

TECHNICAL SPECIFICATIONS
CIVIL ENGINEERING PACKAGE

Sulphur Springs Road Culvert Replacement

Hoover, Alabama

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PREPARED BY

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Sulphur Springs Road Culvert Replacement

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SECTION 31 1000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Protection of existing trees and vegetation to remain.
 - 2. Removing trees and other vegetation.
 - 3. Clearing and grubbing.
 - 4. Topsoil stripping.
 - 5. Removing above-grade site improvements.
 - 6. Removing below-grade improvements.
 - 7. Disconnecting, capping or sealing, and abandoning site utilities in place.
 - 8. Disconnecting, capping or sealing, and removing site utilities.

- B. Related Sections:
 - 1. Section 31 2500 Erosion and Sedimentation Controls
 - 2. Section 31 2000 Earth Moving

1.2 DEFINITIONS

- A. Topsoil: Friable clay loam surface-soil found in depth not less than 4"; free of subsoil, clay, lumps, stones and objects larger than 2"; without weeds, roots, or other objectionable material.

1.3 MATERIAL OWNERSHIP

- A. Except for materials to be stockpiled or remain Owner's property, remove remainder from site.

1.4 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

- B. Record drawings per Contract Closeout Checklist.
 - 1. Identify and accurately locate capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.5 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements of specifications.

1.6 PROJECT CONDITIONS

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

 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

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- B. Improvements on Adjoining Property: Authority for performing indicated removal and alteration work on property adjoining Owner's property will be obtained by Owner before award of Contract.
- C. Notify utility locator service for area where Project is located before site clearing.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31 2000 Earth Moving.
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion and sediment control measures to prevent soil erosion and discharge of runoff or airborne dust to adjacent properties and walkways.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

- A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within drip line.
 - 2. Do not permit vehicles, equipment, or foot traffic within drip line.
- B. Do not excavate within drip line of trees, unless otherwise indicated.
- C. Where excavation is within drip line, hand clear and excavate to minimize damage to root system. Use narrow-tine spades; comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Support and protect roots until covered with soil.
 - 3. Coat cut face of roots with emulsified asphalt.
 - 4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in manner approved by Engineer.
 - 1. Employ qualified arborist, licensed in jurisdiction of Project, to repair damage to trees and shrubs.
 - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities to be removed.
 - 1. Arrange to shut off indicated utilities with utility companies. Pay any required fees.

- B. Do not interrupt utilities serving occupied facilities unless permitted under following conditions and then only after arranging to provide temporary service as required.
 - 1. Notify Engineer two days before proposed interruption.
 - 2. Do not proceed without Engineer's written permission.

- C. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction; dig out stumps and grub roots.
 - 1. Protect trees, shrubs, and vegetation to remain or be relocated.
 - 2. Cut minor roots and branches of trees to remain in a clean and careful manner where obstructing new construction.
 - 3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18" below exposed subgrade.
 - 4. Use only hand methods for grubbing within drip line of trees.
- B. Fill depressions caused by clearing and grubbing with satisfactory soil material, unless further excavation or earthwork is indicated.
 - 1. Place fill in horizontal layers not exceeding 8" loose depth, and compact each layer to a density equal to adjacent original ground.

3.5 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, foundations, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.6 DISPOSAL

- A. No burning shall be permitted on site.
- C. Remove surplus soil, unsuitable topsoil, obstructions, demolished materials, trash and debris, and legally dispose of off site.

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END OF SECTION 31 1000

SECTION 31 2000 – EARTH MOVING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes unclassified excavation, grading, and fill as shown or specified, all as part of Base Bid, and:
 - 1. Site excavation as shown or indicated, including removal of rock, rock deposits, boulders, organic material, soil or any other material to reach grade, subgrade, footing or trench bottom, or other condition indicated.
 - 2. Coordinate work with Owner's Geotechnical Engineer.
 - 3. Grade in stages if required to install new or modify existing utilities.
 - 4. Scarify, compact and test previously graded areas of site for acceptance before beginning work of this contract.
 - 5. Excavate and place embankments to required line, grade and elevation.
 - 6. Prepare low areas for fill placement, including disposal of muck, silt, wet or unsuitable material.
 - 7. Haul-in satisfactory fill material, if satisfactory material is not available on-site to provide site to line and grade shown.
 - 8. Haul-off excess excavation or unsatisfactory material, if material cannot be used on-site to provide line and grade shown.
 - 9. Prepare subgrades for slabs, walks, pavements, and landscaping.
 - 10. Provide base course for walks and pavements.
 - 11. Excavate and backfill for underground mechanical and electrical utilities and appurtenances.

1.2 RELATED WORK

- A. Section 31 2500 Erosion and Sedimentation Controls
- B. Section 31 1000 Site Clearing

1.3 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
- B. Base Course: Layer between subgrade, walks and paving.
- C. Bedding Course: Layer of select material underneath pipes.
- D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill when sufficient satisfactory soil not available on-site.
- E. Unclassified Excavation: Excavation is unclassified, which is defined as removal of any material encountered in reaching elevations or accomplishing the work shown on the drawings without regard to type or character; whether wet or dry; dark or light; dirt or rock; hard or soft; humus or no-humus; smelly or not smelly; heavy or light in weight.
- F. Fill: Soil material used to raise existing grades.
- G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- H. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.

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- I. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

- A. Submit per Conditions of Contract
- B. Samples of:
 - 1. Proposed fill/backfill, 30-lb samples, sealed in airtight containers, from on-site or borrow sources.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of following with requirements indicated:
 - 1. Classification per ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve per ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.
- D. Photographs of existing adjacent structures and site improvements.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.
- B. Owner will employ independent geotechnical testing agency qualified per ASTM E 329 to verify that soils meet requirements, perform required field and laboratory tests. The Contractor shall work with the testing agency to ensure that required testing and results are obtained.

1.6 PROJECT CONDITIONS

- A. Do not interrupt utilities serving Owner or others except when permitted in writing by Engineer and then only after acceptable temporary services are provided.
 - 1. Provide minimum 48-hour notice to Owner and receive written notice to proceed before interrupting any utility.
 - 2. Contact utility-locator service before excavating.
- B. Demolish and remove from site underground utilities indicated to be removed. Coordinate with utility company to shutoff active lines.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Provide approved borrow material from off-site when sufficient approved material not available from on-site excavation.
- B. Satisfactory Soils: ASTM D 2487 classification CL, ML, SM, SW, and SC; free of topsoil and organics, free of rock or gravel larger than 2 inches; with Plasticity Index of less than 30, Liquid Limit less than 55 and maximum dry density above 100 pcf.
- C. Unsatisfactory Soils: Material that will not readily compact, organic material, or material with Plasticity Index greater than or equal 25, Liquid Limit greater than or equal to 50, or unit weight less than or equal to 100 pcf. ASTM D 2487 MH, CH, OL, OH, and PT.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2% of optimum moisture content at time of compaction.

- D. Provide engineered fill as required.
- E. Backfill and Fill Material: Satisfactory soil material.
- F. Base Material: Naturally or artificially graded mix of natural or crushed aggregate conforming to the requirements of ALDOT Standard Specifications for Highway Construction Section 825-Type "B".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage by earthwork operation.
- B. Provide erosion and sediment control; prevent erosion or displacement of soils and discharge of soil-bearing water runoff or dust to adjacent properties. Erosion and sediment control is specified in Section 31 25 00 Erosion and Sedimentation Controls.
- C. Tree protection is specified in Section 31 10 00 Site Clearing.

