

NATIONAL PARKS SERVICE
GRAND CANYON NATIONAL PARK
GRAND CANYON, ARIZONA

CONTRACT DOCUMENTS

for the construction of the
REPLACE WASTEWATER PLANT AT SOUTH RIM VILLAGE
TECHNICAL SPECIFICATIONS FOR
ACCESS ROAD IMPROVEMENT

GRCA 257282

JACOBS
Grand Canyon, Arizona
September 2025

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References to Division 01, General Requirements Sections in these Technical Specifications package refer to 100 Percent Complete Construction Document Specifications for the construction of the Replace Wastewater Plant South Rim Village (GRCA 257282) dated June 2025.

SECTION 00 01 07
SEALS PAGES

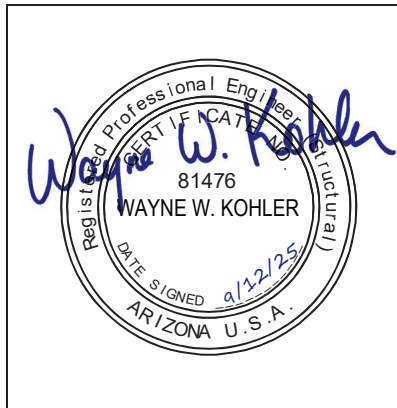
See Table of Contents for author of each specification section, identified by author's initials as follows:

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SPECIFICATIONS



Digitally Signed

Wayne W. Kohler

SPECIFICATIONS



Digitally Signed

James Mills

END OF SECTION

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FOR
ACCESS ROAD IMPROVEMENT**

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END OF SECTION

SPECIFICATIONS

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
 - a. 117, Specification for Tolerances for Concrete Construction and Materials.
 - a. 350.5, Specifications for Environmental Concrete Structures.
 - b. 350, Code Requirements for Environmental Engineering Concrete Structures.

1.02 DEFINITIONS

A. Defective Areas: See definition in Section 03 30 00, Cast-in-Place Concrete.

1.03 DESIGN REQUIREMENTS

A. Design formwork in accordance with ACI 350.5 and ACI 350 to provide concrete finishes specified in Section 03 30 00, Cast-in-Place Concrete.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Formwork drawings signed and sealed by a licensed professional engineer in the state of the Project.
 - b. Layout of panel joints and form liners.
2. Product Data:
 - a. Form release agent.
 - b. Form ties.
 - c. Products to be used for sealing tie holes.
3. Samples:
 - a. One each as follows:
 - 1) Form ties.

B. Informational Submittals: Statement of qualifications for formwork designer.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Formwork Designer: Formwork, falsework, and shoring design shall be designed by an engineer licensed in the state of Project.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Low Water Crossing:

1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish. Use plywood forms when using form liners. Plywood may be of lower finish grade when used in conjunction with form liners.
2. Where steel forms are used, treat steel surfaces to prevent rusting using products approved for use on steel forms.

2.02 ACCESSORIES

A. Form Release Agent:

1. Physical Characteristics:
 - a. Ready-to-use water-based material formulated to reduce or eliminate surface imperfections.
 - b. Contain no mineral oil or organic solvents.
2. Functional Characteristics: None.
3. Performance Characteristics:
 - a. Shall not bond with, stain, or adversely affect concrete surfaces.
 - b. Shall not impair subsequent treatments of concrete surfaces when applied to forms or formliners.

B. Form Snap-Ties:

1. Material: Steel.
2. Spreader Inserts:
 - a. Conical or spherical type.
 - b. Design to maintain positive contact with forming material.
 - c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.
4. Flat bar ties for panel forms; furnish plastic or rubber inserts with minimum 1.5-inch depth and sufficient dimensions to permit patching of tie hole.

PART 3 EXECUTION

3.01 FORM SURFACE PREPARATION

- A. Prior to coating surface, thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants.
- B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by manufacturer.
- C. Steel Forms: Apply form release agent as soon as they are cleaned to prevent discoloration of concrete from rust.

3.02 ERECTION

- A. General: In accordance with ACI 301, unless otherwise specified.
- B. Low Water Crossing Forms:
 - 1. Provide standard steel or wood forms.
 - 2. Set forms to true lines and grades and securely stake in position.
- C. Form Tolerances: Discontinue concrete placement and take corrective action if settlement or deflections occur that deviate more than 3/8 inch from those shown on the approved drawings. If satisfactory corrective action is not taken before initial set, remove unacceptable concrete.

3.03 FORM REMOVAL

- A. Nonsupporting forms, sides of beams, walls, columns, and similar parts of Work, may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
 - 1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
 - 2. Curing and protection operations are maintained.
- B. Elevated Structural Slabs or Beams: In accordance with ACI 318, Chapter 6, and at such time as concrete has reached compressive strength equal to 80 percent of specified 28-day compressive strength as determined by test cylinders.
- C. Form Ties: Remove conical inserts or through bolts and plug holes as specified in Section 03 30 00, Cast-in-Place Concrete.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Section 01 40 00, Quality Requirements, and in and Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 40 00, Quality Requirements.

END OF SECTION

SECTION 03 15 00
CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. A36/A36M, Specification for Carbon Structural Steel.
 - b. A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - d. A767/A767M, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - e. C920, Specification for Elastomeric Joint Sealants.
 - f. D994, Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - g. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
 - h. D1171, Standard Guide for Evaluating Nonwoven Fabrics.
 - i. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - j. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - k. D2240, Standard Test Method for Rubber Property – Durometer Hardness.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Construction Joints, Expansion Joints, and Control Joints: Layout and location for each type. Include joint locations shown on the Drawings, additional required joint locations, and any proposed alternate locations.
2. Product Data:
 - a. Bond breaker.
 - b. Premolded joint fillers.
 - c. Pourable joint fillers.

- d. Preformed control joints.
- e. Epoxy-coated dowels and epoxy-coated reinforcing bars.
- f. Accessories not specified in other sections.

B. Informational Submittals:

- 1. Certification:
 - a. Joint fillers.
 - b. Manufacturer's application instructions for:
 - 1) Bonding agent.
 - 2) Bond breaker.
- 2. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
 - a. Bond breaker.
 - b. Bonding agent.
 - c. Premolded joint fillers.
 - d. Pourable joint fillers (sealant proportions not required as products used only as a filler).
 - e. Preformed control joints.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site: Verify delivered materials are in accordance with Specifications, regulatory agencies, and Manufacturer's product data sheets prior to unloading and storing onsite.
- B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight or as required by Manufacturer.

PART 2 PRODUCTS

2.01 BOND BREAKER

- A. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape. Same width as joint that will adhere to premolded joint material or concrete surface.
- B. Use bond prevention material as specified in Section 03 30 00, Cast-in-Place Concrete, except where bond breaker tape is specifically called for on the Drawings.

2.02 PREMOLDED JOINT FILLER

- A. Bituminous Type: ASTM D994 or ASTM D1751.
- B. Sponge Rubber: Polychloroprene, closed cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits),

119 kPa to 168 kPa (17 psi to 24 psi) minimum. Use in joints for potable and nonpotable water containment structures.

2.03 POURABLE JOINT FILLERS

- A. General: Although product is a sealant, it is being specified as a filler to prevent debris accumulation and allow expansion and contraction under shrinkage and thermal loads. It does not need to meet proportional sealant geometry requirements.
- B. Filler: Multicomponent sealant, self-leveling, or nonsag as required for level, sloping, or vertical joints.

2.04 ACCESSORIES

- A. Joint Sealant: Polyurethane silicone elastomeric single component joint sealant for concrete pavement (self-leveling) in accordance with ASTM D5893, Type SL.
- B. Steel Reinforcement: As specified in Section 03 21 00, Steel Reinforcement.
- C. Nails: Galvanized, as required for securing premolded joint filler.
- D. Galvanized Rebar at Control Joints: ASTM A767/A767M and ASTM A615/A615M Grade 60 prior to galvanizing.

PART 3 EXECUTION

3.01 GENERAL

- A. Commence concrete placement after joint preparation is complete.
- B. Time Between Concrete Pours: As specified in Section 03 30 00, Cast-in-Place Concrete.

3.02 SURFACE PREPARATION

- A. Construction Joints: Clean concrete surface prior to placement of abutting concrete.
 - 1. Remove laitance and spillage from steel reinforcement and dowels.
 - 2. Roughen surface to minimum of 1/4-inch amplitude:
 - a. Sandblast after concrete has fully cured.
 - b. Water blast after concrete has partially cured.
 - c. Green cut fresh concrete with high-pressure water and hand tools.

3.03 CONTROL JOINT INSTALLATION

- A. Locate steel reinforcement as shown.
- B. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

3.04 PREFORMED CONTROL JOINTS

- A. Use only where specifically shown; do not use in water-holding basins.
- B. Locate slightly below top of slab.
- C. Install in accordance with manufacturer's written instructions in straight, full-length pieces.
- D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement using only approved stakes and other secondary installation materials.

3.05 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

3.06 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 40 00, Quality Requirements.

END OF SECTION

SECTION 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 GENERAL

- A. Steel reinforcement shall comply with ACI 301 and as modified in the following.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
 - a. 117, Specification for Tolerances for Concrete Construction and Materials.
 - b. 301, Specifications for Structural Concrete.
 - c. SP-66, Detailing Manual.
2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
3. ASTM International (ASTM):
 - a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - b. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - c. A1064/A1064M, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
4. Concrete Reinforcing Steel Institute (CRSI):
 - a. Placing Reinforcing Bars.
 - b. Manual of Standard Practice.
5. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

- A. Action Submittals:

1. Shop Drawings prepared in accordance with ACI 301 and ACI SP-66:
 - a. Bending lists.
 - b. Placing drawings.
2. Welded, metallic sleeve splice, and mechanical threaded connection.

B. Informational Submittals:

1. Lab test reports for steel reinforcement showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
 - a. Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
 - b. Verification device threads have been tested and meet requirements for thread quality, in accordance with manufacturer's published methods.
 - c. Manufacturer's instructions.
3. Test results of field testing.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with ACI 301 and recommendations of CRSI Placing Reinforcing Bars.

PART 2 PRODUCTS

2.01 MATERIALS

A. Epoxy Coating for Reinforcing Bars:

1. Physical Characteristics: Precoated with epoxy at a CRSI-certified epoxy coating plant in accordance with ASTM A934.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

B. Sustainable Material Requirements:

1. Recycled Content of Steel Products: Provide products with a minimum combined recycled content of 85 percent and a minimum postconsumer recycled content of 80 percent.

C. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60, where welding is not required.

D. Mechanical Threaded Connections:

1. Physical Characteristics: Metal coupling sleeve with internal threads engaging threaded ends of bars.
2. Functional Characteristics: None.

3. Performance Characteristics: Capable of developing in tension or compression 125 percent of yield strength of bar.

2.02 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Use precast concrete bar supports or all-plastic bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
3. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to steel reinforcement.
5. In Walls and Slabs Exposed to View after Form Removal: Use small precast concrete blocks made of same color as concrete in which they are embedded. All-plastic bar supports and side form spacers may be used, except where surface is exposed as described above.
6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify Contracting Officer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.
- B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.

3.02 INSTALLATION

- A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.
- B. Splicing:
 - 1. Minimum length of lap splices shall comply with table in Contract Documents.
 - 2. Use lap splices, unless otherwise shown or permitted in writing by Contracting Officer.
 - 3. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
 - 4. Stagger splices in adjacent bars where indicated.
- C. Mechanical Splices and Connections:
 - 1. Use only in areas specifically approved in writing by Contracting Officer.
 - 2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICC Evaluation Services Report or equivalent code agency report.
 - 3. For metal sleeve splice, follow manufacturer's installation recommendations.
 - 4. Maintain minimum edge distance and concrete cover.
- D. Tying Reinforcing Bars:
 - 1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
 - 2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.
- E. Reinforcement Around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.
- F. Welding Reinforcement: Not permitted.
- G. Straightening and Rebending: Field bending of steel reinforcement bars is not permitted.
- H. Unless permitted by Contracting Officer, do not cut reinforcing bars in field.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 40 00, Quality Requirements.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO).
 - a. M6, Standard Specification for Fine Aggregate for Portland Cement Concrete.
 - b. M80, Standard Specification for Coarse Aggregate for Portland Cement Concrete.
 - c. M153, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - d. M157, Standard Specification for Ready-Mixed Concrete.
 - e. M213, Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - f. M227/M227M, Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
2. American Concrete Institute (ACI):
 - a. 117, Specification for Tolerances for Concrete Construction and Materials.
 - b. 301, Specifications for Structural Concrete.
 - c. 305.1, Specification for Hot Weather Concreting.
 - d. 306.1, Standard Specification for Cold Weather Concreting.
 - e. CP-1, Technical Workbook for ACI Certification of Concrete Field Testing Technician – Grade 1.
3. ASTM International (ASTM):
 - a. A615/A615M, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - b. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - c. C33/C33M, Standard Specification for Concrete Aggregates.
 - d. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - f. C94/C94M, Standard Specification for Ready-Mixed Concrete.

- g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
- h. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
- i. C150/C150M, Standard Specification for Portland Cement.
- j. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
- k. C172, Standard Practice for Sampling Freshly Mixed Concrete.
- l. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
- m. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- n. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
- o. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- p. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
- q. C595/C595M, Standard Specification for Blended Hydraulic Cements.
- r. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- s. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- t. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
- u. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
- v. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
- w. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
- x. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
- y. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
- z. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
- aa. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
- bb. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
- cc. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.

- dd. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
 - ee. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
 - ff. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
 - gg. D920, Standard Specification for Elastomeric Joint Seals.
 - hh. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - ii. D3406, Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
 - jj. D5249, Specification for Backer Material for Use With Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints.
 - kk. D5893, Specification for Cold-Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
 - ll. E329, Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
4. National Ready Mixed Concrete Association (NRMCA).

