized or aluminized steel pipe in accordance with AASHTO M 36 and AASHTO M 196 for aluminum pipe. Use coupling bands that are no more than three nominal sheet thicknesses lighter than the thickness of the pipe to be connected or no lighter than 0.052 in. for steel or 0.048 in. for aluminum. Provide coupling bands made of the same base metal and coating as the pipe.

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### 3. CONSTRUCTION

- 3.1. **Designation of Type.** The types of pipes will be shown on the plans by the following descriptions:
- Pipe type: Corrugated metal pipe (CMP), corrugated metal pipe arch (CMP ARCH), spiral rib corrugated metal pipe (SRCMP), or spiral rib corrugated metal pipe arch (SRCMP ARCH);
  - Type of material: Galvanized steel, aluminum-coated (Type 2), or aluminum;
  - Pipe coating: Bituminous coated or polymer coated;
  - Special requirements: Paved invert or smooth lining; and
  - Pipe size: Diameter or design number.

Furnish any of the material types specified above when pipe is designated as "Corrugated Metal Pipe" without a type of material or pipe coating designation.

- 3.2. **Excavation, Shaping, Bedding, and Backfill.** Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures," except where jacking, boring, or tunneling methods are shown on the plans or permitted. Jack, bore, or tunnel in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box."

Provide uniform backfill material and uniformly compacted density throughout the length of the structure so equal pressure is provided. Allow no heavy earth-moving equipment over the structure until at least 4 ft. of compacted fill (permanent or temporary) has been placed over the top of the structure, unless otherwise shown on the plans or permitted in writing. Inspect the inside periphery of the structure for local or unequal deformation caused by improper construction methods before adding each new layer of loose backfill material. Continue inspections until at least 24 in. of cover is obtained. Evidence of such deformation will be reason for corrective measures as directed. Remove and replace pipe damaged by the Contractor at no additional cost to the Department.

- 3.3. **Laying Pipe.** Lay pipes on the bedding from the outlet end and join the separate sections firmly together with outside laps of annular joints pointing upstream and longitudinal laps on the sides unless otherwise authorized. Coat any metal in joints not protected by galvanizing or aluminizing with a suitable asphalt paint. Lower sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Remove and re-lay, without extra compensation, pipe that is not in alignment or shows excessive settlement after laying.

Lay multiple installations of corrugated metal pipe and pipe arches with the centerlines of individual barrels parallel. Maintain the clear distances between outer surfaces of adjacent pipes shown in Table 9, unless otherwise shown on the plans.

**Table 9  
Required Pipe Clear Distances**

Diameter Full-Circle Pipe (in.)	Pipe Arch Design Size	Clear Distance Between Pipes (Full-Circle Pipe and Pipe Arch)
18	2	1 ft. 2 in.
21	2A	1 ft. 3 in.
24	3	1 ft. 5 in.
30	4	1 ft. 8 in.
36	5	1 ft. 11 in.
42	6	2 ft. 2 in.
48	7	2 ft. 5 in.
54	8	2 ft. 10 in.
60 to 84	9	3 ft. 2 in.
90 to 120	10 and above	3 ft. 5 in.

3.4. **Jointing.** Provide field joints that maintain pipe alignment during construction and prevent infiltration of side material during the life of the installation. Provide one of the following jointing systems unless otherwise shown on the plans.

3.4.1. **Coupling Bands.** Use coupling bands with annular corrugations only with pipe with annular corrugations or with helical pipe or spiral rib pipe on which the ends have been rerolled to form annular corrugations. Provide bands with corrugations that have the same dimensions as the corrugations on the pipe end or are designed to engage the first or second corrugation from the end of each pipe. The band may also include a U-shaped channel to accommodate upturned flanges on the pipe.

Field-join pipe with helically corrugated bands or bands with projections (dimples) when helical end corrugations are allowed.

Coupling bands with projections may be used with pipe that has annular or helical end corrugations or spiral ribs. Provide bands formed with the projections in annular rows with one projection for each corrugation of helical pipe or spiral rib pipe. Provide two annular rows for bands 10-1/2 in. or 12 in. wide and four annular rows of projections for bands 16-1/2 in. or 22 in. wide.