3.2 DEWATERING

- A. Prevent surface or ground water from entering excavations, ponding on prepared subgrades, and from flooding site and surrounding area.
- B. Protect areas receiving fill, subgrades and foundation soils from softening and damage by rain or water accumulation.

3.3 EXCAVATION

- A. Excavation is unclassified and includes all excavation regardless of materials and obstructions encountered.

3.4 STABILITY OF EXCAVATIONS

- A. Comply with all Federal, State and local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevation and dimension within $\pm .10"$. Extend excavation from structure to allow for placing and removing formwork, installing services and other construction, and inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade before placing reinforcement. Trim bottom to required line and grade to leave solid base to receive other work.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Devices: Excavate to elevation indicated within $\pm .10"$. Do not disturb bearing surface.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

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

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated slopes, lines, depths, and elevations.

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1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trench to uniform width to provide 12" working clearance on each side of pipe or conduit. Excavate trench wall vertically from bottom to 12" above top of pipe or conduit, unless otherwise indicated.
- C. Trench Bottoms: Excavate and trench to provide uniform bearing and support of pipe and conduit. Shape subgrade to provide continuous support for bells, joints, barrels and fittings; avoid point loading, remove stones and sharp objects.
 1. For pipes or conduit less than 6" diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 2. For pipes and conduit 6" or larger diameter, shape trench bottom to support bottom 90° of pipe circumference. Fill depression with tamped sand backfill.
 3. Where encountering rock or other unyielding bearing, carry trench excavation 6" below invert elevation to receive bedding course.
 4. Sanitary and storm sewers shall receive a minimum of bedding of 4" of No. 8910 or No. 610 stone to 30" pipe and 6" of No. 8910 or No. 610 stone bedding for pipe sizes 36" and larger.

3.8 APPROVAL OF SUBGRADE

- A. When Geotechnical Engineer determines unsatisfactory soil is present, continue excavation and replace with compacted material as directed.
- B. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.
- C. Reconstruct subgrades damaged by freeze, frost, rain, water, or construction activities, as directed by Engineer.
- D. Any voids deeper than the cutline created by building demolition operations shall be backfilled and compacted with engineered fill. Contractor will be reimbursed for this fill up to the cutline at the established unit price.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation. Use lean concrete when acceptable to Engineer.
 1. Fill unauthorized excavations under other construction as directed by Engineer.
- B. Where indicated width of utility trench is exceeded, provide stronger pipe, or special installation procedures, as required by the Engineer.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile soil materials. Do not intermix. Place and shape stockpiles to drain surface water. Hydroseed and place erosion and sediment control fencing at base of stockpile. Cover to prevent wind-blown dust.
 1. Stockpile away from edge of excavations. Do not store within drip line of trees. If there is not sufficient area for onsite stockpiles, Contractor shall provide storage offsite at no additional cost to Owner.

3.11 BACKFILL

- A. Backfill excavations promptly, but not before:
 1. Acceptance of construction below finish grade including, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for record documents.

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3. Testing, inspecting, and approval of underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.12 UTILITY TRENCH BACKFILL

- A. Place and compact bed course on trench bottoms, on rock and other unyielding bearing, and to fill unauthorized excavations. Shape bed course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Use concrete backfill in trenches that extend below or pass under footings and that are excavated within 18" of footings. Place concrete to level of bottom of footings.
- C. Provide 4" concrete base slab support for piping or conduit less than 30" below surface of roads. After installation and testing, encase pipe or conduit in 4" of concrete before backfilling.
- D. Place and compact initial backfill of satisfactory soil or subbase material, free of particles larger than 1", to 12" over pipe or conduit.
- E. Where sewers, water lines, etc. are to be under paving or other improvements they shall be backfilled full depth with No. 8910 or No. 610 stone. If sewer is located in fill and backfill is six feet or over from the top of pipe to finished subgrade backfill in accordance with Paragraph D above.
 1. Carefully compact material under pipe haunch and backfill evenly on both sides and along pipe or conduit to avoid damage or displacement of system.
- F. Coordinate backfilling with utilities testing.
- G. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.
- H. Place and compact final backfill of satisfactory soil material to final subgrade.
- I. Install warning tape directly above utilities, 12" below finished grade, except 6" below subgrade under pavements and slabs.

3.13 FILL

- A. Remove vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstructions, and deleterious materials from ground before placing fills. Areas receiving fill shall be proof rolled in the presence of the Geotechnical Engineer prior to fill placement. Areas identified as unacceptable by the Geotechnical Engineer shall be excavated (undercut) and backfilled prior to fill placement.
 1. Plow strip, or break up sloped surface steeper than 1 vertical to 4 horizontal so fill will bond with existing material.
- B. When subgrade or existing ground to receive fill has density less than required for fill, break up surface to depth required, pulverize, moisture-condition or aerate soil and recompact to required density.
- C. Place and compact fill in layers to required elevations as follows:
 1. Under grass, use satisfactory soil.
 2. Under walks and pavements, use subbase or base material, or satisfactory soil.
 3. Under steps and ramps, use subbase material.
 4. Under building slabs, use drainage fill over subgrade as shown and engineered fill to bring to subgrade.
 5. Under footings and foundations, use engineered fill.

3.14 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2% optimum moisture content.
 - 1. Do not place backfill or fill on muddy, frozen, or icy surface.
 - 2. Remove and replace, or scarify and air-dry soil too wet to compact as specified. Stockpile, or spread and dry removed material.

3.15 COMPACTION

- A. Place backfill/fill in 8" loose layers when compacted by heavy equipment; 4" loose layers when compacted by hand tamper.
- B. Place backfill/fill evenly on all sides of structures to required elevations. Place uniformly along full length of structure.
- C. Compact soil to not less than following percentage of maximum dry unit weight per ASTM D 698:
 - 1. Under structure, building slab, steps, and pavements, compact each layer of backfill or fill at 98%.
 - 2. Under walkways, compact each layer of backfill or fill material at 98%.
 - 3. Under lawn or unpaved areas, compact each layer of backfill or fill material at 95%.
- D. Crushed stone fill placed directly under the building pads, in utility trenches and under sidewalks shall be compacted to 95% Modified Proctor ASTM-D-1557.
- E. Embankment layers that are composed predominately of rock (approximately 70%) shall be rolled until firm to the satisfaction of the project's geotechnical engineer.

3.16 GRADING

- A. Uniformly grade areas to a smooth surface, free from irregular changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide smooth transition between existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.
- B. Slope grade to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within following tolerances:
 - 1. Lawn or Unpaved Areas: + .16'.
 - 2. Walks: + .08'.
 - 3. Pavements: \pm .04'.
- C. Grading Inside Building Lines: Finish subgrade to tolerance of 1/2" when tested with 10' straightedge.
- D. The upper 3 feet of all subgrade areas shall contain satisfactory soil material. No rock material will be allowed. This may require over excavation and backfill in rock cut areas. This will allow for the installation of utilities and finish grading activities.