1.02 DEFINITIONS

- A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.
- B. Contractor's Licensed Design Engineer: Individual representing Contractor who is licensed to practice engineering as defined by statutory requirements of professional licensing laws in state or jurisdiction in which Project is to be constructed.
- C. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

- D. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.
- E. Hot Weather: As defined in ACI 305.1.
- F. New Concrete: Less than 60 days old.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Mix Designs:
 - a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
 - b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
 - c. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following:
 - 1) Portland cement.
 - 2) Fly ash.
 - 3) Slag cement.
 - 4) Silica Fume.
 - 5) Aggregates, including specified class designation for coarse aggregate.
 - 6) Admixtures.
 - 7) Concrete producer has verified compatibility of constituent materials in design mix.
 - d. Test Reports:
 - 1) Water-Soluble Chloride-Ion Content in Hardened Concrete: Unless otherwise permitted, in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
 - 2) Shrinkage Test Results: In accordance with ASTM C157/C157M as modified herein.
 - e. Aggregates:
 - 1) Coarse Aggregate Gradation: List gradings and percent passing through each sieve.
 - 2) Fine Aggregate Gradation: List gradings and percent passing through each sieve.
 - 3) Percent of fine aggregate weight to total aggregate weight.
 - 4) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
 - 5) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.

- 6) Test Reports:
 - a) Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
 - f. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
2. Product Data: Specified ancillary materials.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
 - a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
 - b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - c. Methods for temperature protection during placement.
 - d. Types of covering, insulation, housing, or heating to be provided.
 - e. Curing methods to be used during and following protection period.
 - f. Use of strength accelerating admixtures.
 - g. Methods for verification of in-place strength.
 - h. Procedures for measuring and recording concrete temperatures.
 - i. Procedures for preventing drying during dry, windy conditions.
4. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
 - a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - b. Use of retarding admixture.
 - c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
 - d. Types of shading and wind protection to be provided.
 - e. Curing methods, including use of evaporation retardant.
 - f. Procedures for measuring and recording concrete temperatures.
 - g. Procedures for preventing drying during dry, windy conditions.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer's application instructions for bonding agent and bond breaker.

3. Manufacturer's Certificate of Compliance to specified standards:
 - a. Bonding agent.
 - b. Bond breaker.
4. Statement of Qualification:
 - a. Batch Plant: Certification as specified herein.
 - b. Mix designer.
 - c. Installer.
 - d. Testing agency.
5. Field test reports.
6. Tightness test results.
7. Concrete Delivery Tickets:
 - a. For each batch of concrete before unloading at Site.
 - b. In accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.
 - c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.04 QUALITY ASSURANCE

- A. Concrete construction shall conform to requirements of ACI 117 and ACI 301, except as modified herein.
- B. Qualifications:
 1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
 2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
 3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
 4. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - a. Where field testing is required of Contractor, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

C. Preinstallation Conference:

1. Required Meeting Attendees:
 - a. Contractor, including pumping, placing and finishing, and curing subcontractors.
 - b. Ready-mix producer.
 - c. Admixture representative.
 - d. Testing and sampling personnel.
 - e. Contracting Officer.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Contracting Officer of location and time.
3. Agenda shall include:
 - a. Admixture types, dosage, performance, and redosing at Site.
 - b. Mix designs, test of mixes, and Submittals.
 - c. Placement methods, techniques, equipment, consolidation, and form pressures.
 - d. Slump and placement time to maintain slump.
 - e. Finish, curing, and water retention.
 - f. Protection procedures for weather conditions.
 - g. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 00, Project Management and Coordination.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:

1. Physical Characteristics: Conform to the requirements of ASTM C150/150M.
2. Functional Characteristics:
 - a. Furnish cement for Project from one source.
 - b. Portland cement shall be Type I.
3. Performance Characteristics:
 - a. In accordance with ASTM C150.
 - b. Pozzolan: ASTM C618, Class C or Class F flyash.

B. Aggregates:

1. General:
 - a. Physical Characteristics:
 - 1) In accordance with ASTM C33/C33M.
 - 2) Aggregate for portland cement concrete mixture shall be 1 1/2 inch maximum size stone meeting requirements of AASHTO M6 and AASHTO M80.
 - 3) Material: Natural aggregates, free from deleterious coatings.

- b. Functional Characteristics: Aggregates shall not be potentially reactive as defined in ASTM C33.
- c. Performance Characteristics: Aggregates not in compliance with soundness and durability requirements of ASTM C33 may be used with prior approval of Contracting Officer; provided it can be shown by special testing or record of past performance that these aggregates produce concrete of adequate strength and durability. Aggregate soundness testing for fine and coarse aggregates shall be in accordance with ASTM C33 and ASTM C88.

2. Fine Aggregates:

a. Physical Characteristics:

- 1) Must be graded coarse to fine within the following limits:

General Requirements	
Sieve Size Passing	Percentages by Weight
3/8"	100
No. 4	90 - 100
No. 8	55 - 85
No. 16	45 - 75
No. 30	25 - 55
No. 50	5 - 30
No. 100	0 - 8

- 2) Sand: Equivalent of not less than 68.

- 3) Materials finer than 200 sieve shall not exceed 4 percent.

- b. Functional Characteristics: Sources near or exposed to saltwater shall be washed, unless it can be shown that chloride content does not exceed 0.15 percent by weight of cement.
- c. Performance Characteristics: Use of beach sand shall not be permitted.

3. Coarse Aggregate:

a. Physical Characteristics:

- 1) Materials finer than 200 sieve shall not exceed 0.5 percent.

- 2) Size: 1 1/2 inch (maximum) to No. 4.

Grading Requirements		
Sieve Size Passing	Separated Sizes 1-1/2 Inch to 3/4 Inch	Percentages (by Weight) 3/4 Inch to No. 4
2"	100	
1-1/2"	90 - 100	
1"	30 - 65	100

Grading Requirements		
Sieve Size Passing	Separated Sizes 1-1/2 Inch to 3/4 Inch	Percentages (by Weight) 3/4 Inch to No. 4
3/4"	0 - 15	90 - 100
3/8"		20 - 50
No. 4		0 - 10

- b. Functional Characteristics: None.
- c. Performance Characteristics: None.

C. Physical Properties:

- 1. Physical Characteristics: None.
- 2. Functional Characteristics: Meet requirements of AASHTO M80 for Class B.
- 3. Performance Characteristics: None.

D. Water:

- 1. Physical Characteristics: None.
- 2. Functional Characteristics: ASTM C94/C94M.
- 3. Performance Characteristics: None.

E. Admixtures:

- 1. Physical Characteristics: Add admixtures to mix at batch plant.
- 2. Functional Characteristics: None.
- 3. Performance Characteristics:
 - a. Air Entraining: ASTM C260.
 - b. Water Reducing:
 - 1) ASTM C494/C494M, Type A, normal, containing no chlorides and compatible with air-entraining admixtures.
 - 2) Do not use calcium chloride, salt, or antifreeze agents.

2.02 ANCILLARY MATERIALS

A. Tie Bars and Reinforcement Bars:

- 1. Physical Characteristics: Epoxy coated Grade 60 deformed steel bars.
- 2. Functional Characteristics: None.
- 3. Performance Characteristics: Conforming to ASTM A615/A615M.

B. Dowels:

1. Physical Characteristics: Grade 70.
2. Functional Characteristics: None.
3. Performance Characteristics: Conform to requirements of AASHTO M227/M227M.

C. Joint Filler:

1. Physical Characteristics: Preformed expansion joint filler as specified in Section 03 15 00, Concrete Joints and Accessories.
2. Functional Characteristics: None.
3. Performance Characteristics: Fillers furnished under AASHTO M213 shall be tested in accordance with ASTM D1751.

D. Joint Sealant:

1. Physical Characteristics: As specified in Section 03 15 00, Concrete Joints and Accessories.
2. Functional Characteristics: None.
3. Performance Characteristics:
 - a. Preformed elastomeric joint seal conforming to ASTM D2628.
 - b. Hot-poured elastomeric joint seal conforming to ASTM D3406.
 - c. Hot-applied, jet-fuel-resistant joint sealant conforming to ASTM D3569.
 - d. Cold-applied single component joint sealant conforming to ASTM D5893.
 - e. Elastomeric joint sealant conforming to ASTM C920.

E. Backer Rod:

1. Physical Characteristics: None.
2. Functional Characteristics: None.
3. Performance Characteristics:
 - a. Backer material conforming to ASTM D5249.
 - b. Cylindrical sealant backing conforming to ASTM C1330.

F. Curing Compound:

1. Physical Characteristics: None.
2. Functional Characteristics: None.
3. Performance Characteristics: Conforming to ASTM C309, Type 1, Class A, suitable for spray application.

G. Curing Membranes:

1. Physical Characteristics:
 - a. White polyethylene sheeting.
 - b. Cotton or jute mats.
2. Functional Characteristics: Waterproof paper.
3. Performance Characteristics: None.

H. Evaporation Retardant:

1. Physical Characteristics: None.
2. Functional Characteristics: None.
3. Performance Characteristics:
 - a. Confilm as manufactured by Master Builders Company.
 - b. Or equal.

2.03 CONCRETE MIX DESIGN

A. Physical Characteristics for Class A (AE) concrete:

1. Maximum water-cement ratio or water-cement plus pozzolan ratio, if applicable, shall not exceed 0.45.
2. Replacement of cement with pozzolan shall not exceed 20 percent.
3. Maximum Aggregate Size: 1 1/2 inch minus.
4. Allowable Slump: 3 inches, plus or minus 1 inch.
5. Air Entrainment Content: 4 percent to 7 percent by volume.
6. Concrete shall contain water reducer. Amount of admixture added to concrete shall be in accordance with manufacturer's written instructions.
7. Do not use frozen materials or materials containing ice or snow.
8. Concrete temperature as delivered to site ready for placement shall be above 50 degrees F and below 90 degrees F.

B. Functional Characteristics:

1. Minimum 28-Day Compressive Strength: 4,500 psi.
2. As specified in Section 03 30 00, Cast-in-Place Concrete, with a minimum flexural strength of 650 psi.
3. Concrete target strengths shall be in accordance with ACI 318/318R.

C. Performance Characteristics: Meeting the requirements of ACI 301.

2.04 CONCRETE MIXING

- A. General: In accordance with ACI 301, except as modified herein.
- B. Ready-Mix Concrete Batch Plants:
 - 1. Physical Characteristics: None.
 - 2. Functional Characteristics: Certified by NRMCA.
 - 3. Performance Characteristics: None.
- C. Ready-Mix Concrete Trucks:
 - 1. Physical Characteristics:
 - a. Agitator mixer type.
 - b. Equipped with operable electrically actuated drum revolution counters.
 - 2. Functional Characteristics:
 - a. Use of nonagitator equipment will not be permitted.
 - b. Each mixer shall carry a clearly visible manufacturer's plate showing capacity of mixer and other pertinent operating rates and limits.
 - c. Provision shall be made at mixer for controlled addition of air-entraining admixtures or other special components of mix.
 - 3. Performance Characteristics:
 - a. Mixing Speed: 70 revolutions to 100 revolutions at a mixing speed recommended by truck mixer manufacturer.
- D. Hauling Equipment:
 - 1. Physical Characteristics: None.
 - 2. Functional Characteristics: Hauling equipment shall conform to AASHTO M157, Paragraph 11.6 and Paragraph 12.
 - 3. Performance Characteristics: Upon delivery of each batch of concrete to Site, a trip ticket shall be submitted to Contracting Officer.
- E. Concrete Saws:
 - 1. Physical Characteristics: None.
 - 2. Functional Characteristics: Provide power driven concrete saws for sawing joints or finishing concrete, adequate in number of units and power to complete sawing at required rate.
 - 3. Performance Characteristics:
 - a. Saws and related equipment shall be of proven adequacy and design to perform efficiently and shall be subject to immediate replacement, if specified results are not obtained.
 - b. Standby saw shall be available at Site.

F. Smoothness Testing Equipment:

1. Physical Characteristics: Two 12-foot straightedges.
2. Functional Characteristics: Determining smoothness.
3. Performance Characteristics: None.

2.05 SOURCE QUALITY CONTROL

- A. Source Quality Control Inspection: Contracting Officer shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and Subcontractors, providing products included in this section.

PART 3 EXECUTION

3.01 PLACING CONCRETE

- A. Preparation: Meet requirements ACI 301, except as modified herein.
1. Prepare base as specified in Section 32 11 23, Aggregate Base and Subbase Course(s).
 2. Dampen base thoroughly prior to concrete placement; standing water will not be permitted.
 3. Area in which concrete is to be placed, shall be smooth and free of ruts, projections, debris, spilled concrete, mud, sloughed soil, standing water, organic and other objectionable materials.
 4. Construction Joints: Inspect prior to placement of concrete.
- B. Inspection: Notify Contracting Officer and Special Inspector at least 1 full working day in advance before starting to place concrete.
- C. Placement into Formwork:
1. Reinforcement: Secure in position before placing concrete.
 2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs which shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
 3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
 4. Use placement devices, for example chutes, pouring spouts, and pumps as required to prevent segregation.
 5. Vertical Free Fall Drop to Final Placement:
 - a. Forms 8 Inches or Less Wide: 5 feet.
 - b. Forms Wider than 8 Inches: 8 feet, except as specified.

6. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
 - a. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
7. Do not use aluminum conveying devices.
8. Cure concrete as specified in Section 03 39 00, Concrete Curing.

D. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Minimum Slopes of Chutes: Angled to allow concrete to readily flow without segregation.
4. Conveyor Belts:
 - a. Approved by Contracting Officer.
 - b. Wipe clean with device that does not allow mortar to adhere to belt.
 - c. Cover conveyor belts and chutes.