Use a coupling band width that conforms to Table 10. Connect the bands using suitable galvanized devices in accordance with AASHTO M 36. Lap coupling bands equally on each of the pipes to form a tightly closed joint after installation. Provide at least the minimum coupling band width recommended by the manufacturer for corrugations not shown in Table 10.

**Table 10**  
**Coupling Band Width Requirements**

Nominal Corrugation Size <sup>1</sup> (in.)	Nominal Pipe Inside Diameter <sup>2</sup> (in.)	Min Coupling Band Width (in.)		
		Annular Corrugated Bands	Helically Corrugated Bands	Bands with Projections
2-2/3 × 1/2	12–36	7	12	10-1/2
	42–72	10-1/2	12	10-1/2
	78–84 <sup>3</sup>	10-1/2	12	16-1/4
3 × 1	36–72	12	14	10-1/2
	78–120	12	14	16-1/4
5 × 1	36–72	20	22	12
	78–120	20	22	22
7-1/2 × 3/4 × 3/4	18–60	10-1/2	12	10-1/2
	66–102	10-1/2	12	16-1/4

1. For helically corrugated pipe or spiral rib pipe with rolled ends, the nominal size refers to the dimensions of the end corrugations in the pipe.
2. Equivalent circular diameter for Type II pipe.
3. Diameter through 120 in. for annular corrugated bands used on rerolled ends of helically corrugated pipe or spiral rib pipe.

The minimum diameter of bolts for coupling bands is 3/8 in. for pipe diameters 18 in. and less and 1/2 in. for pipe diameters 21 in. and greater. Provide at least two bolts for bands 12 in. wide or less. Provide at least three bolts for bands wider than 12 in.

Provide galvanized hardware in accordance with Item 445, "Galvanizing."

- 3.4.2. **Bell and Spigot.** Attach the bell to one end of the corrugated metal pipe at the manufacturing plant before shipment. Provide a bell with a minimum 6-in. stab depth. Install the gasket on the spigot end and apply lubricant in accordance with the manufacturer's recommendations. Provide gaskets that meet ASTM F477 with Type A Shore durometer hardness of 45 ±5. Do not use thermoplastic elastomer as the basic polymer. Push the spigot end of the pipe into the bell end of the previously laid pipe during laying of the pipe.

- 3.4.3. **Pipe Connections and Stub Ends.** Make connections of pipe to existing pipe or appurtenances as shown on the plans or as directed. Mortar or concrete the bottom of the existing structure, if necessary, to eliminate any drainage pockets created by the new connection.

Insulate portions of aluminum pipe that are to be in contact with metal other than aluminum with a coating of bituminous material meeting the requirements of Section 460.2.2., "Protective Coating." Extend the coating at least 1 ft. beyond the area of contact.

Restore any damage that results from making the connection when connecting pipe into existing structures that will remain in service. Seal stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the pipe.

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## 4. MEASUREMENT

This Item will be measured by the foot. Pipe will be measured between the ends of the barrel along the flow line, not including safety end treatments. Safety end treatments will be measured in accordance with Item 467, "Safety End Treatment." Pipe that is required to be jacked, bored, or tunneled will be measured in accordance with Item 476. Where spurs, branches, or connections to existing pipe lines are involved, measurement of the spur or new connecting pipe will be made from the intersection of the flow line with the outside surface of the pipe into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of pipe, the length of pipe tying into the structure wall will be included for measurement but no other portion of the structure length or width will be included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

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**5. PAYMENT**

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 "Corrugated Metal Pipe," "Corrugated Metal Pipe Arch," "Spiral Rib Corrugated Metal Pipe," or "Spiral Rib Corrugated Metal Pipe Arch" of the type, size, and coating specified. This price is full compensation for furnishing, hauling, placing, and joining of pipes; jointing materials; all connections to new or existing structures; breaking back, removing, and disposing of portions of the existing structure; replacing portions of the existing structure; cutting pipe ends on skew or slope; and equipment, labor, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required in accordance with Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400. When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring, or tunneling is required, payment will be made under Item 476.