3.17 SUBSURFACE DRAINAGE

- A. Drainage Piping: See Section 33 40 00 Storm Drainage Utilities.

3.18 BASE COURSE

- A. Under pavements place base course material on prepared subgrades. Place base course material over subbases to pavements.
 - 1. Compact the base to a minimum density of 100% at optimum moisture in accordance with ASTM D1557.
 - 2. Shape to required crown elevations and cross-slope grades.

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3. When thickness is 6" or less, place in single layer.
4. When thickness exceeds 6", place in equal layers, with no layer more than 6" or less than 3" when compacted.

3.19 FIELD QUALITY CONTROL

- A. Testing Agency: The Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow test agency to inspect/test each subgrade and each fill or backfill layer. Do not proceed until tests for previous work verify compliance with requirements.
 1. Test agency will test compaction of soils in place per ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method), or ASTM D 2937 (drive cylinder method), as applicable.
 - a. Field density tests may be performed by nuclear method per ASTM D 2922, provided calibration curves are adjusted to correlate to tests performed using ASTM D 1556 or ASTM D 2167. Check each calibration against curves furnished with moisture gages per ASTM D 3017.
 2. Footing Subgrade: At footing subgrades, perform at least one test of each soil stratum to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on visual comparison of each subgrade with related tested strata when acceptable to Geotechnical Engineer.
 3. Paved Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 2,000 sq ft or less of paved area or building slab, but in no case fewer than three tests.
 4. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 50 feet or less of wall length, but no fewer than two tests along a wall face.
 5. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 50 feet or less of trench, but no fewer than two tests.
- C. When test agency reports subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace to depth required, recompact and retest until required density is obtained.

3.20 PROTECTION

- A. Protect graded areas from traffic and erosion, and free of trash and debris.
- B. Repair and re-establish grade to specified tolerance if eroded, rutted, settled, or compaction is lost due to construction or weather.
 1. Scarify or remove and replace material to depth directed by Engineer; reshape and recompact at optimum moisture content to required density.
- C. Where settling occurs during warranty period, remove surface, backfill with additional approved material, compact, and reconstruct surface.
 1. Restore appearance, quality, and condition of surface to match adjacent work; eliminate evidence of restoration.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Legally dispose of soil and waste material off-site.

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END OF SECTION

SECTION 312500 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work described in this section includes providing, establishing, and maintaining temporary erosion and sediment control work items which consist of measures indicated on drawings and as necessary during the life of the contract to control erosion and sedimentation on or beyond project limits.
- B. Related Work:
 - 1. Section 312000 Earth Moving.

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. General:
 - a. Current Federal, State, and City Standards apply to this Project.
 - b. Listings: Issues listed by reference, including revisions of issuing authority, form part of this Section to extent indicated. Issues listed are identified by number, edition, date, title, or other designation established by issuing authority. Issues subsequently referred to are by an issuing authority abbreviation and a basic designation.
 - c. Modifications: Modifications by Engineer to reference Standards, if any are noted with Standard.
 - 2. Alabama Department of Transportation (ALDOT), Standard Specifications for Highway Construction, Latest Edition.
 - 3. "Alabama Nonpoint Source Management Program" published by the Alabama Department of Environmental Management, April 1989.
 - 4. Local Codes, Ordinances, Regulations.
- B. Pre-Construction Meeting: Before proceeding with site clearing operations, review site features to remain and be protected at the site with Owner and Engineer.
- C. Site Damage: If any protection materials or measures are dismantled, removed or altered, even temporarily, or if areas of the site designated to remain are utilized in any manner without the Owner's written authorization, the Contractor agrees to pay the Owner five hundred dollars (\$500.00) per infraction, as determined by the Engineer, as fixed and liquidated damages.

PART 2 - PRODUCTS

2.1 HAY BALES

- A. Bales may be either hay or straw containing five cubic feet of material and weighing not less than 35 lbs.

2.2 SILT FENCE

- A. Silt fences approved by governing authorities, consist of a polymeric filter fabric mounted on posts with wire backing as shown on the drawings.

PART 3 - EXECUTION

3.1 EROSION AND SEDIMENTATION CONTROL

- A. General: Employ erosion and sediment control management practices as required. The Contractor is responsible for obtaining all required permits for construction activity. The Contractor will be

responsible for application and maintenance of all conditions required by the permits. The Contractor will be responsible for all requirements of the permits until acceptance of all work under this Contract.

1. Control and abate water pollution, erosion and sedimentation at its potential source; employ downstream sediment entrapment measures as a backup to primary control at the source.
 2. Take all reasonable precautions to prevent and suppress fires and other detrimental occurrence which may be caused by construction operations.
 3. Protect streams and drainage systems from contamination by siltation or other harmful materials.
 4. The Contractor, his employees and subcontractors must use conservation practices during the work:
 - a. Comply with all State and local laws, rules and regulations for prevention and suppressive action for forest fires and for the prevention of pollution of streams and drainage ways.
 - b. Protect and preserve soil and vegetation cover on the property and on adjacent lands. Any disturbance of soil and vegetation cover outside the project area will not be permitted under any circumstances. Special consideration will be given to the protection of adjacent areas.
 - c. Prevent and control soil erosion and gulleying within the property covered by the Contract and the lands immediately adjacent as a result of construction.
 - d. Do not deposit waste, loose soil or other materials in live streams, swales or drainage ways.
 - e. Do not allow fuels, oils, bitumen or other greasy or chemical substances originating from construction operations to enter or be placed where they may enter a live stream or drainage way. Service and repair equipment in selected areas as far as possible from streams and drainage ways.
 - f. Coordinate erosion and sedimentation control measures with the clearing and grubbing operation so both activities occur in the correct relation to one another.
 - g. Install and maintain erosion and sedimentation control measures (both temporary and permanent) as a continuing program until the site work is complete. This includes repairs, damage from storms, regular maintenance, removal and disposal of accumulated silt.
 - h. Protect downstream properties.
- B. Hay bales shall be anchored by use of stakes.
- C. Once installed, maintain silt fence until its capacity has been reached or erosion activity in the areas has been stabilized. When a silt fence has reached its capacity to function and need for a backup fence becomes evident, provide an additional line of silt fence. Repair of a damaged silt fence shall be accomplished by utilizing same type of materials used in original construction.
- D. Install and maintain erosion and sedimentation control measures as a continuing program until the site work is complete. This includes, repairs, damage from storms, regular maintenance and removal and disposal of accumulated silt.

3.2 MAINTENANCE

- A. Maintain erosion and sediment control features that have been installed. Maintenance of erosion and sediment control features will be considered as an incidental part of the work and no specific payment for this will be made.

END OF SECTION 31 2500

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of work is shown and includes hot-mixed asphalt paving over prepared sub-base.
- B. Verify grades and elevations before beginning. Notify Engineer of discrepancies.
- C. Engineer may make minor field adjustments without additional cost.
- D. Construct sub-grade per Section 312000 Earth Moving.