E. Retempering: Not permitted for concrete where cement has partially hydrated.

F. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

G. Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
2. Locate expansion, control, and contraction joints where shown on the Drawings.
3. Construction Joints: Unless otherwise shown or permitted, locate construction joints as shown on the Drawings or where approved in joint location submittal required in Section 03 15 00, Concrete Joints and Accessories.

H. Minimum Time between Adjacent Placements:

1. Construction or Control Joints: 7 days unless otherwise specified.
2. Expansion or Contraction Joints: 1 day.

I. Consolidation and Visual Observation:

1. Consolidation Equipment and Methods: ACI 301.
2. Provide at least one standby vibrator in operable condition at Site prior to placing concrete.
3. Vibrate concrete in vicinity of joints to obtain impervious concrete.

J. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
 - a. Maintain concrete temperature below 90 degrees F at time of placement or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
 - b. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
2. Concrete Curing: As specified in Section 03 39 00, Concrete Curing.

K. Cold Weather Placement:

1. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:
 - a. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
 - b. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Contracting Officer.
 - c. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
 - d. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
 - e. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.

- f. Cure concrete as specified in Section 03 39 00, Concrete Curing.
 - 1) Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.
- 2. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.
- 3. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.
- 4. Maintain curing conditions as specified in Section 03 39 00, Concrete Curing.

3.02 CONCRETE BONDING

- A. Construction Joints in New Concrete Members: Prepare surface of construction joint as specified in Section 03 15 00, Concrete Joints and Accessories.

3.03 REPAIRING CONCRETE

- A. General:
 - 1. Repair defective areas of concrete.
 - 2. Repair concrete surface using specified materials. Select system, submit for review, and obtain approval from the Contracting officer prior to use.
 - 3. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Contracting Officer.

3.04 CONCRETE SLAB FINISHES

- A. General:
 - 1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
 - 2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
 - 3. Pavement shall have surface tolerance of 1/4 inch in 10 feet in accordance with ACI 325.9R.

4. Exposed pavement edges shall be edged to a 1/2-inch radius and construction joints shall be edged to 1/8-inch radius after finishing. Edging shall not form ridges on pavement surface.
5. Finish slab in accordance with specified slab finish.
6. Do not dust surfaces with dry materials nor add water to surfaces.
7. Cure concrete as specified in Section 03 39 00, Concrete Curing.

B. Transverse Tine Finish:

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
2. Wood float to true, even plane with no coarse aggregate visible.
3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, and while the concrete is still plastic enough to make a granular surface possible, texture the surface to produce a skid resistant surface.
5. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
6. Drag two layers of moistened burlap along the pavement in the direction of paving without tearing or marring the surface. Following the burlap drag, use a timing comb to form grooves in the pavement surface. Space times randomly 1/2-inch to 3/4-inch apart. Produce grooves that are 1/16-inch to 3/16-inch wide and 1/8-inch to 3/16-inch deep. Tine perpendicular to the centerline without tearing the concrete surface or loosening surface aggregate.

3.05 CURING OF PORTLAND CEMENT CONCRETE

- A. Immediately after the final floating, surface finishing, and edging has been completed, and while portland cement concrete surface is still moist, cover and cure entire exposed surface for at least 72 hours in accordance with one of the following provisions:
1. Liquid Membrane-Forming Compounds: Apply compound uniformly to portland cement concrete by pressure spray methods at a rate which will form an impervious membrane, but at least at a rate of 1 gallon per 150 square feet.
 2. Other Membranes:
 - a. Apply to damp portland cement concrete as soon as it can be placed without marring surface.
 - b. Place in contact with surface, extend beyond sides or edges of slabs or forms, and fasten down to hold it in position as a waterproof and moisture proof covering.
 - c. Laps shall be sufficient to maintain tightness equivalent to sheeting.

- d. Transverse laps for waterproof paper shall be at least 18 inches, and longitudinal seams shall be cemented.
 - e. Cotton or jute mats shall be saturated with water prior to placing and kept fully wetted during curing period.
- B. Concrete shall be cured by use of curing compound, for minimum of 7 days after concrete placement, in accordance with ACI 308. Curing compounds shall be applied in accordance with manufacturer's written instructions.
- C. Exposed surfaces shall be sprayed with curing compound immediately after free surface water has disappeared from finished surface.
- D. Concrete temperature shall be maintained in accordance with ACI 306R.
- E. Curing compounds shall not come in contact with hardened concrete that is to be concreted against.

3.06 FIELD QUALITY CONTROL

- A. Retain independent testing or inspection agency to perform inspection, sampling, and testing.
- B. Concrete Sampling: In accordance with ASTM C172. Take sample not less than every 5,000 square feet or fraction thereof of concrete placed each day.
- C. Perform following tests on each sampling:
 - 1. Slump: ASTM C143/C143M.
 - 2. Air Content: ASTM C231.
 - 3. Compressive Strength: ASTM C39/C39M.
 - 4. Flexural Strength: ASTM C78.
- D. Strength Tests:
 - 1. Make and cure cylinders and beams in accordance with ASTM C31/C31M.
 - 2. Cylinders: Make four, standard 6-inch diameter by 12 inches high. Cure one in field and three in laboratory.
 - 3. Beams: Make three, standard 6 inches by 6 inches by 21 inches. Cure in field.
 - 4. Compressive: Test one field-cured cylinder at 7 days and two laboratory-cured cylinders at 28 days. Test last cylinder at 56 days if 28-day cylinder is below specified strength.
 - 5. Flexural: Test one beam at 7 days and two beams at 28 days.
- E. Acceptance of concrete shall be in accordance with ACI 318/318R.

- F. Concrete with compressive strength less than specified, as evidenced by cylinder tested at 56 days, shall be additionally tested as follows:
1. Less Than 500 psi Low in Compression or Less Than 75 psi Low in Flexure:
 - a. Penetration Resistance Test: ASTM C803.
 - b. Rebound Hammer Test: ASTM C805.
 - c. Perform tests within 24 hours of noncomplying strength tests.
 2. More Than 500 psi Low in Compression or More Than 75 psi Low in Flexure:
 - a. Concrete Coring: Take three standard cores from concrete representing original specimens.
 - b. Take and prepare cores in accordance with ASTM C42/C42M.
 - c. Test cores in accordance with ASTM C39/C39M.
 - d. Take cores within 24 hours of noncomplying strength test.

3.07 CLEANING

- A. Clean concrete splatter from exposed surfaces.
- B. Thoroughly broom and wash concrete surfaces before opening to traffic.

3.08 PROTECTION OF CONCRETE

- A. Do not operate construction equipment or allow traffic on newly placed portland cement concrete until the following requirements are met:
 1. Joints have been filled.
 2. Concrete has attained a compressive strength of at least 4,000 pounds per square inch.
- B. Protect new concrete from construction operations, mechanical disturbances, water flow, and soiling until open for traffic.
- C. Erect and maintain suitable barriers to protect concrete from traffic or other detrimental trespass until pavement is opened to traffic.
- D. Maintain watchmen after normal working hours for at least a 24-hour period to ensure barriers are not removed or destroyed, and that trespass and vandalism upon pavement does not occur.
- E. Wherever it is necessary that traffic, including Contractor's vehicles and equipment, be carried from one side of pavement to the other, construct suitable bridges over pavement, and maintain them in good condition as long as they may be required. Leaving gaps in pavement to facilitate movement of traffic will not be allowed, unless prior written permission is obtained from Contracting Officer.

- F. Protect new concrete from dirt, asphalt, and other deleterious substances that may be tracked onto new pavement from construction activities.
- G. Pavement damaged by traffic or damaged from any other cause, prior to its official acceptance, shall be repaired or replaced to the satisfaction of Contracting Officer.

END OF SECTION

SECTION 03 39 00 CONCRETE CURING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 308.1, Specification for Curing Concrete.
2. ASTM International (ASTM):
 - a. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' data indicating compliance with the requirements specified herein for the following products:
 - a. Evaporation retardant.
 - b. Curing compound.
 - c. Penetrating water repellent sealer.
2. Curing methods proposed for each type of element such as slab, walls, beams, and columns in each facility.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following:
 - a. Curing compound showing moisture retention requirements.

PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound: Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.

B. Evaporation Retardant:

1. Manufacturers and Products:
 - a. BASF Construction Chemicals, Shakopee, MN; MasterKure ER 50.
 - b. Or equal.
2. Physical Characteristics: None.
3. Functional Characteristics: None.
4. Performance Characteristics: Reduces surface moisture evaporation from freshly placed concrete.

C. Water: Clean and potable, containing less than 500 ppm of chlorides.

PART 3 EXECUTION

3.01 CONCRETE CURING

A. General:

1. Cure all concrete in accordance with Project Specifications and ACI 308.1.
2. Where curing compound cannot be used, water curing as described below or special methods using moisture shall be agreed upon by Contracting Officer prior to placing concrete.
3. As required in Section 03 30 00, Cast-in-Place Concrete, if result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified below, by 7 additional days.

B. Use one of the following methods as approved by Contracting Officer:

1. Vertical Surfaces:
 - a. Method 1: Leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
 - b. Method 2: Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.
 - c. Method 3: Apply curing compound, where allowed, immediately after removal of forms.
2. Horizontal Surfaces:
 - a. Method 1: Protect surface by water ponding for 7 days.
 - b. Method 2: Cover with burlap or cotton mats and keep continuously wet for 7 days.
 - c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 7 days.
 - d. Method 4: Continuously sprinkle exposed surface for 7 days.

- e. Method 5: Apply curing compound, where allowed, immediately after final finishing when surface will no longer be damaged by traffic.

3.02 EVAPORATION RETARDANT APPLICATION

- A. Use on flatwork when environmental conditions are anticipated to cause rapid drying of the concrete surface. Do not use evaporation retardant on potable water structures unless product is NSF 61 approved.
- B. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.
- C. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.03 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.
- B. Provide curing compound manufacturer's representative to demonstrate proper application of curing compound to show coverage in one coat.

END OF SECTION

SECTION 10 14 00 SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

- A. This work includes installing flexible object markers and ground mounted roadside traffic sign systems consisting of signposts, foundations, and panels.

1.02 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. LTS-6, Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
 - 2. ASTM International (ASTM):
 - a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - b. A 123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. A242, Standard Specification for High-Strength Low-Alloy Structural Steel.
 - d. A499, Standard Specification for Steel Bars and Shapes, Carbon Rolled from "T" Rails.
 - e. A513, Standard Specification for Carbon Steel.
 - f. A588, Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance.
 - g. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - h. A787, Standard Specification for Electric-Resistance-Welded Metallic-Coated Carbon Steel Mechanical Tubing.
 - i. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - j. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - k. D709, Standard Specification for Laminated Thermosetting Materials.
 - l. D4956, Standard Specification for Retroreflective Sheeting for Traffic Control.

3. U.S. Department of Transportation, Federal Highway Administration: Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways.
4. National Cooperative Highway Research Program (NCHRP): Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer's literature for items specified.
2. Shop Drawings: Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.

B. Informational Submittals: Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 TRAFFIC SIGN SYSTEMS

A. Physical Characteristics:

1. Signpost:
 - a. Provide signposts that are straight, smooth, and without defects affecting strength, durability, or appearance.
 - b. Provide galvanized steel or aluminum alloy U-channel or square signposts that conform to ASTM A499 Grade 60 with AASHTO M111 galvanizing after punching, ASTM A1011 Grade 55 with ASTM A123 or ASTM B695 galvanizing after punching, ASTM A588 or ASTM A242.
2. Hardware: Provide galvanized steel or aluminum alloy lag screws, washers, clip angles, wood screws, shear plates, U-bolts, clamps, bolts, nuts, and other fasteners.
3. Panels:
 - a. Standard design meeting MUTCD requirements.
 - b. Provide panels conforming to ASTM B209, alloy 6061-T6 or 5052-H38.
 - c. Types III, IV, VIII, IX, or XI prismatic retroreflective sheeting per ASTM D4956, including supplementary requirements. Clean and degrease the face of the metal panels using methods recommended by the manufacturer before applying retroreflective sheeting.
 - d. Materials and Fabrication: Arizona Department of Transportation Standard Specifications for Road and Bridge Construction.

- B. Functional Characteristics: Inform road users of selected traffic laws or regulations and indicate the applicability of the legal requirements.
- C. Performance Characteristics: Breakaway signposts per AASHTO LTS-6 meeting crashworthiness criteria of NCHRP 350.

2.02 OBJECT MARKERS

- A. Physical Characteristics:
 - 1. Provide flexible delineator posts made with high-impact resistant polymer material.
 - 2. Provide a prismatic retroreflective sheeting with a minimum dimension of 3-inch width and with a Class 1 or Class 2 adhesive backing per ASTM D4956.
- B. Functional Characteristics: Delineate roadside obstructions.
- C. Performance Characteristics:
 - 1. Meet Cold Bend Test:
 - a. Subject two posts to a temperature of minus 10 degrees F, plus or minus 5 degrees F for at least 4 hours.
 - b. Immediately bend each post four times through a 90-degree angle around a 2-inch mandrel.
 - c. Each post must return to its original straight configuration within a plus or minus 10-degree angle within 5 minutes at the end of the four bends.
 - d. Any cracking or significant loss of rigidity are grounds for failure.
 - 2. Meet Hot Bend Test:
 - a. Subject two posts to a temperature of 100 degrees F, plus or minus 5 degrees F for at least 4 hours.
 - b. Satisfy all bending and physical requirements specified in the Cold Bend Test.
 - 3. Meet Impact Resistance Test:
 - a. Subject post to impacts by a typical sedan as follows:
 - 1) Three hits, 0-degree angle at 0 degree F.
 - 2) Three hits, 0-degree angle at 100 degrees F.
 - 3) Ten hits, 0-degree angle at 35 mph.
 - 4) Five hits, 15-degree angle at 55 mph.
 - b. Acceptable Results:
 - 1) Installed post remain intact, securely anchored, and within plus or minus 10 degrees of vertical orientation.
 - 2) Installed post shows minimal signs of cracking or loss of rigidity.
 - 3) Installed post retains at least 50 percent of its reflective sheeting.