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## Item 480

### Cleaning Existing Culverts

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#### 1. DESCRIPTION

Remove all extraneous material from existing culvert barrels and pipes.

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#### 2. WORK METHODS

Expose all inside surfaces of the specified culverts. Do not move or damage the culvert. Dispose of material in conformance with federal, state, and local regulations. Place on roadway slopes when approved.

Perform cleaning to maintain drainage during construction. Acceptance of the cleaned culverts occurs at final acceptance of the project in accordance with Article 5.11., "Final Cleanup," unless otherwise shown on the plans.

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#### 3. MEASUREMENT

This Item will be measured by each complete culvert cleaned regardless of the number of barrels or pipes at each location or by the cubic yard. If measurement is by the cubic yard, the volume of material to be removed will be computed by the method of average end areas in its original position.

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#### 4. PAYMENT

The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Cleaning Existing Culverts." This price is full compensation for excavation, disposal of excavated material, equipment, labor, tools, and incidentals.

# Item 529

## Concrete Curb, Gutter, and Combined Curb and Gutter



### 1. DESCRIPTION

Construct hydraulic cement concrete curb, gutter, and combined curb and gutter.

### 2. MATERIALS

Furnish materials in accordance with the following.

- Item 360, "Concrete Pavement"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

Use Class A concrete or material specified on the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved. When curbs are monolithically placed with the concrete pavements, use the same class of concrete as the concrete pavement.

Use of fibers in accordance with [DMS-4550](#), "Fibers for Concrete," to replace reinforcing steel in Class A concrete is allowed unless otherwise shown on the plans. Dose fibers in accordance with the Department's MPL of pre-qualified fibers for concrete.

### 3. CONSTRUCTION

Provide finished work with a well-compacted mass and a surface free of voids and honeycomb, in the required shape, line, and grade. Round exposed edges using an edging tool of the radius shown on the plans. Mix, place, and cure concrete in accordance with Item 420. Construct joints at locations shown on the plans. Cure for at least 72 hr.

Furnish and place reinforcing steel in accordance with Item 440 unless fiber reinforced concrete is used.

Set and maintain a guideline that conforms to alignment data shown on the plans, with an outline that conforms to the details shown on the plans. Ensure that changes in curb grade and alignment do not exceed 1/4 in. between any two contacts on a 10-ft. straightedge.

- 3.1. **Conventionally Formed Concrete.** Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement.

Pour concrete into forms, and strike off with a template 1/4–3/8 in. less than the dimensions of the finished curb unless otherwise approved. After initial set, plaster surface with mortar consisting of one part hydraulic cement and two parts fine aggregate. Brush exposed surfaces to a uniform texture.

Place curbs, gutters, and combined curb and gutters in 50-ft. maximum sections unless otherwise approved.

- 3.2. **Extruded or Slipformed Concrete.** Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement. Provide clean surfaces for concrete placement. Coat cleaned

surfaces, if required, with approved adhesive or coating at the rate of application shown on the plans or as directed. Place concrete using approved self-propelled equipment.

The forming tube of the extrusion machine or the form of the slipform machine must be easily adjustable vertically during the forward motion of the machine to provide variable heights necessary to conform to the established gradeline.

Attach a pointer or gauge to the machine so that a continual comparison can be made between the extruded or slipform work and the grade guideline. Other methods may be used when approved.

Finish surfaces immediately after extrusion or slipforming.

- 3.3. **Curb Joints for Concrete Pavements.** Provide transverse expansion and contraction joints in the curb of the same type and location as the adjacent or underlying pavement. Use expansion joint material of the same thickness and type required for the pavement. Extend expansion joints through the curb. Place reinforcing steel for non-monolithic curb construction joints as shown on the plans, unless otherwise approved. Form or saw the contraction joint through the full depth of the monolithic curb.

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#### 4. MEASUREMENT

This Item will be measured by the foot.