1.2 SUMMARY

- A. Section includes:
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt patching.
 - 3. Hot-mix asphalt overlays.
 - 4. Asphalt surface treatments:
 - a. Fog seals.
 - 5. Pavement-marking paint.
 - 6. Hot-mix asphalt curbs.
 - 7. Wheel stops.
- B. Related Sections:
 - 1. Section 311000 Site Clearing
 - 2. Section 312000 Earth Moving
 - 3. Section 321373 Concrete Paving Joint Sealants

1.3 SYSTEM DESCRIPTION

- A. Provide hot-mix asphalt pavement per requirements of Alabama Department of Transportation (ALDOT) "Standard Specifications for Highway Construction" latest edition.

1.4 SUBMITTALS

- A. Product Data: For each product specified. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for Work.
- C. Job-Mix Designs: For each job mix proposed for Work.
- D. Shop Drawings: Indicate pavement markings, lane separations, defined parking spaces and dedicated handicapped spaces with international graphics symbol.
- E. Samples: 12" x 12" of geotextile materials.
- F. Qualification Data: As required under "Quality Assurance".
- G. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.

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- H. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.5 QUALITY ASSURANCE

- A. Engage experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that required and with record of successful in-service performance.
- B. Engage firm experienced in manufacturing hot-mix similar to that required and with record of successful performance.
- C. Test Agency Qualification: Demonstrate to Architect's satisfaction, based on ASTM D 3666, that independent test agency has experience and ability to conduct testing indicated without delaying Work.
- D. Comply with State of Alabama Department of Transportation (ALDOT) "Standard Specifications for Highway Construction."
- E. Preinstallation Conference: Conduct at Project site to comply with "Project Meetings" Review methods and procedures:
 1. Review proposed source of paving material, including capabilities and location of plant that will manufacture hot-mix asphalt.
 2. Review condition of substrate and preparatory work performed by other trades.
 3. Review requirements for protecting paving, including restriction of traffic during installation and for remainder of construction.
 4. Review and finalize schedule for paving and related work. Verify availability of materials, paving Installer's personnel, and equipment required to execute Work without delays.
 5. Review inspection and test requirements, governing regulations, and proposed installation procedures.
 6. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking material in original packages with seal unbroken and bearing manufacturer's labels containing brand name, type of material, date of manufacture, and directions for storage.
- B. Store in clean, dry, protected location; per manufacturer's direction.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if following conditions are not met:
 1. Prime and Tack Coat: Minimum surface temperature 60°F.
 2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
 3. Asphalt Base Course: Minimum surface temperature of 40°F and rising at time of placement.
 4. Asphalt Surface Course: Minimum surface temperature of 40°F and rising, at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surface at minimum ambient or surface temperature of 40°F for oil-based material, 50°F for water-based, and not exceeding 95°F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: Shall be in accordance with ALDOT Section 801.10.

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- C. Fine Aggregate: Shall be in accordance with ALDOT Section 802.04.
 - 1. For hot-mix asphalt, limit natural sand to a maximum of 20% by weight of total aggregate mass.

- D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material per ASTM D 242.

2.2 ASPHALT MATERIAL

- A. Asphalt Cement: Shall be in accordance with ALDOT Section 804.02.
- B. Aggregate Base Course: Crushed aggregate per requirements of ALDOT Section 301 (825-Type B). Place to width and depth shown.
- C. Plant Mix Bituminous Base (Black Base): Aggregate and bituminous material hot mixed in plant per ALDOT Section 327, Mix 1.
- D. Prime Coat: Bituminous treatment Type A, full width per requirements of ALDOT Section 401.02 (a) 1 and ASTM D 2027; medium-curing cutback asphalt; MC-30, MC-70.
- E. Binder Course: Bituminous Concrete binder layer in accordance with ALDOT Section 424.
- F. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, per requirements of ALDOT Section 405.02.
- G. Wearing course: Bituminous Concrete wearing course in accordance with ALDOT Section 424.
- H. Water: Potable.

2.3 AUXILIARY MATERIAL:

- A. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wet table powder form.
- B. Sand: ASTM D 1073, Grade Nos. 2 or 3.
- C. Paving Geotextile: Nonwoven polypropylene, specifically designed for paving applications, resistant to chemical attack, rot, and mildew. If required on drawings.
- D. Pavement-Marking Paint: Alkyd-resin type, ready-mixed, per FS TT-P-115, Type I, or AASHTO M-248, Type N.
 - 1. Color: As indicated.
 - 2. Color: White.
 - 3. Color: Yellow.
 - 4. Blue for handicapped markings.
- E. Glass Beads: In accordance with ALDOT Section 856.05.
- F. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, approximately 6" high, 9" wide, and 84" long. Provide chamfered corners, drainage slots, and anchorage holes.
 - 1. Dowels: Galvanized steel, 3/4" x 10".

2.4 MIXES

- A. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mix meeting requirements of applicable sections of ALDOT "Standard Specifications for Highway Construction."
 - 1. Provide mix with history of satisfactory performance in area of Project.

- B. Bituminous Concrete Binder Layer: Plant mixed, bituminous concrete binder per requirements of ALDOT Section 424 (Max. RAP per ALDOT).
- C. Bituminous Concrete Wearing Surface: Plant mixed, meeting requirements of ALDOT Section 429 (Max. RAP per ALDOT).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- C. Notify Architect in writing of any unsatisfactory conditions. Do not proceed until conditions have been satisfactorily corrected.

3.2 PATCHING AND REPAIRS

- A. Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12" into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.
 - 1. Tack coat faces of excavation and allow to cure before paving.
 - 2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
 - 3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while hot. Cover asphalt base course with compacted, hot-mix surface layer flush with adjacent surface.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
 - 1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
 - 2. Remove disintegrated or badly broken pavement. Prepare and patch with hot-mix asphalt.
- C. Leveling Course: Install and compact leveling course of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 1" in existing pavements.
 - 1. Install leveling wedges in compacted lifts not exceeding 3" thick.
- D. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of 1/4". Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.
- E. Tack Coat: Apply uniformly to surface of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, asphalt pavement; 0.05 to 0.15 gal/sq yd.
 - 1. Allow tack coat to cure undisturbed before paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 SURFACE PREPARATION

- A. Immediately before placing asphalt material, remove foreign material from substrate. Ensure that subgrade is ready to receive paving.
 - 1. Sweep loose aggregate from surface of unbound-aggregate base course. Do not dislodge aggregate in compacted base course.

- B. Herbicide Treatment: Apply herbicide per manufacturer's recommended rates and instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat when formulated by manufacturer for that purpose.
- C. Prime Coat: Apply uniformly over surface of compacted-aggregate base at a rate of 0.3 to 0.5 gal/sq yd.
 - 1. Comply with ALDOT, Section 401.03 (d)4.
 - 2. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure for 72 hours minimum.
 - 3. Protect primed substrate from damage until ready to receive paving.

3.4 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted.
 - 1. Place hot-mix asphalt base course in lifts and thickness indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at minimum temperature of 250°F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears.
- B. Place paving in consecutive strips not less than 10' wide, except where edge strips of lesser width are required.
 - 1. After first strip is placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course.
- C. Promptly correct irregularities in paving course behind paver. Use hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use hand tools to smooth surface.

3.5 JOINTS

- A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat.
 - 2. Offset longitudinal joints in successive courses minimum of 6".
 - 3. Offset transverse joints in successive courses minimum of 24".
 - 4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AI's "The Asphalt Handbook."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to within 2% of specified course density.