- 4) Impact vehicle suffers little or no damage during the impact test.
4. Exposure:
 - a. Expose the specimens for 500 hours in a carbon arc-type apparatus according to ASTM G23, Method 1.
 - b. Acceptable Results:
 - 1) Exposure does not result in delamination, distress, or discoloration.
 - 2) Sheeting is not removable from the specimens without damage.
 - 3) Post is resistant to ultraviolet light, ozone, hydrocarbons, and other weathering.

PART 3 EXECUTION

3.01 TAFFIC SIGN SYSTEM

- A. Mount sign panels securely, plumb, and level with the legend horizontal on breakaway metal support using two 1/4-inch bolts through sign and post.
- B. Turn sign panels 3 degrees away from the road in the direction of travel to reduce specular glare (mirror reflection).
- C. Cover the sign face with an opaque material if a sign message is not applicable. Maintain the covering in good condition until the message becomes applicable. Do not use adhesive tape on the sign face.
- D. Install breakaway signposts in ground or foundation per manufacturer's instruction.
- E. The top of foundations and projections of any rigidly attached anchor bolts or anchor supports should not extend above the ground level enough to increase the hazard or to interfere with the operation of a breakaway support.
- F. Anchor in place for easy removal and reinstallation with ordinary hand tools.
- G. Affix to each sign a 2-inch by 2-inch impermeable, non-fading weather-resistant, self-adhesive label which includes the month and year of manufacture, Contractor's name, and type of sheeting. Attach label where it will not obscure sheeting.

3.02 OBJECT MARKER

- A. Bury to manufacturer depth.
- B. Wipe plastic panels clean with a slightly dampened cloth before applying retroreflective sheeting.

END OF SECTION

SECTION 31 10 00 SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

- A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface including but not limited to stumps, bushes, rubbish, refuse, and other deleterious materials.
- B. Debris: Broken concrete or asphalt, trash, rubbish, rubble, destroyed ruins or other similar items.
- C. Grubbing: Removal by raking or by excavation of vegetation and other organic matter including stumps, debris, grass, buried logs, and roots greater than 2-inch caliper to depth of 6 inches below subgrade.
- D. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- E. Project Limits: Areas, as shown or specified, within which Work is to be performed.
- F. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.
- G. Stripping: Removal of topsoil remaining after applicable scalping is completed.
- H. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by drip line of individual trees or perimeter drip line of groups of trees, unless otherwise indicated.

1.02 SUBMITTALS

- A. Action Submittals: Overall Site Plan along with applicable drawings clearly showing clearing, grubbing, and stripping limits for planned work prior to construction and as part of the Quality Assurance.
- B. Information Submittals: Provide survey information delineating limits of debris disposal. Survey to include top elevation of piles.

1.03 QUALITY ASSURANCE

- A. Obtain approval by Contracting Officer of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.04 SCHEDULING AND SEQUENCING

- A. Prepare Site only after adequate erosion and sediment controls are in place and in accordance with Section 01 57 13, Temporary Erosion and Sediment Control.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Comply with federal, state, and local regulations concerning control of erosion and sediment. Sequence work to reduce erosion as directed in construction sequence. Comply with erosion and sedimentation regulations and permit conditions.
- B. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.
- C. Locate and clearly flag trees and vegetation to remain.
- D. Clear, grub, and strip areas needed for waste disposal, borrow, staging areas, or Site improvements within limits shown or specified.
- E. Do not injure or deface vegetation that is not designated for removal. Protect areas of milkweed, that are outside of the road construction limits, with orange plastic construction fencing or other physical signage and fencing.
- F. Protect remaining Site improvements from damage during construction. Restore damaged improvements to their original condition.

3.02 TREE PROTECTION

- A. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Cleanly cut roots as close to excavation as possible.
- B. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations.
- C. Review permits and applicable tree preservation plans prior to construction.

3.03 UTILITY LINE PROTECTION

- A. Verify existing utilities.
- B. Verify clearances at all crossings of overhead power and communications lines and underground utilities.
- C. Protect existing utility lines from damage.
- D. Repair damage to existing utility lines.
- E. Coordinate in accordance with Section 01 31 00, Project Management and Coordination.

3.04 LIMITS

- A. As follows, but not to extend beyond Project limits.
 - 1. Excavation 5 feet beyond top of cut slopes.
 - 2. Fill:
 - a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
 - b. Stripping and Scalping: 2 feet beyond toe of permanent fill.
 - 3. Waste Disposal:
 - a. Clearing: 5 feet beyond perimeter.
 - b. Scalping and Stripping: Not required.
 - c. Grubbing: Around perimeter as necessary for neat, finished appearance.
 - 4. Other Areas: As shown.
- B. Remove rubbish, trash, and junk from entire area within Project limits.

3.05 CLEARING

- A. Clear areas within limits shown or specified.
- B. Timber Removal:
 - 1. Fell trees so they fall away from facilities and vegetation not designated for removal.
 - 2. Remove felled timber.
 - 3. Clearing materials are not allowed to be placed in wetlands, streams, buffers, or lakes.
- C. Cut stumps not designated for grubbing to within 6 inches of ground surface.
- D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.06 GRUBBING

- A. Grub areas within limits shown or specified.
- B. Grub Holes:
 - 1. Fill excavated areas with suitable on-site material.
 - 2. Compact fill areas to same density require for embankment.
 - 3. Grade excavation to conform to surrounding surface.

3.07 STRIPPING

- A. Strip areas within limits to 2-inch minimum depth or as directed by Contracting Officer. Do not remove subsoil with topsoil.
- B. Stockpile strippings for topsoil, separately from other excavated material.

3.08 MERCHANTABLE TIMBER

- A. Saleable logs will remain property of Government and be stored in a pile in a location designated by the Contracting Officer.

3.09 TREE REMOVAL OUTSIDE CLEARING LIMITS

- A. Remove Within Project Limits:
 - 1. Dead, dying, leaning, or otherwise unsound trees that may strike and damage Project facilities in falling.
 - 2. Trees designated by site design.
- B. Cut stumps off flush with ground, remove debris, and if disturbed, restore surrounding area to its original condition.

3.10 SALVAGE

- A. Saleable log timber will remain property of Government as determined by the Contracting Officer.
- B. Sod with commercial value will remain property of Government as determined by the Contracting Officer.

3.11 DISPOSAL

- A. Timber: Remove felled timber that cannot be sold from Site.
- B. Clearing and Grubbing Debris:
 - 1. Burning of combustible debris onsite will not be allowed.
 - 2. Dispose of debris offsite.
- C. Scalpings: As specified for clearing and grubbing debris.

3.12 EROSION AND DUST CONTROL

- A. Perform clearing and grubbing operations to minimize erosion and dust transport.
- B. Provide additional protective measures to prevent sediment and dust from being removed from Site.
- C. Provide equipment or stabilize areas to prevent dust.

END OF SECTION

SECTION 31 23 13 SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): T180, Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
 2. ASTM International (ASTM):
 - a. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - b. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

- A. Bedrock Subgrade: Surface of bedrock after completion of clearing, grubbing, scalping of topsoil, removing of overburden soil and removal of disturbed or loosened materials to expose undisturbed bedrock. Where structure walls are cast against bedrock, Bedrock Subgrade shall include the sidewalls of the excavation.
- B. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.
- C. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, dewatering, excavation to grade, and scarification and compaction of subgrade.
- D. Proof-Rolling: Test rolling of subgrade by heavily load vehicle or roller to identify areas that will not support the future loading without excessive settlement or rutting.
- E. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.
- F. Soil Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure, or concrete pavement.
- G. Subgrade: As defined in Section 32 91 13, Soil Preparation.

- H. Unsuitable Material: Subgrade material unsuitable for the project consisting of rubble, debris, vegetation, and undocumented fill.

1.03 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 31 10 00, Site Clearing; and Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

- A. Notify Contracting Officer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.
- B. Rock Subgrade: Notify Contracting Officer when rock excavation has reached subgrade level and when rock subgrade has been prepared and cleaned.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
- B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.
- D. Maintain prepared ground surface in finished condition until next course is placed.

3.01 BEDROCK SUBGRADE

- A. Excavate to required grades and remove overlying soils, dirt, debris, mud, and loose disturbed material.
- B. Protect prepared Bedrock Subgrade from disturbance, contamination, loosening of rock blocks. If subgrade damage, contamination, or deterioration occurs, complete additional excavation and subgrade preparation to relatively undisturbed bedrock.

- C. Remove loose blocks or pieces disturbed during excavation to expose undisturbed bedrock subgrade.
- D. Clean subgrade with pressurized water, pressurized air, or other means to remove soil, film, mud, debris, or other loose material.
- E. Obtain Contracting Officer's approval of subgrade and maintain prepared subgrade in clean prepared condition until concrete placement is complete.

3.02 COMPACTION

- A. Under Riprap: Scarify to 6-inches below subgrade and compact upper 6 inches to minimum of 90 percent relative compaction as determined in accordance with ASTM D1557 Method.
- B. Aggregate Base for Low Water Crossing on Soil Subgrade: Scarify and compact the upper 10 inches to minimum of 92 percent relative compaction as determined in accordance with ASTM D1557 Method.
- C. Under Roadway:
 - 1. Subgrade soil and fill should be moisture treated within 2 percent of the optimum moisture content and compacted to a dense and unyielding condition and at least 95 percent of maximum dry density determined in accordance with AASHTO T180 (modified compaction effort).
 - 2. The compacted surface should be proof rolled with a fully loaded, tandem-axle, 10-yard dump truck or equivalent. Compaction to be approved by Contracting Officer.
 - a. If the Contracting Officer identified area as being loose, soft, or yielding during proof-rolling, these areas of the subgrade should be improved by further compaction or overexcavation to bedrock.

3.03 MOISTURE CONDITIONING

- A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.
- B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

- A. Bedrock Subgrade: Inspect completed cleaned subgrade using a pry bars, steel rod, rock hammer, or similar tools to inspect for loose rock blocks, soft zones, or areas of disturbance.

B. Soil Subgrade:

1. In-place density test in accordance with ASTM D6938. Test as follows:
 - a. One test every 1,000 square feet of subgrade.
 - b. Minimum of one test for each structure having a footprint greater than 500 square feet.

C. Additionally, in areas determined by the Contracting Officer, proof-roll subgrade with equipment specified in Article Compaction, to detect soft or loose subgrade or unsuitable material, as determined by Contracting Officer.

3.05 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact.
2. Overexcavate subgrade material as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation that meet the requirement for earth backfill material as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Overexcavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan, Detailing:
 - a. Methods and sequencing of excavation.
 - b. Proposed locations of stockpiled excavated material.
 - c. Proposed onsite and offsite spoil disposal sites.
 - d. Numbers, types, and sizes of equipment proposed to perform excavations.
 - e. Anticipated difficulties and proposed resolutions.
 - f. Temporary excavation slopes.
2. Excavation Equipment Technical Data Including:
 - a. Manufacture information for crawler excavator to be used for soil including:
 - 1) Manufacture.
 - 2) Model number.
 - 3) Flywheel power.
 - 4) Operating weight.
 - 5) Bucket size and type.
 - b. Manufacture information for hydraulic hammer to be used for rock breaking/loosening including:
 - 1) Manufacture.
 - 2) Model number.
 - 3) Working weight.
 - 4) Impact frequency.
 - 5) Impact energy.

1.02 QUALITY ASSURANCE

- A. Provide adequate survey control to avoid unauthorized over excavation.**

1.03 WEATHER LIMITATIONS

- A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.**
- B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.**

1.04 SEQUENCING AND SCHEDULING

- A. Excavate only after adequate erosion and sediment controls are in place and in accordance with Section 01 57 13, Temporary Erosion and Sediment Control.
- B. Clearing, grubbing, and stripping for vegetation and soil management, refer to Section 01 35 00, Environmental Protection and Special Controls.
- C. Excavation Support: Install and maintain as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.
- B. All disturbed rock should be removed. If this results in over excavation then backfill per Section 31 23 23, Fill and Backfill.
- C. If unsuitable material below subgrade and beneath embankment areas is encountered, or subgrade cannot be compacted to a firm and stable condition, over excavate and backfill per Section 31 23 23, Fill and Backfill. Do not over excavate without written authorization of Contracting Officer.
- D. Remove or protect obstructions as shown, as directed by Contracting Officer, and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.
- E. Use of explosives is not allowed for excavation.
- F. Use of expansive compounds shall be approved by the Contracting Officer.

3.02 TRENCH WIDTH

- A. Maximum Trench Width: 36 inches greater than the outside diameter or width of pipe.

3.03 EMBANKMENT AND CUT SLOPES

- A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross sections shown, with proper allowance for topsoil or slope protection, where shown.
- B. Remove loose stones and rock that exceed 3-inch diameter. Remove exposed roots from cut slopes.
- C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.
- D. Install soil stabilization and erosion protection measures as specified in Section 01 57 13, Temporary Erosion and Sediment Controls, immediately upon completion of embankments or cut slopes.

3.04 STOCKPILING EXCAVATED MATERIAL

- A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
- B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
- C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.
- D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
- E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could cause damage by structural failure or settlement.