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#### 5. PAYMENT

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 "Concrete Curb," "Concrete Curb (Mono)," or "Concrete Curb and Gutter" of the type specified. This price is full compensation for surface preparation of curb foundation, equipment, labor, materials, tools, and incidentals.

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# Item 530

## Intersections, Driveways, and Turnouts

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### 1. DESCRIPTION

Construct and pave intersections, driveways, and turnouts. Pave existing intersections, driveways, and turnouts.

Intersections are considered areas off the travel lanes and shoulders of the Contract highway on the intersecting highway on the state system. The intersecting on-system highway work will be paid for under this Item only when shown on the plans.

Driveways are defined as private (residential or commercial) and public (county road and city street) access areas off the travel lanes and shoulders.

Turnouts include but are not limited to mailbox and litter barrel widenings.

---

### 2. MATERIALS

Furnish materials that meet the following.

- Item 247, "Flexible Base"
- Item 260, "Lime Treatment (Road-Mixed)"
- Item 275, "Cement Treatment (Road-Mixed)"
- Item 276, "Cement Treatment (Plant-Mixed)"
- Item 292, "Asphalt Treatment (Plant-Mixed)"
- Item 316, "Seal Coat"
- Item 330, "Limestone Rock Asphalt Pavement"
- Item 334, "Hot-Mix Cold-Laid Asphalt Concrete Pavement"
- Item 341, "Dense-Graded Hot-Mix Asphalt"
- Item 360, "Concrete Pavement"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

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### 3. CONSTRUCTION

Construct and pave intersections, driveways, and turnouts, and pave existing intersections, driveways, and turnouts as shown on the plans or as directed. Place materials in conformance with construction Articles of pertinent Items. Provide uninterrupted access to adjacent property unless otherwise directed. Ensure that abrupt elevation changes in driveway or turnout areas that serve as sidewalks do not exceed 1/4 in. and that the sidewalk area cross slope does not exceed 2%. Ready-mix concrete and hand finishing will be permitted when concrete pavement is specified unless otherwise shown on the plans for intersections.

---

### 4. MEASUREMENT

This Item will be measured by the square yard of the final pavement surface, as placed in the field, including radii and turnout.

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**5. PAYMENT**

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 "Intersections," "Driveways," "Turnouts," "Intersections, Driveways, and Turnouts," or "Driveways and Turnouts" of the surface specified.

This price is full compensation for furnishing and operating equipment; excavation and embankment; base and pavement materials; and labor, materials, tools, and incidentals. Drainage structures will be measured and paid for in conformance with the pertinent bid Items.

# Item 531

## Sidewalks



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### 1. DESCRIPTION

Construct hydraulic cement concrete sidewalks, Americans with Disabilities Act ramps, and steps.

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### 2. MATERIALS

Furnish materials in accordance with the following.

- Item 360, "Concrete Pavement"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

Use Class A concrete unless otherwise shown on the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved.

Use of fibers meeting the requirements of [DMS-4550](#), "Fibers for Concrete," to replace reinforcing steel in Class A concrete is allowed unless otherwise shown on the plans. Dose fibers in accordance with the Department's MPL of prequalified fibers for concrete.

Furnish detectable warning material in accordance with [DMS-4350](#), "Detectable Warning Material."

---

### 3. CONSTRUCTION

Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement. Hand-tamp and sprinkle foundation when placement is directly on subgrade or foundation materials. Remove and dispose of existing concrete in accordance with Item 104, "Removing Concrete." Provide a clean surface for concrete placement directly on the surface material or pavement.

Furnish and place reinforcing steel in accordance with Item 440 unless fiber reinforced concrete is used.

Mix and place concrete in conformance with the pertinent Items. Hand-finishing is allowed for any method of construction. Finish exposed surfaces to a uniform transverse broom finish surface. Curb ramps must include a detectable warning surface and conform to details shown on the plans. Install joints as shown on the plans. Ensure that abrupt changes in sidewalk elevation do not exceed 1/4 in., sidewalk cross slope does not exceed 2%, curb ramp grade does not exceed 8.3%, and flares adjacent to the ramp do not exceed 10% slope measured parallel to the curb line. Ensure that the sidewalk depth and reinforcement are not less than the driveway cross-sectional details shown on the plans where a sidewalk crosses and is part of the concrete driveway.