3.6 COMPACTION

- A. Begin compaction as soon as paving will bear roller weight without excessive displacement. Compact paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185°F.
- B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surface by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevation.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while asphalt is hot enough to achieve specified density. Continue rolling until asphalt course is uniformly compacted to following density:

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1. Average Density: 96% of reference laboratory density per ASTM D 1559, but not less than 94% nor greater than 100%.
 2. Average Density: 92% of reference maximum theoretical density per ASTM D 2041, but not less than 90% nor greater than 96%.
- D. Finish Rolling: Finish roll to remove roller marks while asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edge of pavement to proper alignment. Bevel edge while still hot. Compact thoroughly.
- F. Repairs: Remove areas that are defective or contaminated with foreign material. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- I. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- J. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
- 3.7 INSTALLATION TOLERANCES
- A. Thickness: Compact each course to produce thickness indicated within following tolerances:
1. Base Course: Plus or minus 1/2"
 2. Surface Course: Plus 1/4", no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within following tolerances as determined by using a 10' straightedge applied transversely or longitudinally to paved areas:
1. Base Course: 1/4".
 2. Surface Course: 1/8".
 3. Crowned Surface: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4".
- 3.8 PAVEMENT MARKING
- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to cure for 30 days before starting marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rate to provide a minimum wet film thickness of 15 mils.
1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal.
- 3.9 WHEEL STOPS
- A. Securely attach wheel stops into pavement with not less than 2 galvanized steel dowels embedded in precast concrete at one-third points. Firmly bond each dowel to wheel stop and pavement.
1. Extend upper portion of dowel 5" into wheel stop and lower portion a minimum of 5" into pavement.
- 3.10 FIELD QUALITY CONTROL
- A. Test Agency: Owner will engage a qualified independent test agency to perform field inspections and tests and to prepare test reports.
1. Agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.

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- B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined per ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerance.
- E. In-Place Density: Samples of uncompacted paving mixture and compacted pavement will be secured by test agency per ASTM D 979.
 - 1. Reference laboratory density will be determined by averaging results from 4 samples of hot-mix asphalt-paving delivered daily to site, prepared per ASTM D 1559, and compacted per job-mix specifications.
 - 2. Reference maximum theoretical density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 - 3. In-place density of compacted pavement will be determined by testing core samples per ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq yd or less of installed pavement, but in no case less than 3 cores.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate it does not comply with requirements.

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END OF SECTION 32 1216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, apply to this Section.

1.2 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Driveways
 - 2. Parking lots.
 - 3. Curbs and gutters & curb inlets.
 - 4. Walkways.
 - 5. Cast in place inlets, headwalls, flumes, etc.
- B. Related Sections include the following:
 - 1. Section 312000 Earth Moving for subgrade preparation, grading, and subbase course.
 - 2. Section 321373 Concrete Paving Joint Sealants

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
- D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials and aggregates.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent or adhesive.
 - 8. Joint fillers.

1.5 QUALITY ASSURANCE

- A. Industry Standards and Specifications: Issues listed (including modifications designated) form a part of this specification to extent indicated by reference thereto. Hereinafter, issues are referred to by basic numerical designation only, and revisions (if any) are noted herein.
 - 1. American Society for Testing and Materials:
 - C91 Masonry Cement, Spec. for
 - C136 Sieve or Screen Analysis of Fine and Coarse Aggregate for Masonry Mortar, Spec. for

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- C144 Aggregate for Masonry Mortar, Spec. for
- C150 Portland Cement, Spec. for
- C207 Hydrated Lime for Masonry Purposes, Spec. for
- C404 Aggregates for Masonry Grout, Spec. for

- B. Installer Qualifications: An experienced installer who has completed pavement work similar 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.
- C. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- D. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.
- E. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.
- G. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.
- H. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.
- I. Alabama Department of Transportation (ALDOT) Standard Specifications for Highway Construction, Latest Edition.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic.

PART 2 - PRODUCTS

2.1 FORMS

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

2.1 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.
- C. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- D. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.

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- E. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, 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.

2.3 CONCRETE MATERIALS

- A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.
- B. Portland Cement: ASTM C 150, Type I or II.
 - 1. Fly Ash: ASTM C 618, Class F or C.
 - 2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- C. Aggregate: ASTM C 33, uniformly graded, from a single source, with coarse aggregate as follows:
 - 1. Class: 4S.
 - 2. Class: 4M.
 - 3. Class: 1N.
 - 4. Maximum Aggregate Size: 1-1/2 inches (38 mm) nominal.
 - 5. Maximum Aggregate Size: 1 inch (25 mm) nominal.
 - 6. Maximum Aggregate Size: 3/4 inch (19 mm) nominal.
 - 7. Do not use fine or coarse aggregates containing substances that cause spalling.
- D. Water: ASTM C 94.

2.4 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

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- D. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- E. Clear Solvent-Borne Liquid-Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- F. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- G. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.
- H. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- I. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Evaporation Retarder:
 - a. Cimfilm; Axim Concrete Technologies.
 - b. Finishing Aid Concentrate; Burke Group, LLC (The).
 - c. Spray-Film; ChemMasters.
 - d. Aquafilm; Conspec Marketing & Manufacturing Co., Inc.
 - e. Sure Film; Dayton Superior Corporation.
 - f. Eucobar; Euclid Chemical Co.
 - g. Vapor Aid; Kaufman Products, Inc.
 - h. Lambco Skin; Lambert Corporation.
 - i. E-Con; L&M Construction Chemicals, Inc.
 - j. Confilm; Master Builders, Inc.
 - k. Waterhold; Metalcrete Industries.
 - l. Rich Film; Richmond Screw Anchor Co.
 - m. SikaFilm; Sika Corporation.
 - n. Finishing Aid; Symons Corporation.
 - o. Certi-Vex EnvioAssist; Vexcon Chemicals, Inc.
 - 2. Clear Solvent-Borne Liquid-Membrane-Forming Curing Compound:
 - a. AH Curing Compound #2 DR; Anti-Hydro International, Inc.
 - b. Res-X Cure All Resin; Burke Group, LLC (The).
 - c. RX Cure; Conspec Marketing & Manufacturing Co., Inc.
 - d. Day-Chem Rez Cure; Dayton Superior Corporation.
 - e. Kurez DR; Euclid Chemical Co.
 - b. Nitocure S; Fosroc.
 - c. #64 Resin Cure; Lambert Corporation.
 - d. L&M Cure DR; L&M Construction Chemicals, Inc.
 - e. 3100-Clear; W. R. Meadows, Inc.
 - f. Seal N Kure FDR; Metalcrete Industries.
 - g. Rich Cure; Richmond Screw Anchor Co.
 - h. Resi-Chem C309; Symons Corporation.
 - i. Horncure 30; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
 - j. Uni Res 150; Unitex.
 - k. Certi-Vex RC; Vexcon Chemicals, Inc.
 - 3. Clear Waterborne Membrane-Forming Curing Compound:
 - l. AH Curing Compound #2 DR WB; Anti-Hydro International, Inc.
 - m. b. Aqua Resin Cure; Burke Group, LLC (The).
 - n. Safe-Cure Clear; ChemMasters.
 - o. W.B. Resin Cure; Conspec Marketing & Manufacturing Co., Inc.
 - p. Day Chem Rez Cure (J-11-W); Dayton Superior Corporation.
 - q. Nitocure S; Fosroc.
 - r. Aqua Kure-Clear; Lambert Corporation.
 - s. L&M Cure R; L&M Construction Chemicals, Inc.
 - t. 1100 Clear; W. R. Meadows, Inc.
 - u. Resin Cure E; Nox-Crete Products Group, Kinsman Corporation.