3.05 DISPOSAL OF SPOIL

- A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.
- B. Dispose of debris resulting from removal of organic matter as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

- C. Dispose of debris resulting from removal of trash, refuse and junk as specified in Section 01 74 19, Construction Waste Management and Disposal.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. D75, Standard Practice for Sampling Aggregates.
 - b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - c. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

- A. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.
- B. Completed Course: A course or layer that is ready for next layer or next phase of Work.
- C. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.
- D. Geosynthetics: Geotextiles, geogrids, or geomembranes.
- E. Imported Material: Materials obtained from sources offsite, suitable for specified use.
- F. Influence Area:
 1. Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
 - a. 1 foot outside outermost edge at base of foundations or slabs.
 - b. 1 foot outside outermost edge at surface of roadways or shoulder.
 - c. 0.5 foot outside exterior at spring line of pipes or culverts.
- G. Lift: Loose (uncompacted) layer of material.
- H. Optimum Moisture Content:
 1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.
- I. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.
- J. Relative Compaction:
 1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
 2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Contracting Officer.
- K. Well-Graded:
 1. A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:
 - a. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
 - b. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

1.03 SUBMITTALS

- A. Action Submittals:
 1. Gradation Test Results for Imported Materials.
 2. Gradation Test Results for Processed Earthfall material.
 3. Samples: Imported material taken at source in accordance with ASTM D75.
- B. Informational Submittals:
 1. Manufacturer's data sheets for compaction equipment.
 2. Certified test results from independent testing agency for all grain size analysis, relative compaction tests, and all other test results obtained by the testing laboratory.

1.04 QUALITY ASSURANCE

A. Notify Contracting Officer when:

1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Access road is ready for backfilling and when backfilling operations are resumed after a period of inactivity.
3. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
4. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.
- B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Contracting Officer's acceptance of concrete work and attained strength prior to placing backfill.
- C. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

- A. Gradation Tests: As necessary to locate acceptable sources of imported material.
- B. Samples: Collected in accordance with ASTM D75. Clearly mark to show source of material and intended use.

2.02 PROCESSED EARTH BACKFILL

- A. Physical Characteristics: On-site excavated material free of organic material, clay balls, and debris and a maximum particle size of 3-inches.
- B. Functional Characteristics: None.
- C. Performance Characteristics: None.

2.03 GRANULAR FILL

A. Physical Characteristics:

1. 1-inch minus crushed gravel or crushed rock.
2. Free from dirt, clay balls, debris, rock fragments larger than 3 inches, and organic material.

B. Functional Characteristics: None.

C. Performance Characteristics: Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

D. Excavated bedrock, that has been crushed, processed to meet the above requirements, and approved by Contracting Office can be used as Granular Fill.

2.04 WATER FOR MOISTURE CONDITIONING

A. Physical Characteristics: None.

B. Functional Characteristics: Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

C. Performance Characteristics: None.

2.05 AGGREGATE BASE

A. As specified in Section 32 11 23, Aggregate Base and Subbase Course(s).

2.06 FOUNDATION STABILIZATION ROCK

A. Physical Characteristics:

1. Crushed rock or pit run rock.
2. Uniformly graded from coarse to fine.
3. Maximum 2-1/2-inch particle size.

B. Functional Characteristics: Free from excessive dirt and other organic material.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.
- E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 2 feet above top of item to be laid.
 - 2. Excavate trench for installation of item.
 - 3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
 - 4. Install item.
 - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.
- F. Tolerances:
 - 1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.
- G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 QUALITY CONTROL TESTING

A. Gradation:

1. One sample from each 1,000 tons of finished product or more often as determined by Contracting Officer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.
4. Minimum Number of Tests: Three Tests per product.

B. Laboratory Moisture Density Test: Perform no less than two tests for each material with additional tests for each 100 in-place moisture density tests performed. Tests will also be conducted when noticeable material differences are observed.

C. In-Place Density Tests:

1. In accordance with ASTM D6938. During placement of materials, test as follows:
 - a. One test per 2,500 square feet for any lift covering areas greater than or equal to 2,500 square feet.
 - b. Minimum of one test for each structure having a footprint greater than 1,000 square feet.

3.03 BACKFILL UNDER AND AROUND STRUCTURES

- A. Within influence area beneath concrete slabs, pavements, and culverts, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.
- B. Other Areas: Backfill with processed earth backfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 12-inch maximum thickness and compact each lift to minimum 92 percent relative compaction as determined in accordance with ASTM D1557.

3.04 FILL

- A. Outside Influence Areas Beneath Access Road, Connector Road, Structures, and Culverts:
 1. Unless otherwise shown, place processed earth backfill as follows:
 - a. Allow for 3-inch topsoil for seeding areas.

- b. Maximum 6-inch thick lifts.
- c. Place and compact fill across full width of embankment.
- d. Compact to minimum 92 percent relative compaction as determined in accordance with ASTM D1557.
- e. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.05 AGGREGATE BASE, SUBBASE, AND GRAVEL SURFACING

- A. Place and Compact as specified in Section 32 11 23, Aggregate Base and Subbase Course(s).

3.06 REPLACING OVEREXCAVATED MATERIAL

- A. Replace excavation carried below grade lines shown or established by Contracting Officer as follows:
 - 1. Beneath Footings: Concrete of strength equal to that of respective footing, as specified in Section 03 30 00, Cast-in-Place Concrete.
 - 2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
 - 3. Beneath Slabs-On-Grade: Granular fill.
 - 4. Trenches:
 - a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe bedding material or CLSM, as specified in Section 31 23 23.15, Trench Backfill.
 - b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
 - 5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
 - a. Flat to Moderate Steep Slopes (3:1, Horizontal Run:
 - 1) Vertical Rise or Flatter): Processed Earth Backfill.
 - b. Steep Slopes (Steeper than 3:1):
 - 1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
 - 2) Backfilling overexcavated areas is prohibited, unless in Contracting Officer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earth backfill.
 - 6. Within Embankment Fill: Use embankment fill material.

3.07 EROSION AND DUST CONTROL

- A. Perform fill and backfill operations to minimize erosion and dust transport.
- B. Provide additional protective measures to prevent sediment and dust from being removed from Site.
- C. Provide equipment or stabilize areas to prevent dust.

END OF SECTION

SECTION 31 23 23.15 TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
 - a. C33/C33M, Standard Specification for Concrete Aggregates.
 - b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - e. C150/C150M, Standard Specification for Portland Cement.
 - f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
 - h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
 - j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 - p. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

- A. Base Rock: Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material: Granular material upon which pipes are placed.
- C. Earth Backfill: Native on-site material for backfill around and above the pipes above the bedding material.
- D. Imported Material: As defined in Section 31 23 23, Fill and Backfill.
- E. Lift: As defined in Section 31 23 23, Fill and Backfill.
- F. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe.
- G. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.
- H. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.
- I. Selected Backfill Material: Material available onsite that Contracting Officer determines to be suitable for a specific use.
- J. Well-Graded: As defined in Section 31 23 23, Fill and Backfill.

1.03 SUBMITTALS

- A. Action Submittals:
 1. Samples:
 - a. Trench stabilization material.
 - b. Bedding and pipe zone material.
 - c. Granular backfill.
- B. Informational Submittals:
 1. Catalog and manufacturer's data sheets for compaction equipment.
 2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.

3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 GEOTEXTILE

- A. As specified in Section 31 32 19.16, Geotextile.

2.02 TRENCH STABILIZATION MATERIAL

- A. As specified for foundation stabilization rock in Section 31 23 23, Fill and Backfill.

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Unfrozen, friable, and no clay balls, roots, or other organic material.
- B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.
 1. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
 2. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.

2.04 GRANULAR FILL

- A. As specified in Section 31 23 23, Fill and Backfill.

2.05 PROCESSED EARTH BACKFILL

- A. Clean native material obtained from onsite excavations, free from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious material, meeting the following additional requirement.
 1. Cohesionless, free-draining material with 100 percent passing 3-inch sieve, at least 70 percent passing 1-1/2-inch sieve, and less than 15 percent passing No. 200 sieve.
 2. Having a liquid limit less than 30 and a plasticity index less than 6 when tested in accordance with ASTM D4318.

2.06 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.
- B. Materials:
 - 1. Cement: ASTM C150/C150M, Type I or Type II.
 - 2. Aggregate: ASTM C33/C33M, Size 7.
 - 3. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
 - a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
 - 4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.07 GRAVEL SURFACING

- A. As specified in Section 32 11 23, Aggregate Base and Subbase Course(s).

2.08 TOPSOIL

- A. As specified in Section 32 91 13, Soil Preparation.

2.09 SOURCE QUALITY CONTROL

- A. Perform gradation analysis in accordance with ASTM C136 for:
 - 1. Earth backfill.
 - 2. Trench stabilization material.
 - 3. Bedding and pipe zone material.
- B. Certify Laboratory Performance of Mix Designs: Controlled low strength material.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

- A. Water Control:
 - 1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes and pipes. Do not place concrete or lay pipe in water.
 - 2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
 - 3. Provide continuous water control until trench backfill is complete.

- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

- A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, remove loose and disturbed rock, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.
- B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Contracting Officer. Contracting Officer will determine depth of overexcavation, if any required.

3.03 GEOTEXTILE INSTALLATION

- A. Where shown and as specified in Section 31 32 19.16, Geotextile, except as follows:
 - 1. Extend nonwoven geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures, as directed by Contracting Officer.
 - 2. Anchor nonwoven geotextile trench walls prior to placing trench stabilization or bedding material.
 - 3. Provide 24-inch minimum overlap at joints.

3.04 TRENCH STABILIZATION MATERIAL INSTALLATION

- A. Rebuild trench bottom with trench stabilization material.
- B. Place nonwoven geotextile on bottom of trench prior to placing trench stabilization material and anchor the geotextile to trench support to wrap and cover the trench stabilization material after it is placed and compacted.
- C. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.
- D. Compact each lift to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.05 BEDDING

- A. Furnish imported bedding material.
- B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.

- D. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe.
- E. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.
- F. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe.

3.06 BACKFILL PIPE ZONE

- A. Restrain pipe as necessary to prevent their movement during backfill operations.
- B. Place material simultaneously in lifts on both sides of pipe with maximum 6-inch thick lifts.
- C. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.
- D. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor only over area between sides of pipe and trench walls.

3.07 BACKFILL ABOVE PIPE ZONE

- A. General:
 - 1. Process excavated material to meet specified gradation requirements.
 - 2. Adjust moisture content as necessary to obtain specified compaction.
 - 3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
 - 4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
 - 5. Backfill to grade with proper allowances for topsoil, aggregate base course , and pavement thicknesses, wherever applicable.
 - 6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Granular Backfill:

1. Backfill trench above pipe zone with granular backfill in lifts not exceeding 6 inches.
2. Compact each lift to a minimum of 92 percent relative compaction in accordance with ASTM D1557, prior to placing succeeding lifts.
3. The upper 2 feet of trench backfill shall be compacted to a minimum of 95 percent relative compaction in accordance with ASTM D1557.

3.08 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top of backfilled trench to match adjacent depths of topsoil.
- B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.
- C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.
- D. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.
- E. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.10 SITE TESTING

A. In-Place Density Tests:

1. In accordance with ASTM D6938.
2. During placement of materials, test as follows:
 - a. Bedding and Pipe Zone: One test each 500 cubic yards.
 - b. Backfill Above Pipe Zone: One test each 500 cubic yards.

B. Atterberg Limit Tests:

1. In accordance with ASTM D4318.

2. For processed earth backfill above pipe zone, test as follows:
 - a. Minimum of one test each 500 cubic yards, or more often as determined by the Contracting Officer, if variation in material is occurring, or if material appears to depart from specifications.

3.11 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 32 19.16 GEOTEXTILE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): M 288, Geotextiles.
2. ASTM International (ASTM):
 - a. D737, Standard Test Method for Air Permeability of Textile Fabrics.
 - b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
 - c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - e. D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
 - f. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - g. D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
 - h. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - i. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - j. D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
 - k. D4886, Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).
 - l. D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
 - m. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
 - n. D6193, Standard Practice for Stitches and Seams.

1.02 DEFINITIONS

- A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.
- B. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.
- C. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.
- D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.
- E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.
- F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings: Manufacturer material specifications and product literature.
- B. Informational Submittals: Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.
- B. Handle products in manner that maintains undamaged condition.
- C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

1.05 SCHEDULING AND SEQUENCING

- A. Where geotextile is to be laid directly upon ground surface, prepare subgrade as specified in Section 31 23 13, Subgrade Preparation, first.

- B. Notify Contracting Officer whenever geotextiles are to be placed. Do not place geotextile without Contracting Officer's approval of underlying materials.

PART 2 PRODUCTS

2.01 NONWOVEN GEOTEXTILE

- A. Separation Geotextile: Conform to AASHTO M 288 Table 1, Class 1, and Table 3. Separation geotextiles can be in either the less than 50 percent elongation category (woven) or the greater than or equal to 50 percent elongation (non-woven) category.
- B. Stabilization Geotextile: Conform to AASHTO M 288 Table 1, Class 1, less than 50 percent elongation (woven) only, and AASHTO M 288 Table 5.
- C. Geotextile Filter:
 - 1. Conform to AASHTO M 288 Table 1, Class 1 and Table 6 for riprap and other high survivability applications.
 - 2. Conform to AASHTO M 288 Table 1, Class 2 and Table 2 for underdrains and other subsurface drainage applications.
 - 3. Geotextile filter can be in either the less than 50 percent elongation category (woven) or the greater than or equal to 50 percent elongation (non-woven) category.

2.02 SECURING PINS

- A. Steel Rods or Bars:
 - 1. Physical Characteristics:
 - a. 3/16-inch diameter.
 - b. Pointed at one end.
 - c. Minimum Length: 12 inches.
 - 2. Functional Characteristics: With head on other end sufficiently large to retain washer.
 - 3. Performance Characteristics: None.
- B. Steel Washers for Securing Pins:
 - 1. Physical Characteristics:
 - a. Outside Diameter: Not less than 1-1/2 inches.
 - b. Inside Diameter: 1/4 inch.
 - c. Thickness: 1/8 inch.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

C. Steel Wire Staples:

1. Physical Characteristics:
 - a. U-shaped.
 - b. 10 gauge.
 - c. Minimum Length: 6 inches.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

- A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.02 SHEET ORIENTATION ON SLOPES

- A. Orient geotextile with long dimension of each sheet parallel to direction of slope.
- B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and to extend at least 18 inches beyond toe of slope.