Use construction methods in conformance with manufacturers' recommendations when installing detectable warning surface. Install detectable warning surface as shown on the plans.

Provide finished work with a well-compacted mass, a surface free of voids and honeycomb, and the required true-to-line shape and grade. Cure for at least 72 hr. in accordance with Item 420.

- 3.1. **Conventionally Formed Concrete.** Provide pre-molded or board expansion joints of the thickness shown on the plans for sidewalk section lengths greater than 8 ft. but less than 40 ft., unless otherwise directed. Terminate workday production at an expansion joint.
- 3.2. **Extruded or Slipformed Concrete.** Provide any additional surface finishing immediately after extrusion or slipforming as shown on the plans. Construct joints at locations as shown on the plans or as directed.

---

**4. MEASUREMENT**

Sidewalks will be measured by the square yard of surface area. Curb ramps will be measured by the square yard of surface area or by each. A curb ramp consists of the ramp, landing or turning space, adjacent flares or side curb, and detectable warning surface as shown on the plans. Steps will be measured by the square yard of horizontal surface area.

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**5. PAYMENT**

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 "Concrete Sidewalks" of the depth specified, "Concrete Sidewalk (Steps)," and "Curb Ramps" of the type specified. This price is full compensation for surface preparation of sidewalk foundation; materials; removal and disposal of existing concrete; excavation, hauling, and disposal of excavated material; drilling and doweling into existing concrete curb, sidewalk, and pavement; repair of adjacent street or pavement structure damaged by these operations; and equipment, labor, materials, tools, and incidentals.

Sidewalks that cross and are part of the concrete driveways or turnouts will be measured and paid for in accordance with Item 530, "Intersections, Driveways, and Turnouts."

# Item 636

## Signs



### 1. DESCRIPTION

- **Installation.** Furnish, fabricate, and erect aluminum signs. Sign supports are provided for under other Items.
- **Replacement.** Replace existing signs on existing or replaced sign supports.

### 2. MATERIALS

- 2.1. **Signs.** Furnish completed signs in accordance with [DMS-8301](#), "Highway Sign Fabrication."
- 2.2. **Hardware.** Use galvanized steel, stainless steel, or dichromate-sealed aluminum for bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. Use plastic or nylon washers when in direct contact with the reflective sheeting. Furnish steel or aluminum products in accordance with [DMS-7120](#), "Sign Hardware."
- When dissimilar metals are used, select or insulate metals to prevent corrosion.
- 2.3. **Sign Identification Decals.** Furnish materials that meet the requirements of [DMS-8315](#), "Sign Identification Decals."

### 3. CONSTRUCTION

- 3.1. **Decals.** The sign fabricator must code the sign identification decals by punching out the appropriate letter or digits for Rows 1–7 as shown in Figure 1 and Table 1.
- Rows 8–12 (Installation Date) are only for coding by the Engineer at their discretion.
- Affix the decal to lower left corner of the sign back in an upright position.
- Figure 1 shows the sign identification decal. The numbers to the far right as shown in Figure 1 are reference row numbers for Table 1 and are not part of the decal. Table 1 describes the information required in each row of the decal.

Texas Department of Transportation													
<b>C</b>	<b>Fabrication Date</b>											<b>T</b>	1
J	F	M	A	M	J	J	A	S	O	N	D		2
	202		203		204		205		206				3
	0	1	2	3	4	5	6	7	8	9			4
Sheeting MFR—Substrate													
A	B	C	D	E	F	G	H	J	K	L	M		5
Film MFR													
A	B	C	D	E	F	G	H	J	K	L	M		6
Sheeting MFR—Legend													
A	B	C	D	E	F	G	H	J	K	L	M		7
Installation Date													
				0	1	2	3						8
	0	1	2	3	4	5	6	7	8	9			9
J	F	M	A	M	J	J	A	S	O	N	D		10
	202		203		204		205		206				11
	0	1	2	3	4	5	6	7	8	9			12
Name of Sign Fabricator Physical Address City, State, Zip Code													
													13