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- v. Rich Cure E; Richmond Screw Anchor Co.
- w. Resi-Chem Clear Cure; Symons Corporation.
- x. Horncure 100; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
- y. Hydro Cure; Unitex.
- z. Certi-Vex Enviocure; Vexcon Chemicals, Inc.
- 4. White Waterborne Membrane-Forming Curing Compound:
 - aa. a. AH Curing Compound #2 WB WP; Anti-Hydro International, Inc.
 - bb. Aqua Resin Cure; Burke Group, LLC (The).
 - cc. W.B. Resin Cure; Conspec Marketing & Manufacturing Co., Inc.
 - dd. Thinfilm 450; Kaufman Products, Inc.
 - ee. Aqua Kure-White; Lambert Corporation.
 - ff. L&M Cure R-2; L&M Construction Chemicals, Inc.
 - gg. 1200-White; W. R. Meadows, Inc.
 - hh. White Pigmented Resin Cure E; Nox-Crete Products Group, Kinsman Corporation.
 - ii. Rich Cure White E; Richmond Screw Anchor Co.
 - jj. Resi-Chem High Cure; Symons Corporation.
 - kk. Horncure 200-W; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
 - ll. Hydro White 309; Unitex.

2.6 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Pavement-Marking Paint: Alkyd-resin type; ready mixed; complying with FS TT-P-115, Type I, or AASHTO M 248, Type N.
- C. Glass Beads: AASHTO M 247.

2.7 CONCRETE MIXES

- A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.
 - 1. Do not use Owner's field quality-control testing agency as the independent testing agency.
- C. Proportion mixes to provide concrete with the following properties, unless otherwise noted on plans:
 - 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Slump Limit: 3 inches (75 mm).
 - a. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches (200 mm) after adding admixture to plant- or site-verified, 2- to 3-inch (50- to 75-mm) slump.
- D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
- E. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 - 4. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.

- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2.5 to 4.5 percent.
- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus or minus 1.5 percent:
 - 1. Air Content: 5.5 percent for 1-1/2-inch (38-mm) maximum aggregate.
 - 2. Air Content: 6.0 percent for 1-inch (25-mm) maximum aggregate.
 - 3. Air Content: 6.0 percent for 3/4-inch (19-mm) maximum aggregate.
- H. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m).
- I. Coloring Agent: Add coloring agent to mix according to manufacturer's written instructions.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.
 - 1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (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.

PART 3 - EXECUTION

3.1 MATERIALS REFERENCES

- A. Portland Cement: ASTM C150, of natural color.
 - 1. Type 1 non-staining and without air entrainment.
- B. Masonry Cement: ASTM C91, non-staining, except with 12% maximum air content by volume.
- C. Hydrated Lime: ASTM C207.
 - 1. Type N - Normal hydrated lime.
 - 2. Type S - Special hydrated lime, high-early-plasticity and high water retention.
- D. Aggregates: ASTM C144
- E. Aggregates for Masonry Grout: ASTM C404.
- F. Water: Clean, free from deleterious materials which would impair strength or bond.
- G. Masonry ties shall be rectangular galvanized steel, 3/16" diameter, C length as required for stone veneer over concrete unless otherwise noted on the drawings.

3.2 MORTAR MIXES

- A. Do not lower the freezing point of mortar by use of admixtures or anti-freeze agents. Do not use calcium in mortar or grout.
- B. Mortar: Comply with ASTM C270, Proportion Specification, except limit materials to those specified herein.
 - 1. Mortar Proportions:

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Type	Portland Cement	Hydrated Lime Putty	Masonry Cement	Maximum Damp Loose Aggregate	Minimum Compression Strength 2" cubes in 28 days psi
M or	1	1/4	-	3	2500
	1	-	1	6	2500
S or	1	1/2	-	4-1/2	1800
	1/2	-	1	4-1/2	1800
N or	1	1	-	6	750
	-	-	1	3	750

The weight of one cubic foot of materials is considered to be: Portland Cement 94 lbs. (1 bag); hydrated lime, 40 lbs.; lime putty, 80 lbs.; dry sand, 80 lbs.' masonry cement, weight printed on bag.

For each type of mortar, the figures above the dotted line show proportions for Portland cement-lime mortar. Mortar made with masonry cement are shown below dotted line.

Damp, loose aggregate shall not be less than 2-1/4 times, nor more than three times the cementitious materials used.

3.4 PREPARATION

- A. Proof-roll prepared base surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.
- B. Remove loose material from compacted base surface immediately before placing concrete.

3.5 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement 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.

3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.
 - 1. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy-coated 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 fabric 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 (50-mm) overlap to adjacent mats.

3.7 JOINTS

- A. General: Construct construction, expansion, and contraction joints and tool edgings 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 pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.
 - 1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 - 2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 3. Provide tie bars at sides of pavement strips where indicated.
 - 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 50 feet (15.25 m), unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler less than 1/2 inch (12 mm) or more than 1 inch (25 mm) 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. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the following radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
 - a. Radius: 1/4 inch (6 mm).
 - b. Radius: 3/8 inch (10 mm).
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
- F. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
 - 1. Radius: 1/4 inch (6 mm).
 - 2. Radius: 3/8 inch (10 mm).

3.8 CONCRETE PLACEMENT

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- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from base surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten base to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery, at Project site, or during placement.
- 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 by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.
 - 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. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
 - 1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent if approved by Engineer.
- I. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.
- J. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete.

If results are not approved, remove and replace with formed concrete.
- K. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
 - 1. Compact base and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
- L. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) 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 mix designs.
- N. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.9 CONCRETE FINISHING

- A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the 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.
 2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

3.10 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.
- B. 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 (1 kg/sq. m 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.
- C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.
- D. 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 (300-mm) lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during 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.

3.11 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 1. Elevation: 1/4 inch (6 mm).
 2. Thickness: Plus 3/8 inch (9 mm), minus 1/4 inch (6 mm).
 3. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/4 inch (6 mm).
 4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch (25 mm).
 5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch (6 mm).
 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch (13 mm).
 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches (6 mm per 300 mm).
 8. Joint Spacing: 3 inches (75 mm).
 9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
 10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.12 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.
- B. Allow concrete pavement to cure for 28 days and be dry 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 (0.4 mm).
 1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.
- B. Testing Services: Testing shall be performed according to the following requirements:
 1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.
 2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
 3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
 5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
 6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m). One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.

7. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.
 9. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi (3.4 MPa).
- C. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as the sole basis for approval or rejection.
- E. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.14 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.
- B. Drill test cores where directed by Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313

SECTION 32 1373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Expansion and contraction joints within portland cement concrete pavement.
 - 2. Joints between portland cement concrete and asphalt pavement.
- B. Related Sections include the following:
 - 1. Section 32 1216 Asphalt Paving for constructing joints between concrete and asphalt pavement.
 - 2. Section 32 1313 Concrete Paving for constructing joints in concrete paving.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.
- D. 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 and addresses of architects and owners, and other information specified.
- E. Compatibility and Adhesion Test Reports: From joint sealant manufacturer indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backer materials have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- F. Product Test Reports: From a qualified testing agency indicating joint sealants comply with requirements, based on comprehensive testing of current product formulations.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

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- C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency, based on testing current sealant formulations within a 36-month period.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Test joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

- D. Preconstruction Compatibility and Adhesion Testing: Submit to joint sealant manufacturer, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - a. Perform tests under environmental conditions replicating those that will exist during installation.
 - 2. Submit not fewer than nine pieces of each type of material, including joint substrates, joint-sealant backer materials, secondary seals, and miscellaneous material.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain joint sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
 - 5. Testing will not be required if joint sealant manufacturer submits joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: 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.
 - 2. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F (4.4 deg C).
 - 3. When joint substrates are wet.

- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than that allowed by joint sealant manufacturer for application indicated.

- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are 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 of Exposed Joint Sealants: Match Architect's samples.
- C. Colors of Exposed Joint Sealants: As indicated by referencing manufacturer's designations.
- D. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Multicomponent Jet-Fuel-Resistant Sealant for Concrete: Pourable, chemically curing elastomeric formulation complying with the following requirements for formulation and with ASTM C 920 for type, grade, class, and uses indicated:
 - 1. Urethane Formulation: Type M; Grade P; Class 12-1/2; Uses T, M, and, as applicable to joint substrates indicated, O.
 - 2. Coal-Tar-Modified Polymer Formulation: Type M; Grade P; Class 25; Uses T and, as applicable to joint substrates indicated, O.
 - 3. Bitumen-Modified Urethane Formulation: Type M; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
- B. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete: Single-component, pourable, coal-tar-modified, urethane formulation complying with ASTM C 920 for Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
- C. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
- D. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
- E. Multicomponent Low-Modulus Sealant for Concrete and Asphalt: Proprietary formulation consisting of reactive petropolymer and activator components producing a pourable, self-leveling sealant.
- F. Available Products: Subject to compliance with requirements, cold-applied joint sealants that may be incorporated into the Work include, but are not limited to, the following:
- G. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Multicomponent Jet-Fuel-Resistant Sealant for Concrete:
 - a. Vulkem 202; Mameco International.
 - b. SEALTIGHT GARDOX; W.R. Meadows, Inc.
 - c. Urexpan NR-300; Pecora Corporation.
 - d. Sonomeric 2; Sonneborn Building Products Div., ChemRex, Inc.
 - 2. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete:
 - a. Vulkem 200; Mameco International.
 - b. Sonomeric 1; Sonneborn Building Products Div., ChemRex, Inc.
 - 3. Type NS Silicone Sealant for Concrete:
 - a. Roadsaver Silicone-SL; Crafcro Inc.
 - b. 888; Dow Corning.
 - 4. Type SL Silicone Sealant for Concrete and Asphalt:
 - a. 890-SL; Dow Corning.
 - 5. Multicomponent Low-Modulus Sealant for Concrete and Asphalt:
 - a. SOF-SEAL; W.R. Meadows, Inc.

2.3 HOT-APPLIED JOINT SEALANTS

- A. Jet-Fuel-Resistant Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3569.
- B. Jet-Fuel-Resistant Sealant for Concrete and Tar Concrete: Single-component formulation complying with ASTM D 3581.
- C. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.
- D. Sealant for Concrete and Asphalt: Single-component formulation complying with ASTM D 3405.
- E. Available Products: Subject to compliance with requirements, hot-applied joint sealants that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Jet-Fuel-Resistant Elastomeric Sealant for Concrete:
 - a. Superseal 444/777; Crafc0, Inc.
 - b. POLY-JET 3569; W.R. Meadows, Inc.
 - 2. Jet-Fuel-Resistant Sealant for Concrete and Tar Concrete:
 - a. SUPERSEAL 1614A; Crafc0 Inc.
 - b. POLY-JET 1614; W.R. Meadows, Inc.
 - c. POLY-JET 3406; W.R. Meadows, Inc.
 - d. POLY-JET 3569, W.R. Meadows, Inc.
 - 3. Elastomeric Sealant for Concrete:
 - a. Superseal 444/777; Crafc0, Inc.
 - b. POLY-JET 3406; W.R. Meadows, Inc.
 - 4. Sealant for Concrete and Asphalt:
 - a. ROADSAVER 221; Crafc0 Inc.
 - b. Product #9005; Koch Materials Company.
 - c. Product #9030; Koch Materials Company.
 - d. SEALTIGHT HI-SPEC; W.R. Meadows, Inc.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rod for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depths, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint- sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's written installation instructions applicable to products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support 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 backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for 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 Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below 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 sealants from surfaces adjacent to joint.
 - 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. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. 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 so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 32 1373

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

- A. This Section includes storm drainage, piping and appurtenances from 5 feet outside the building to point of disposal.
- B. Related Sections include the following:
 - 1. Section 312500 Erosion and Sedimentation Controls
 - 2. Section 312000 Earth Moving

1.3 DEFINITIONS

- A. PE: Polyethylene plastic.
- B. PVC: Polyvinyl chloride plastic.
- C. RCP: Reinforced concrete pipe.
- D. HDEP: High Density Polyethylene pipe.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Stormwater disposal systems.
- B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
 - 1. Precast concrete manholes and other structures, including frames, covers, and grates.
 - 2. Cast-in-place concrete manholes and other structures, including frames, covers, and grates.
- C. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.
- D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

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- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than 48 hours in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements,

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 PIPES AND FITTINGS

- A. Ductile-Iron Sewer Pipe: ASTM A 746, Class 52, for push-on joints.
 - 1 Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.
 - 2 Compact-Pattern, Ductile-Iron Fittings: AWWA C153, for push-on joints.
 - 3 Gaskets: AWWA C111, rubber.
- B. Ductile-Iron Culvert Pipe: ASTM A 716, for push-on joints.
 - 1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.
 - 2. Gaskets: AWWA C111, rubber.
- C. ABS Sewer Pipe and Fittings: ASTM D 2751, for solvent-cemented or gasketed joints.
 - 1. Wall Thickness for NPS 3 to NPS 6 (DN80 to DN150): SDR 35.
 - 2. Wall Thickness for NPS 8 to NPS 12 (DN200 to DN300): SDR 42.
 - 3. Gaskets: ASTM F 477, elastomeric seals.
- D. Corrugated PE Drainage Tubing and Fittings: AASHTO M 252, Type S, with smooth waterway for coupling joints.
 - 1. Soiltight Couplings: AASHTO M 252, corrugated, matching tube and fittings to form soiltight joints.
 - 2. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings to form silttight joints.
- E. Corrugated PE Pipe and Fittings: AASHTO M 294, Type S, with smooth waterway for coupling joints.
 - 1. Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings to form soiltight joints.
 - 2. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings to form silttight joints.
- F. Corrugated HDPE Pipe and Fittings: AASHTO M-252 and M-294
 - 1. Soiltight Coupling: Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM D-1248 with the applicable requirements define in ASTM D-1248.
 - 2. Pipe and fittings shall be Advanced Drainage Systems N-12 or equivalent.
- G. PVC Pressure Pipe: AWWA C900, Class 150, for gasketed joints.
 - 1. PVC Pressure Fittings: AWWA C907, for gasketed joints.
 - 2. Gaskets for PVC Piping: ASTM F 477, elastomeric seals.
 - 3. Ductile-Iron, Compact Fittings: AWWA C153, for push-on joints.
 - 4. Gaskets for Ductile-Iron Fittings: AWWA C111, rubber.