3.03 JOINTS

- A. Unseamed Joints:
1. Overlapped.
 2. Overlap, unless otherwise shown:
 - a. Foundation/Subgrade Stabilization: Minimum 18 inches.
 - b. Riprap: Minimum 18 inches.
 - c. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.
 - d. Other Applications: Minimum 12 inches.

3.04 SECURING GEOTEXTILE

- A. Secure geotextile during installation as necessary with sandbags or other means approved by Contracting Officer.

B. Secure Geotextile with Securing Pins or Staples:

1. Insert securing pins with washers through geotextile.
2. Securing Pin Alignment:
 - a. Midway between edges of overlaps.
 - b. 6 inches from free edges.
3. Spacing of Securing Pins:

<u>Slope</u>	<u>Maximum Pin Spacing</u>
Steeper than 3:1	2 feet
3:1 to 4:1	3 feet
Flatter than 4:1	5 feet

4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.
6. Where staples are used instead of securing pins, install in accordance with alignment and spacing above. Push in to secure geotextile firmly to subgrade.

3.05 PLACING PRODUCTS OVER GEOTEXTILE

- A. Before placing material over geotextile, notify Contracting Officer. Do not cover installed geotextile until after Contracting Officer provides authorization to proceed.
- B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.06 INSTALLING GEOTEXTILE IN TRENCHES

- A. Place geotextile in a way to completely envelope granular drain material to be placed in trench and with specified overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.
- B. After granular drain material is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.07 REPAIRING GEOTEXTILE

- A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.
- B. Repair Procedure:
 - 1. Place patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.
 - 2. Remove interfering material as necessary to expose damaged geotextile for repair.
 - 3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Contracting Officer.

3.08 REPLACING CONTAMINATED GEOTEXTILE

- A. Protect geotextile from contamination that would interfere, in Contracting Officer's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

END OF SECTION

SECTION 32 01 90
TREE AND SHRUB PRESERVATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes all work, materials, labor, and equipment necessary to complete the Work of this section, and includes, but is not limited to:
 - 1. Tree and plant protection fencing.
 - 2. Pruning of any damaged limbs.
 - 3. All other tree and plant protection indicated.

1.02 RELATED SECTIONS

- A. Coordinate the Work of this section with the Work of other sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the Work of other sections. Other sections containing related work include but are not limited to the following:
 - 1. Section 01 35 00, Environmental Protections and Special Controls.
 - 2. Section 31 10 00, Site Clearing.

1.03 SUBMITTALS

- A. Proposed methods, materials, and schedule for effecting tree and plant protection shall be submitted for approval.
- B. Certifications: Submit appropriate evidence of certification of all arborists to be employed on the Project.
- C. Licenses: Submit appropriate evidence of licensing of all chemical applicators to be employed on the Project.

1.04 QUALITY ASSURANCE

- A. Work of root pruning, fertilizing, spraying, and similar activities shall be undertaken only by certified Arborists and chemical applicators, as pertinent to the Work being performed.
 - 1. Application of chemicals shall be performed by licensed chemical applicators.
 - 2. Arborist shall be a professional Certified Arborist with a minimum 5 years' experience, who has successfully completed a certification program in the State of Arizona.

1.05 LIABILITY FOR DAMAGES

- A. For Bidding and general Work guidelines prior to onsite tree protection conference, the Contractor shall assume all trees within the Limit of Work shall be saved unless specifically designated to be removed on the Contract Documents.
- B. Damage and/or disturbance to existing adjacent lands beyond the Limit of Work which, in Government's opinion, can be remedied by corrective action shall be repaired immediately to the satisfaction of the Contracting Officer, at no additional cost to the Government.
- C. Damaged trees which require removal and/or replacement shall be removed according to the Specification requirements for removals, including refilling and repair of ground surface, with such costs to be borne by the Contractor in addition to assessed charges described herein.

1.06 PREINSTALLATION MEETINGS

- A. Before the start of any work on the Site, preceding the arrival of equipment, materials or vehicles to the Site, and prior to the commencement of any clearing on the Site, the Contractor shall arrange a preconstruction conference on the Site with the Contracting Officer to identify trees that are to be protected or removed. Do no clearing without a clear understanding of existing conditions to be preserved. In addition to the responsibilities and penalties described in this section, the Contractor shall be held responsible for any and all clearing, damage or destruction to plant material that results from the Contractor's failure to schedule and attend the preconstruction conference onsite prior to any Work.

PART 2 PRODUCTS

2.01 TREE PROTECTION

- A. Level I Fence Protection:
 - 1. Fabric: Fabric (4-foot height) shall consist of orange plastic safety fencing around milkweed plants and trees with 4-inch maximum mesh openings.
 - 2. Installation Posts: Installation posts shall be a minimum of 60 inches long and steel "T" shaped with a minimum weight of 1.3 pounds per linear foot.
 - 3. Tie Wire: Wire for attaching the fabric to the T-posts shall be not less than No. 12-gauge galvanized wire or plastic ties. Sufficient fastening material shall be furnished to provide for the securing of the fabric to the "T" line posts.

4. Used Materials: Previously used materials, meeting the above requirements and when approved by the Contracting Officer, may be used.
- B. Level II Fence Protection: Materials same as Level I.
- C. Other Materials:
 1. Tree Dressing: Asphaltic Tree Wound Paint.

PART 3 EXECUTION

3.01 IDENTIFICATION OF TREES AND PLANTS TO REMAIN

- A. Prior to starting site clearing operations, stake out all areas of trees and milkweed plants to be protected as directed by the Contracting Officer.
- B. Before any clearing is done, the Contractor shall arrange a conference on the Site with the Contracting Officer to identify trees and plants that are to be protected or removed. Do no clearing or cutting of individual trees and plants without clear understanding of existing conditions to be preserved and trees and plants to be saved.
- C. The Contractor shall be responsible for the protection of all existing trees and plants designated to remain for the length of the construction period, including liability for all damages as specified herein. The placement of protection devices additional to those specified shall, however, be at the Contractor's discretion and with no additional cost to the Government.

3.02 PROTECTION OF EXISTING TREES AND PLANTS

- A. The Contractor shall make every effort not to damage existing plant materials to remain. The Contractor is required to install protection as necessary to assure undamaged plant material and adjacent conditions.
- B. Level I Fence Protection:
 1. All trees and shrubs in the proximity of the construction site shall be protected prior to beginning any development activity.
 2. Protective fencing shall be erected outside the dripline at locations shown on the Drawings or as directed by the Contracting Officer. Fencing shall be maintained and repaired by the Contractor during site construction.
 3. The protective fencing shall be erected before Site Work commences and shall remain in place during the entire construction phase. Access to fenced areas will be permitted only with the approval of the Contracting Officer.

4. The installation posts will be placed every 6 feet around the drip line or Root Protection Zone (RPZ) and embedded 12 inches to 18 inches deep. Fabric attachment shall be attached to the installation posts by the use of sufficient ties to securely fasten the fabric to the “T” posts as to hold the fabric in a stable and upright position.
 - a. Do not clear, fill or grade in the RPZ of any tree unless directed by the Contracting Officer.
 - b. Do not store, stockpile or dump any job material, soil or rubbish under the spread of the tree branches.
 - c. Do not park or store any equipment or supplies under the spread of tree branches.
 - d. Do not set up any construction operations under the spread of the tree branches. (such as, pipe cutting).
 - e. Do not nail or attach temporary signs, meters, switches, wires, bracing or any other item to the trees.
 - f. Do not permit runoff from waste materials including solvents, concrete washouts, and asphalt tack coats (MC-30 oil), to enter the RPZ. Barriers are to be provided to prevent such runoff substances from entering the RPZ whenever possible, including in an area where rain or surface water could carry such materials to the root system of the tree.
 5. The Contractor shall avoid cutting roots larger than 1 inch in diameter when excavation occurs near existing trees.
 6. Excavation in the vicinity of trees shall proceed with caution.
 7. Remove all trees, shrubs, or bushes to be cleared from protected root zone areas as by hand.
 8. Trees damaged or lost due to Contractor’s negligence during construction shall be mitigated at the Contractor’s expense and to the Contracting Officer’s satisfaction.
 9. Any tree removal shall be approved by the Contracting Officer prior to its removal.
 10. Cover exposed roots at the end of each day with soil, mulch, or wet burlap.
 11. In critical root zone areas that cannot be protected during construction and where heavy traffic is anticipated, cover those areas with 8 inches of organic mulch to minimize soil compaction. This 8-inch depth of mulch shall be maintained throughout construction.
 12. When installing concrete adjacent to the root zone of a tree, use a plastic vapor barrier behind the concrete to prohibit leaching of lime into the soil. See related specifications.
- C. Level II Fence Protection: Protective fencing shall be erected within the RPZ at locations shown on the Drawings or as directed by the Contracting Officer. Fencing shall be maintained and repaired by the Contractor during site construction.

3.03 PROTECTION MAINTENANCE

- A. After the tree and plant protection has been installed, and the Contracting Officer has inspected and given written approval of the tree and plant protection, will the Contractor be allowed to begin excavation. All tree and plant protection shall be maintained throughout the duration of the Project.
- B. If any fencing, barriers, staking or marking, which designates protected areas limits of demolition or work limits, is knocked down, moved or destroyed by the Contractor, the Contractor will immediately move the work operation to another area, or wholly or in part suspend work operations, until the fence or other protection is repaired to the Contracting Officer's satisfaction at the end of Contractor's expense. Time lost due to such stoppage will not be considered basis for adjustment of completion date nor additional payment.

3.04 ROOT PRUNING WITHIN DRIPLINE OF EXISTING TREE TO REMAIN

- A. Where construction will be near existing trees designated to remain, the Contractor shall do all excavation within the root zones and drip line of the tree by hand using only hand-held equipment. This is to protect the tree from compaction of the root zone due to heavy equipment. This will allow individual major roots of the tree to be exposed without damage. When major roots are uncovered, the Contractor shall notify the Contracting Officer and ask for direction about that specific condition and how the root should be treated.

3.05 WATERING

- A. Existing trees impacted by the construction shall be watered to keep the ground damp in periods of no rain within a week period of time. This condition shall be for the length of the entire Contract unless the temperature drops to less than 40 degrees.

3.06 REMOVAL OF TREE AND PLANT PROTECTION MATERIAL

- A. Contractor shall remove and discard in a legal manner all tree and plant protection material, excavated soil, pruned vegetation and all debris and trash from the Site at the completion of the Contract.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE AND SUBBASE COURSE(S)

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C29, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
 - b. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - c. C117, Standard Method of Test for Materials Finer Than 75 μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - d. C131, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - e. C183, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
 - f. D75, Standard Practice for Sampling Aggregates.
 - g. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³)).
 - h. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³ (2700 kN-m/m³)).
 - i. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
 - j. D2216, Standard Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
 - k. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - l. D2844, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
 - m. D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 - n. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
 - o. D5195, Standard Test Methods for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.
 - p. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T 11, Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. T 27, Sieve Analysis of Fine and Coarse Aggregates.
 - c. T 89, Determining the Liquid Limit of Soils.
 - d. T 90, Determining the Plastic Limit and Plasticity Index of Soils.
 - e. T 96, Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - f. T 180, Moisture-Density Relations of Soils Using a 4.54 kg (10 lb) Rammer and 457 mm (18 in) Drop.
 - g. T 210, Standard Method of Test for Aggregate Durability Index (ASTM D3744/D3744-11a).
 - h. T 335. Determining the Percent of Fracture in Coarse Aggregate.

1.02 DEFINITIONS

- A. Aggregate Base: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.
- B. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.
- C. Completed Lift: Compacted with uniform cross-section thickness.
- D. Gravel Surfacing/Gravel Pullout: Aggregate used for construction of low-volume access and staging area that can be easily graded and compacted.
- E. Specifications: Contract Documents that describe the Work and include the General Conditions, the Technical Specifications, the Supplementary Conditions, and any Reference Specifications incorporated therein.

1.03 SUBMITTALS

- A. Action Submittals:
 1. Samples: Submit for specified materials 20 days prior to delivery to Site.
- B. Informational Submittals:
 1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.
 2. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 AGGREGATE BASE

A. Physical Characteristics:

1. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted. Gradation as specified in Table 1.
2. Crushed Recycled Concrete: Aggregate Base course may consist of crushed recycled concrete consisting of previously hardened Portland cement concrete or other concrete containing pozzolanic binder material. Provide recycled material free of all reinforcing steel, bituminous concrete surfacing, and any other foreign material, crushed and processed to meet Gradation as specified in Table 1. Crushed material may be blended with native aggregate.

Table 1					
Aggregate Base Gradation					
Percent Passing Sieve					PI Max.
1	3/4	1/4	8	200	
100	90 - 100		35 - 55	0 - 0.8	3
Notes: (1) The percentage, by weight, passing each sieve will be determined in accordance with the requirements of Arizona Test Method 201. (2) The PI (Plasticity Index) will be determined in accordance with the requirements of AASHTO T 90. (3) The amount of fractured coarse aggregate particles shall be at least 30 percent, when tested in accordance with the requirements of Arizona Test Method 212. (4) Resistance to abrasion will be determined in accordance with the requirements of AASHTO T 96 and shall meet the following requirements: Maximum loss of 9 percent at 100 revolutions. Maximum loss of 40 percent at 500 revolutions.					

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.02 GRAVEL SURFACING/GRAVEL PULLOUT

- A. Same as for aggregate base.