Figure 1  
Decal Design (Row Numbers Explained in Table 1)

Table 1  
Decal Description  
Row Explanation

1—Sign fabricator
2—Month fabricated
3—First 3 digits of year fabricated
4—Last digit of year fabricated
5—Manufacturer of the sheeting applied to the substrate
6—Film (colored transparent or non-reflective black) manufacturer
7—Manufacturer of the sheeting for the legend
8—Tens digit of date installed <sup>1</sup>
9—Ones digit of date installed <sup>1</sup>
10—Month installed <sup>1</sup>
11—First 3 digits of year installed <sup>1</sup>
12—Last digit of year installed <sup>1</sup>
13—Name of sign fabricator and physical location of sign shop

1. Only for coding by the Engineer at their discretion.

Code the decal by punching out the following:

- "C" if fabricated by a commercial sign fabricator or "T" if fabricated by the Department or the Texas Department of Criminal Justice,
- month fabricated,
- first three digits of the year fabricated,
- fourth digit of the year fabricated, and
- sheeting and film manufacturers. (Codes for these manufacturers are located on the Department's MPL.)

- 3.2. **Storage and Handling.** Ship, handle, and store completed sign blanks and completed signs so that corners, edges, and faces are not damaged. Damage to the sign face that is not visible when viewed at a distance of 50 ft., night or day, will be acceptable. Replace unacceptable signs.

Store all finished signs off the ground and in a vertical position until erected. Store finished sheet aluminum substrate signs in a weatherproof building. Extruded aluminum substrate signs may be stored outside.

Stockpile salvageable materials at the location shown on the plans or as directed. Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

- 3.3. **Cleaning.** Wash completed signs in the fabrication shop using a biodegradable cleaning solution acceptable to the manufacturers of the sheeting, colored transparent film, and screen ink to remove grease, oil, dirt, smears, streaks, finger marks, and other foreign material. Wash again before final inspection after erection.

- 3.4. **Installation.** Install signs as shown on the plans or as directed.

- 3.5. **Replacement.** Remove the existing signs from the existing or replaced supports and replace with new signs, including mounting hardware, as shown on the plans. At the Engineer's discretion, existing galvanized mounting hardware can be reused if it was not damaged during removal of existing sign.

- 3.6. **Documentation.** Provide a notarized original of the project-specific Signing Material Statement (Form 2273), from the sign fabricator, along with attached copies of pertinent material certifications for verification of compliance.

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## 4. MEASUREMENT

Signs installed or replaced will be measured by the square foot of the sign face.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

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## 5. PAYMENT

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 "Aluminum Signs," or "Replacing Existing Aluminum Signs," of the type specified.

- 5.1. **Installation.** This price is full compensation for furnishing and installing new signs and hardware; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams, and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.

- 5.2. **Replacement.** This price is full compensation for furnishing and installing new aluminum signs and hardware; reusing existing hardware (when applicable); removal of existing signs; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams, and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; salvaging and disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

# Item 644

## Small Roadside Sign Assemblies



### 1. DESCRIPTION

- 1.1. **Installation.** Furnish, fabricate, and erect small roadside sign assemblies or bridge-mounted clearance sign assemblies consisting of the signs, sign supports, foundations (when required), and associated mounting hardware.
- 1.2. **Relocation.** Relocate existing small roadside sign assemblies or bridge-mounted clearance sign assemblies and furnish and fabricate material as required.
- 1.3. **Removal.** Remove existing small roadside sign assemblies or bridge-mounted clearance sign assemblies.

### 2. MATERIALS

Furnish all materials unless otherwise shown on the plans. Furnish only new materials. Furnish and fabricate materials in accordance with the following Items and as shown on the plans.

- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 636, "Signs"
- Item 656, "Foundations for Traffic Control Devices"

Use galvanized steel, stainless steel, dichromate sealed aluminum, or other materials shown on the plans for pipe, bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. When dissimilar metals are used, select or insulate metals to prevent corrosion.