- H. VC Sewer Pipe and Fittings: According to the following:
 - 1. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
 - a. Gaskets: ASTM F 477, elastomeric seals.
 - 2. PVC Sewer Pipe and Fittings, NPS 18 (DN450) and Larger: ASTM F 679, T-1 wall thickness, bell and spigot for gasketed joints.
 - a. Gaskets: ASTM F 477, elastomeric seals.
- I. PVC, Ribbed Drain Pipe: AASHTO M 304M, bell and spigot, with smooth waterway for bell-gasketed joints.
 - 1. Fittings: AASHTO M 304M or ASTM F 794 for bell-gasketed joints.
 - 2. Gaskets: ASTM F 477, elastomeric seals to form soiltight joints.
- J. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 2, for gasketed joints.
 - 1. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
- K. Concrete sewer pipe: Shall conform to ASTM Standard Specification C76, Latest Revision, for reinforced concrete pipe. Pipe smaller than 12 inches in diameter shall be non-reinforced. Pipe 12 inches and larger shall be reinforced. Pipe laid under proposed pavement and in streets shall be Class III unless otherwise noted on drawings. Certificates from manufacturer must be furnished which state that the pipe furnished was manufactured according to the above requirements. Concrete sewer pipe shall have standard tongue and groove type joints and shall be made water tight by use of a Portland cement mortar with a 1:2 cement-sand mixture and a minimum of water. Joints shall be made smooth inside and outside the pipe.
- L. Reinforced-Concrete Arch Pipe: ASTM C 506 (ASTM C 506M), latest revision.

2.4 SPECIAL PIPE COUPLINGS AND FITTINGS

- A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.
 - 1. Sleeve Material for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.
 - 2. Sleeve Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
 - 3. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 - 4. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
 - 5. Bands: Stainless steel, at least one at each pipe insert.
- B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.
 - 1. Material for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.
 - 2. Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
 - 3. Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 - 4. Material for Dissimilar Pipe: Compatible with pipe materials being joined.
- C. Pressure-Type Pipe Couplings: AWWA C219, iron-body sleeve assembly matching OD of pipes to be joined, with AWWA C111 rubber gaskets, bolts, and nuts. Include PE film, pipe encasement.
- D. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated. Include PE film, pipe encasement.

2.5 PRECAST MANHOLES

- A. Precast concrete manhole sections shall conform to the requirement of ASTM Specifications C-478, Latest Addition. The concrete when tested in compression shall not be less than 400 PSI and absorption shall not exceed 9%. Minimum wall thickness of manhole riser sections shall be as follows:

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48" I.D. - 5" 60" I.D. - 6" 72" I.D. - 7"

- B. Cone sections shall have a minimum 5" wall at the bottom and 8" wall thickness at the top. The minimum thickness of the manhole bottoms shall be 6". Manholes shall have concentric cones.
- C. Joints between the manhole sections will be made with o-rings rubber gaskets or performed butyl section and shall meet the requirements of ASTM Specifications C-443, latest revision.
- D. Openings for inlet and discharge sewer pipes shall be provided in the manhole base section at the position shown on the plans.
- E. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch diameter frame and cover.
- F. Manhole steps shall be reinforced plastic complying with the requirements of ASTM-478. Para. 11 and shall be No. PSI-PF as manufactured by M.A. Industries or approved equal.
- G. Precast manholes shall be as manufactured by Sherman Industries or approved equal.
- H. Cast-in-Place Concrete Manholes: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
- I. Manhole Frames and Covers: ASTM A 48 Class 30, grey iron castings designed for heavy-duty service. Include indented top design with lettering "STORM SEWER" cast into cover. Castings shall be Vulcan Foundry Corp. No. V-1480-1 or approved equal.
- J. Cast-in-Place Concrete: Construct of reinforced concrete; designed according to ASTM C 890 for structural loading; of depth, shape, dimensions, and appurtenances indicated.
 - 1. Bottom, Walls, and Top: Reinforced concrete.
 - 2. Channels and Benches: Concrete.

2.6 STORMWATER INLETS

- A. Curb Inlets: Vertical curb opening, of materials and dimensions indicated.
- B. Grate Inlets: Horizontal opening, of materials and dimensions indicated. Include heavy-duty frames and grates.
- C. Yard Inlets: Vertical and horizontal openings, of materials and dimensions indicated. Include heavy-duty frames and grates.
- D. Frames and Grates: Dimensions, opening pattern, free area, and other attributes indicated.
 - 1. Material: ASTM A 48, Class 30 (ASTM A 48M, Class No. 200A) minimum, gray-iron casting.
 - 2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.7 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.

- C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water-cementitious ratio.
 - 1. Include channels (inverts) and benches in manholes.
 - a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - b. Benches: Concrete, sloped to drain into channel.
 - 2. Include channels in catch basins.
 - a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

2.8 PROTECTIVE COATINGS

- A. Description: One- or two-coat, coal-tar epoxy; 15-mil minimum thickness, unless otherwise indicated; factory applied to the following surfaces:
 - 1. Stormwater Inlet Frames and Grates: On entire surfaces.
 - 2. Stormwater Detention-Structure Manhole Frames and Covers: On entire surfaces.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 20 00 Earth Moving.

3.2 IDENTIFICATION

- A. Materials and their installation are specified in Section 31 20 00 Earth Moving. Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 PIPING APPLICATIONS

- A. General: Include watertight, silttight, or soiltight joints, unless watertight or silttight joints are indicated.

3.4 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
- C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

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1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
 2. Install piping with 36-inch minimum cover.
- F. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

3.5 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to installations indicated.
- B. ABS Pipe and Fittings: As follows:
1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
 2. Install according to ASTM D 2321.
- C. PE Pipe and Fittings: As follows:
1. Join pipe, tubing, and fittings with couplings for soiltight joints according to manufacturer's written instructions.
 2. Install according to ASTM D 2321 and manufacturer's written instructions.
 3. Install corrugated piping according to the Corrugated Polyethylene Pipe Association's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."
- D. PVC Sewer Pipe and Fittings: As follows:
1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
 2. Install according to ASTM D 2321.
- E. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual."
- F. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.
- G. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.6 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Form continuous concrete channels and benches between inlets and outlet.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements and concrete. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.
- D. Install precast concrete manhole sections with gaskets according to ASTM C 891.
- E. Construct cast-in-place manholes as indicated.

3.7 CATCH-BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.8 STORM DRAINAGE INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.

- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipators at outlets, as indicated.

3.9 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.10 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Structures: Excavate around structure as required and use one procedure below:
 - 1. Remove structure and close open ends of remaining piping.

3.11 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
 - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 - 2. Place plug in end of incomplete piping at end of day and when work stops.
 - 3. Flush piping between manholes and other structures to remove collected debris.
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate reports for each test.

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END OF SECTION 33 4100