2.03 SOURCE QUALITY CONTROL

- A. Physical Characteristics: None.
- B. Functional Characteristics:
 - 1. Perform tests necessary to locate acceptable source of materials meeting specified requirements.
 - 2. Final approval of aggregate material will be based on test results of installed materials.
- C. Performance Characteristics: Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. As specified in Section 31 23 13, Subgrade Preparation.
- B. Obtain Contracting Officer's acceptance of subgrade before placing base course or surfacing material.
- C. Do not place base course or surfacing materials in snow or on soft, muddy, subgrade.

3.02 EQUIPMENT

- A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

- A. Hauling Materials:
 - 1. Do not haul over surfacing in process of construction.
 - 2. Loads: Of uniform capacity.
 - 3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway or prepared surface without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 CONSTRUCTION OF COURSES

A. Aggregate Base:

1. Maximum Completed Lift Thickness: As shown.
2. Spread lift on preceding course to required cross-section.
3. Lightly blade and roll surface until thoroughly compacted.
4. Add keystone to achieve compaction and as required when aggregate does not compact readily because of lack of fines or natural cementing properties, as follows:
 - a. Use surfacing material as keystone.
 - b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
 - c. Roll surface until keystone is worked into interstices of aggregate base without excessive displacement.
 - d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
5. Blade or broom surface to maintain true line, grade, and cross-section.

B. Gravel Surfacing/Gravel Pullout:

1. Maximum Completed Lift Thickness: As shown.
2. Spread on preceding course in accordance with cross-section shown.
3. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

- A. Commence compaction of each layer of base course gravel surfacing after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by ASTM D1557.
- B. Commence rolling at outer edges and continue toward center; do not roll center of road first.
- C. Apply water as needed to obtain specified densities.

- D. Place and compact each lift to the required density before succeeding lift is placed.
- E. Remove floating or loose stone from surface of preceding course before placing next course.
- F. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.
- G. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

- A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.
- B. Finished Surface of Untreated Aggregate Base: Within plus or minus 0.04 foot of grade shown at any individual point.
- C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.
- D. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.07 FIELD QUALITY CONTROL

- A. In-Place Density Tests:
 - 1. Provide Contracting Officer at least 24 hours' advance notification prior to testing.
 - 2. Show proof that areas meet specified requirements before identifying density test locations.
 - 3. Refer to Table 2 for minimum sampling and testing requirements for aggregate base and gravel surfacing/gravel pullout.

Table 2 Minimum Sampling and Testing Requirements			
Property	Test Method	Frequency	Sampling Point
Gradation	ASTM C117and ASTM C183	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing

Table 2 Minimum Sampling and Testing Requirements			
Property	Test Method	Frequency	Sampling Point
Moisture Density (Maximum Density)	ASTM D1557, Method D	One test for every aggregate grading output produced or stockpile	Production output or stockpile
In-Place Density and Moisture Content	ASTM D5195, ASTM D6938, and ASTM D2216 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

3.08 CLEANING

- A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

SECTION 32 12 16 ASPHALT PAVING

PART 1 GENERAL

1.01 SUMMARY

- A. Work under this section includes constructing one or more courses of asphalt pavement. Furnish all labor, material, equipment, tools, transportation and supplies necessary to complete the work according to the Contract.
- B. Furnish asphalt pavement mixture (pavement) composed of mineral aggregate, performance graded asphalt binder (PGAB), recycled asphalt, mineral filler, antistrip additives and, if applicable, manufactured warm mix asphalt (WMA) additive and/or WMA plant process modifications. Pavements must be mixed in a central mixing plant and placed on a prepared surface(s) in accordance with these specifications. Use an aggregate mix and asphalt binder of a quality conforming to those normally used and approved locally by either Federal or State agencies, within the last 12 months, for the type of work being constructed.
- C. Related Sections:
 - 1. Section 31 23 13, Subgrade Preparation.
 - 2. Section 31 23 23, Fill and Backfill.
 - 3. Section 32 11 23, Aggregate Base and Subbase Course(s).
- D. Measurement Procedures:
 - 1. Surface preparation and asphalt emulsion for tack coat, as required by the Drawings and these specifications, will not be measured separately for payment. It will be included in the price of the asphalt pavement in place.
 - 2. Asphalt pavement will be measured by the lump sum for all work required. Work constructed outside of the planned lines and grades, or exceeding the dimensions as detailed in the Contract, will not be measured for payment.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M156, Standard Specification for Requirements for Mixing Plants for Hot-mixed, Hot-laid Bituminous Paving Mixes.

- b. M320, Standard Specification for Performance-Graded Asphalt Binder.
 - c. R26, Standard Practice for Certifying Suppliers of Performance-Graded Asphalt Binders.
 - d. R35, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt.
 - e. T11, Standard Method of Test for Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - f. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
 - g. T84, Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate.
 - h. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
 - i. T166, Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Mixtures Using Saturated Surface-Dry Specimens.
 - j. T209, Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA).
 - k. T245, Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus.
 - l. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Hot Mix Asphalt (HMA) by Means of Hveem Apparatus.
 - m. T247, Standard Method of Test for Preparation of Test Specimens of Hot Mix Asphalt (HMA) by Means of California Kneading Compactor.
 - n. T255, Standard Method of Test for Total Evaporable Moisture Content of Aggregate by Drying.
 - o. T283, Standard Method of Test for Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage.
 - p. T308, Standard Method of Test for Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method.
 - q. T312, Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of a Superpave Gyratory Compactor.
- 2. ASTM International (ASTM):
 - a. D2950, Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
 - b. D7227, Standard Practice for Rapid Drying of Compacted Asphalt Mixture Specimens Using Vacuum Drying Apparatus.
 - 3. Arizona Department of Transportation (ADOT):
 - a. Materials Testing manual, Sampling and Testing Procedures.
 - b. ARIZ 815d, Marshal Mix Design Method of Asphalt Concrete.

1.03 DEFINITIONS

- A. Blotter: Sound durable particles of gravel or crushed stone used to absorb excess emulsified asphalt on newly paved asphalt surfaces.
- B. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.
- C. EASL: Equivalent Single Axle Load.
- D. Fog Seal: Thin coat of emulsified asphalt applied to the surface of the final lift of the paved asphalt to help seal the surface.
- E. Maximum Aggregate Size: One sieve size larger than the nominal aggregate size.
- F. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.
- G. Reclaimed Asphalt Pavement (RAP): Removed and/or processed pavement materials containing binder and aggregate.
- H. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.
- I. Warm Mix Asphalt (WMA): Generic term used to describe reduction in production, paving and compaction temperatures achieved through application of one or combination of several WMA technologies. Technologies involve HMA plant foaming processes and equipment, mineral additives, or chemicals that allow reduction of mix production to temperatures between 185 degrees F to 275 degrees F (85 degrees C to 135 degrees C).

1.04 DESIGN REQUIREMENTS

- A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of this specification.
- B. Design Criteria:
 - 1. Mix design aggregate grading limits in Table 1.
 - 2. Aggregate Characteristics in Table 2.

Table 1	
Mix Design Grading Limits Aggregate Surfacing Material	
Sieve Size	Gradation F
1 inch	-

Table 1 Mix Design Grading Limits Aggregate Surfacing Material	
Sieve Size	Gradation F
3/4 inch	100
1/2 inch	-
3/8 inch	62 to 90
No. 4	36 to 74
No. 10	-
No. 40	12 to 26
No. 200	4 to 7
Notes: Values shown are percent passing the sieve. From FP-24 (U.S. Department of Transportation and Federal Highway Administration, 2024). “-” = no requirement.	

Table 2 Aggregate Characteristics		
Characteristic	Test Method	Requirement
Combined Bulk Oven Dry Specific Gravity	Arizona Test Method 251	2.350 – 2.850
Combined Water Absorption	Arizona Test Method 251	0 – 2.5%
Sand Equivalent	Arizona Test Method 242 (After thoroughly sieving the sample, no additional cleaning of the fines from the plus No. 8 material is required.)	Minimum 55
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Minimum 85% (at least two fractured faces) and minimum 92% (at least one fractured face)
Flakiness Index	Arizona Test Method 233	Maximum 25%
Carbonates	Arizona Test Method 238	Maximum 20%
Abrasion	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%

1.05 WMA MIX CRITERIA

- A. Meet all the requirements for HMA.
- B. Binder grade shall be the same as for hot-mix asphalt (HMA) unless production temperatures are less than 100 degrees F lower than HMA, in which case a one-bump higher grade binder shall be used.
- C. 95 percent coating of coarse aggregate as determined by ASTM D2489.

D. Gyration ratio of less than 1.25 by comparing number of gyrations to reach 92 percent relative density described below:

1. Relative Density shall be determined using AASHTO T166, AASHTO T209, and AASHTO T312.
2. Gyration Ratio (GR) is determined by the following equation:

$$GR = (N92)T-54/(N92)T$$

where: (N92)T-54 = gyrations to 92 percent relative density at 54 degrees F below the planned field compaction temperature
(N92) = gyrations to 92 percent relative density at the planned field compaction temperature.

1.06 SUBMITTALS

A. Action Submittals:

1. Samples:
 - a. Sample per ASTM D140 and ASTM D195.
 - b. Core Samples of Compacted Asphalt Concrete: 4 inches (100 millimeters).

B. Informational Submittals:

1. Asphalt Concrete Mix Formula:
 - a. Submit minimum of 15 days prior to start of production.
 - b. Submittal to include the following information:
 - 1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
 - 2) Bulk specific gravity for each aggregate constituent.
 - 3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
 - 4) Properties as stated in this section for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
 - 5) Percent of asphalt lost due to absorption by aggregate.
 - 6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
 - 7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
 - 8) Optimum mixing temperature.
 - 9) Optimum compaction temperature.
 - 10) Temperature-viscosity curve of asphalt cement to be used.

- 11) Brand name of any additive to be used and percentage added to mixture.
2. Test Report for Asphalt Cement:
 - a. Submit minimum 10 days prior to start of production.
 - b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following materials:
 - a. Aggregate: Gradation, source test results as defined in this section.
 - b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
 - c. Tack Coat: Type and grade of asphalt.
 - d. Additives.
 - e. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
 - a. Mix design.
 - b. Asphalt concrete core.
 - c. Gradation and asphalt content of uncompacted mix.
 - d. Field density.
 - e. Quality control.
6. WMA Mix Design Information: All information required per AASHTO R35.

1.07 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329 Rev. A.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F or air temperature is lower than 40 degrees F. Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.
- B. WMA may be applied at temperatures ambient temperatures of 35 degrees F or higher and rising. Provide documentation demonstrating proposed WMA technology can successfully place and compact mix at site temperatures and perform control strip or initial production testing and verification.
- C. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fog Seal:

1. Physical Characteristics: None
2. Functional Characteristics: Emulsified Asphalt for Fog coat:
Grade SS-1, SS-1h, CSS-1, or CSS-1h conforming to AASHTO M=140
or AASHTO M 208.
3. Performance Characteristics: None.

B. Tack Coat:

1. Physical Characteristics: None.
2. Functional Characteristics:
 - a. Emulsified Asphalt for Tack Coat: Grade SS-1, SS-1h conforming
to AASHTO M140.
3. Performance Characteristics: None.

C. Sand for Blotter Material:

1. Physical Characteristics:
 - a. Clean.
 - b. Dry.
 - c. 100 percent passing No. 4 sieve.
 - d. Maximum of 10 percent passing No. 200 sieve.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.02 ASPHALT CONCRETE MIX

A. Physical Characteristics:

1. Hot-plant mix of aggregate.
2. Paving grade asphalt cement with PGAB grade of PG 64-22.
3. The several aggregate fractions shall be:
 - a. Sized.
 - b. Uniformly graded.
 - c. Combined in such proportions that resulting mixture meets
grading requirements of mix formula.
4. Coarse Aggregate:
 - a. Material retained on a No. 8 sieve.
 - b. Minimum 75 percent by weight of individual pieces having two or
more fractured faces, and 90 percent by weight having at least one
fractured face.

5. Fine Aggregate:
 - a. Material passing a No. 8 sieve.
 - b. Clean, sound, durable, angular shaped particles produced by crushing.
6. Natural Sand: May be used to a maximum of 15 percent by weight of total aggregate.

B. Functional Characteristics:

1. Mineral filler if required.
2. Fine Aggregate:
 - a. Plasticity Index: Maximum 6.
 - b. Liquid Limit: Maximum 25, when tested in accordance with ASTM D4318.
3. Mineral Filler: In accordance with AASHTO M17.
4. WMA Information:
 - a. Anti-stripping additives, silicone additives, WMA additives, and WMA technologies used.
 - b. Comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mix.
 - c. Comply with manufacturer's recommendations regarding receiving, storage, and delivery of additives.

C. Performance Characteristics:

1. Mix formula shall not be modified except with written approval of Contracting Officer.
2. Source Changes:
 - a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
 - b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Contracting Officer to confirm that properties are in compliance with design criteria.
 - c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.
3. WMA Information: Maintain supplier recommendations on file at the asphalt mixing plant and make available for reference while producing WMA.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control:

1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
2. Minimize inconvenience to traffic but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

3.02 LINE AND GRADE

- #### **A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.**
- #### **B. Shoulders: Construct to line, grade, and cross-section shown.**

3.03 APPLICATION EQUIPMENT

- #### **A. Use equipment and WMA technologies capable of producing asphalt mixture that meets specification requirements and is workable at the minimum placement and compaction temperature desired, regardless of storage or haul distance considerations.**
- #### **B. Provide haul trucks with insulated beds and waterproof and windproof covers of suitable material and sufficient size to protect WMA from weather. Securely fasten covers to maintain temperature and prevent water from entering truck bed.**

3.04 PREPARATION

A. Prepaving Requirements:

1. Prior to placing any WMA mix, produce a sufficient amount of mix to calibrate the plant and procedures using the approved mix design. Sample and test WMA mix for the following:
 - a. Voids in mineral aggregate (VMA).
 - b. Asphalt binder content.
 - c. Gradation.
 - d. Air voids.
 - e. Tensile strength ratio.
2. Heat WMA field samples, transported to the laboratory, to the field production temperature, or lower, when reheating is required for WMA mixture testing.