### 3. CONSTRUCTION

Construct foundations in accordance with Item 656. Plumb sign supports. Do not spring or rake posts to secure proper alignment. Use established safety practices when working near underground or overhead utilities. Consult the appropriate utility company before beginning work.

- 3.1. **Fabrication.** Fabricate sign supports in accordance with Item 441. Ensure all components fit properly.

Verify the length of each post for each sign before fabrication to meet field conditions and sign-mounting heights shown on the plans.

Hot-dip galvanize fabricated parts in accordance with Item 445. Punch or drill any holes in steel parts or members before galvanizing. Repair galvanizing for any steel part or member damaged during assembly, transit, or erection, or for any steel part or member welded, when permitted, after galvanizing. Perform all galvanizing repairs in accordance with Section 445.3.4., "Repairs."

- 3.2. **Installation.** Locate and install sign supports as shown on the plans, unless directed to shift the sign supports within design guidelines to secure a more desirable location or avoid conflict with utilities and underground appurtenances. Stake sign support locations for verification by the Engineer.

Install stub posts of the type, spacing, orientation, and projection shown on the plans. Remove and replace posts damaged during installation at the Contractor's expense.

Connect the upper post sections to the stub post sections as shown on the plans. Torque connection bolts as shown on the plans.

Attach signs to supports in conformance with the plans and pertinent Items.

- 3.3. **Relocation.** Reuse the existing signs as required unless otherwise shown on the plans. Furnish and install new stub posts in new foundations for relocated sign assemblies. Erect the new supports on the new stub posts and attach the existing signs to the supports in conformance with the plans and pertinent Items. Remove existing foundations to be abandoned in accordance with Section 644.3.4., "Removal."

- 3.4. **Removal.** Remove abandoned concrete foundations to 2 ft. below finished grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing with like material to equivalent condition.

- 3.5. **Handling and Storage.** Handle and store existing signs or portions of signs removed so they are not damaged. Store all signs to be reused off the ground and in a vertical position until erected. Prevent any damage to the various sign assembly components. Replace any portion of the sign damaged by the Contractor designated for reuse or salvage, including messages removed.

Store all new signs off the ground and in a vertical position until erected. Store new sheet aluminum substrate signs in a weatherproof building. Extruded aluminum substrate signs may be stored outdoors.

Stockpile all removed sign components that will be reused or become the property of the Department at designated locations. Accept ownership of unsalvageable materials and dispose of them in conformance with federal, state, and local regulations.

- 3.6. **Cleaning.** Wash the entire sign after installation using a biodegradable cleaning solution acceptable to the sign face materials manufacturer to remove dirt, grease, oil smears, streaks, finger marks, and other foreign materials.

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## 4. MEASUREMENT

This Item will be measured as each small roadside assembly or bridge-mounted clearance sign assembly installed, removed, or relocated.

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## 5. PAYMENT

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 "Install Small Roadside Sign Assemblies" of the type specified, "Install Bridge-Mounted Clearance Sign Assemblies" of the type specified, "Relocate Small Roadside Sign Assemblies" of the type specified, "Relocate Bridge-Mounted Clearance Sign Assemblies" of the type specified, "Remove Small Roadside Sign Assemblies," or "Remove Bridge-Mounted Clearance Sign Assemblies."

- 5.1. **Installation.** This price is full compensation for furnishing, fabricating, galvanizing, and erecting the supports; constructing foundations, including concrete (when required); furnishing complete signs, including sign connections and all hardware; attaching the signs to the supports; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.
- 5.2. **Relocation.** This price is full compensation for removing existing sign assemblies and related materials; furnishing and installing new stub posts and new sign supports; constructing foundations, including concrete

(when required); new hardware; reinstallation of signs; preparing and cleaning the signs; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.

- 5.3. **Removal.** This price is full compensation for removing existing sign assemblies and related materials; salvaging; disposal of unsalvageable materials; removing existing foundations, backfilling, and surface placement; and materials, equipment, labor, tools, and incidentals.