- #### **B. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.**

C. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
2. Areas of exposed roadway subgrade shall be scarified to a depth of 8 inches, moisture treated, and recompactd (this treatment is not required where rock is exposed in subgrade).
3. Paint edges of meet line with tack coat prior to placing new pavement.

D. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with this section.

B. Tack Coat:

1. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
2. Do not apply more tack coat than necessary for the day's paving operation.
3. Touch up missed or lightly coated surfaces and remove excess material.
4. Application Rate:
 - a. 0.05 gallon per square yard to 0.15 gallon per square yard of asphalt (residual if diluted emulsified asphalt).
 - b. Apply at rate, within range specified, sufficient to assure good bonding, but not so heavy that surplus asphalt flushes into asphalt concrete being placed.

C. Pavement Mix:

1. Prior to Paving:
 - a. Sweep primed surface free of dirt, dust, or other foreign matter.
 - b. Patch holes in primed surface with asphalt concrete pavement mix.
2. Place asphalt concrete pavement mix in two equal lifts.
3. Compacted Lift Thickness:
 - a. Minimum: Twice maximum aggregate size, but in no case less than 1 inch.
 - b. Maximum: 3 inches.
4. Total Compacted Thickness: As shown.
5. Sequence placement so that meet lines are straight and edges are vertical.

6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
 - a. Offset edge of each layer a minimum of 6 inches so joints are not directly over those in underlying layer.
 - b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
 - c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
9. After placement of pavement, seal meet line by painting a minimum of 6 inches on each side of joint with cutback or emulsified asphalt. Cover immediately with sand.

D. Compaction:

1. Do not overcompact WMA mixtures above a density that will result in less than 3 percent air voids. Carefully monitor compaction procedures to establish rolling patterns and techniques to attain specified density without overcompaction.
2. Roll until roller marks are eliminated and density of 95 percent of measured maximum density at optimum asphalt content determined in accordance with ASTM D2041 is obtained.
3. Joint Compaction:
 - a. Place top or wearing layer as continuously as possible.
 - b. Pass roller over unprotected end of freshly laid mixture only when placing of mix is discontinued long enough to permit mixture to become chilled.
 - c. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
 - d. Cut away waste material and lay new mix against fresh cut.

E. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
2. Completed Surface or Wearing Layer Smoothness:
 - a. Uniform texture, smooth, and uniform to crown and grade.
 - b. Maximum Deviation: 1/8 inch from lower edge of a 12-foot straightedge, measured continuously parallel and at right angle to centerline.
 - c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.

3. Transverse Slope Maximum Deviation: 1/4 inch in 12 feet from rate of slope shown.
4. Finished Grade:
 - a. Perform field differential level survey on maximum 50-foot grid and along grade breaks.
 - b. Maximum Deviation: 0.02 foot from grade shown.

3.06 FIELD QUALITY CONTROL

- A. General: Provide services of approved certified independent testing laboratory to conduct tests.
- B. Field Density Tests:
 1. Perform tests from cores or sawed samples in accordance with AASHTO T166.
 2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
 3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.
- C. Testing Frequency:
 1. Quality Control Tests:
 - a. Asphalt Content, Aggregate Gradation: Once per every 500 tons of mix or once every 4 hours, whichever is greater.
 - b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons or once every 8 hours, whichever is greater.
 2. Density Tests: Once every 500 tons of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 91 13 SOIL PREPARATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes testing and amending onsite soil to meet the specified composition for planting soils.

1.02 RELATED DOCUMENTS

- A. Comply with Section 01 35 00, Environmental Protection and Special Controls, for topsoil salvage.

1.03 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. D557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
 - b. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and other Organic Soils.
 - c. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

1.04 DEFINITIONS

- A. Backfill: The earth backfill used to replace or the act of replacing earth in an excavation.
- B. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- C. Imported Soil: Soil that is transported to Project site for use.
- D. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called “humus” or “soil organic matter.”
- E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- F. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

- G. Surface Soil/Topsoil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called “topsoil”; includes the duff layer.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Topsoil shall be stripped and stockpiled in accordance with Section 31 10 00, Site Clearing.

1.07 SITE CONDITIONS

- A. Environmental Requirements:
 - 1. Do not work soil when moisture content is so great that excessive compaction will occur, when it is muddy, when it is so dry that dust will form in the air, or when clods will not break readily and when it is frozen.
 - 2. Apply water, if necessary, to bring soil to an optimum moisture content for grading.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. Native Topsoil Stripped Under this Contract:
 - 1. Topsoil shall not be moved from the Job Site unless specifically authorized by the Government.
 - 2. Imported topsoil will not be used.

PART 3 EXECUTION

3.01 EXAMINATION

- A. General: Examine Site and verify that conditions are suitable for finish grading Work, and that no defects or errors are present which would interfere with or cause incorrect finish grading Work to occur. Contractor shall advise Government, in writing, of any conditions or defects encountered on Site before or during construction upon which the work of this section depends and which may adversely affect its performance.
- B. Notification of Unsuitable Conditions: Before proceeding with Work, notify Government of unsuitable conditions, discrepancies, or conflicts. Do not

commence work until unsuitable conditions or defects have been evaluated by the Government and corrective measures have been taken.

- C. Soil Preparation: Verify that subsoil preparation Work is complete prior to commencing with topsoil placement.

3.02 PREPARATION

- A. Existing Conditions: Inspect and verify that rough subgrade preparation and elevations conform to grading plans before proceeding with Work of this section.
- B. Protection of Existing Conditions:
 - 1. Use every possible precaution to prevent damage to existing conditions to remain such as structures, utilities, irrigation systems, plant materials and paving on or adjacent to the Site of the Work.
 - 2. Provide barricades, fences, or other barriers to protect existing conditions to remain from damage during construction.
 - 3. Do not store materials or equipment, permit burning, or operate or park equipment within tree protection zones.
 - 4. Submit written notification of conditions damaged during construction to the Government.
- C. Topsoil shall be keyed to the underlying material by scarifying the top 6 inches of subgrade. Remove materials larger than 3 inches from the subsoil surface prior to topsoil placement.
- D. Do not place topsoil on surfaces without prior approval from the Government.

3.03 FIELD ENGINEERING

- A. General:
 - 1. Establish lines and levels, locate, and lay out by instrumentation and similar appropriate means for planting area finish grades.
 - 2. Provide grade stakes and string lines to achieve smooth finish grades with positive surface drainage acceptable to the Government.
- B. Swale Flow Lines, Bottom of Slopes, Top of Slopes and Grade Breaks: Install grade stakes at maximum 20 feet on center.
- C. High Points and Low Points: Provide grade stakes at high points and low points including top of berms, catch basin rims and area drain rims.

3.04 TOPSOIL PLACEMENT AND GRADING

A. Placement:

1. Conditions: Do not place topsoil when either the topsoil or subgrade are frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to proper grading.
2. Where possible, promptly re-distribute stripped topsoil and vegetation so that plants will reestablish and limit the opportunity for exotic invasive species to propagate.
3. Distribution:
 - a. Prior to distribution of topsoil spread any stockpiled subsoil evenly over areas designated for landscape restoration on the Drawings.
 - b. Distribution of topsoil shall be ecologically specific. Stripped and stockpiled topsoil shall be distributed according to the dominant habitat (Housing area, Lodgepole, Mesic Meadow 1, 2, 3, Meadow Edge, Dry Meadow, and Decomposed Granite) from which they originated. Placement of topsoil in as near to its original location will help preserve microorganisms and seeds of native plants.
 - c. Uniformly distribute topsoil in a loose condition over decompacted subsoil areas to provide an effective rooting medium.
 - d. Topsoil shall have an even thickness after natural settlement.
4. Adjust placement of conserved topsoil as directed by the Government in the field.
5. Topsoil placement shall be coordinated with seeding timeframe by Park.

B. Grading:

1. Complete final topsoil grading to:
 - a. The designated lines and grades as shown on the Drawings.
 - b. To match adjoining surface elevations and profiles.
2. Grade soil surface with smooth uniform slope between points where elevations are given.
3. Unless indicated otherwise, slope finish grades to drain surface water away from buildings, walks, paving, and other structures.
4. Slope finish grades to drain surface water to catch basins, area drains, and along indicated flow lines.
5. Grade soil surface smooth to be free of high and low areas that may inhibit surface drainage.
6. Do not cover or slope finish grades toward valve covers, manholes, vaults, hand holes, pull boxes, tracer wire boxes or any other surface feature or structure utilized by the Government.

7. Cut smooth falls to catch basin rim, finish flush.
8. Provide smooth transitions at top and bottom of slopes.

C. Excessive Compaction:

1. Take precautions and use appropriate equipment to prevent topsoil and subgrade compaction.
2. Topsoil shall be loosely placed and free of any compaction from spreading or handling equipment including pickups, heavy equipment, etc., for the full depth.
3. Scarify and regrade areas showing any visible compaction from spreading or handling equipment.

D. Equipment: Use equipment of appropriate size and type to achieve the profiles and smooth soil surface free of high areas, depressions, and equipment tracks.

E. Depressions and Loose Material: Fill and compact any depressions and remove loose material to finish surface true to line and grade, presenting a smooth, compacted, and unyielding surface.

3.05 TOLERANCES

A. Hand Graded Areas:

1. Grade to within 0.03 foot of grades indicated on the Drawings, except bring soil edge surface grades, paving, curbs, and other structures to within 0.01 foot of grades shown on the Drawings.
2. Transition soil edge surface grades along paving, curbs, and other structures to areas of less strict tolerance over 10 feet distance.

B. Machine Graded Areas: Grade to within 0.05 foot of grades indicated on the Drawings.

C. Allowances: Make proper allowances for settlement.

3.06 MAINTENANCE

- A. In accordance with Section 01 57 23, Temporary Storm Water Pollution Prevention, employ erosion and sediment control practices as necessary to prevent soil erosion. Install erosion control measure immediately after placing topsoil.
- B. Permanent revegetation seeding performed by Park. Schedule with Government.

3.07 FIELD QUALITY CONTROL

- A. Aesthetic Acceptance of Grades: Upon completion of finish grading Work, schedule with the Contracting Officer a review to obtain aesthetic acceptance. Provide 5-day advance written notification.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

- A. Maintenance Period: Begin maintenance immediately after each area is planted and continue for a period of 8 weeks after all planting under this section is completed.
- B. Satisfactory Stand:
 - 1. Grass or section of grass of 10,000 square feet or larger that has:
 - a. Not more than 10 percent of total area with bare spots larger than 1 square foot.
 - b. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

- A. Action Submittals:
 - 1. Product labels/data sheets.
 - 2. Mulch: 15-pound sample to be used as a reference for acceptability of Project material.
- B. Informational Submittals: Product cut sheet for netting.
- C. No submittal needed for seeding. All seed furnished by the Government.

1.03 DELIVERY, STORAGE, AND PROTECTION

- A. Seed: To be provided by the Government.
- B. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

- A. Planting is not permitted during the following conditions, unless otherwise approved:
 - 1. Cold Weather: Less than 32 degrees F.
 - 2. Hot Weather: Greater than 90 degrees F.
 - 3. Wet Weather: Saturated soil or standing water.
 - 4. Windy Weather: Wind velocity greater than 20 mph.

1.05 SEQUENCING AND SCHEDULING

- A. Complete Soil Preparation, before starting Work of this section.
- B. Complete Work under this section within 3 days following completion of soil preparation.
- C. Notify Contracting Officer at least 5 days in advance of:
 - 1. Each material delivery.
 - 2. Start of planting activity.
 - 3. Contractor shall submit requests for seed to the Government 2 weeks prior to need.

1.06 MAINTENANCE SERVICE

- A. The Park will maintain plantings beyond the Maintenance Period.

PART 2 PRODUCTS

2.01 FERTILIZER

- A. No fertilizer will be used in any revegetation work unless requested by the Government. If requested, the Government will specify the composition of the fertilizer.

2.02 SEED

- A. Government will mix and provide all seed for this Project.

2.03 STRAW MULCH

- A. Not used.

2.04 HYDROSEEDING MULCH

- A. Wood Cellulose Fiber Mulch:
 - 1. Physical Characteristics:
 - a. Specially processed wood fiber containing no growth or germination inhibiting factors.
 - b. Dyed a suitable color to facilitate inspection of material placement.
 - 2. Functional Characteristics: When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.
 - 3. Performance Characteristics: Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.

2.05 NETTING

A. Jute:

1. Physical Characteristics:
 - a. Heavy-duty, organic fiber material, twisted, weighing 0.3 pound per square yard.
 - b. Openings Between Strands: Approximately 0.5 inch square.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

B. Plastic: Not used.

C. Matting:

1. Physical Characteristics: Aspen excelsior or coir mat; biodegradable stakes for fastening; netting/backing material must be of natural and biodegradable material such as jute fiber.
2. Functional Characteristics: None.
3. Performance Characteristics: for use on 3H:1V slopes or steeper.

PART 3 EXECUTION

3.01 PREPARATION

A. Grade areas to smooth, even surface with loose, uniformly fine texture.

1. Roll and rake, remove ridges, fill depressions to meet finish grades.
2. Limit such Work to areas to be planted within immediate future.
3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.

B. Remove weeds and weed debris.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

- #### A. No fertilizer will be used in any revegetation work unless requested by the Government. If requested, the Government will specify the composition of the fertilizer.

3.03 SEEDING

- A. Start within 2 days of preparation completion.
- B. Mechanical: Broadcast seed in two different directions. Apply seed at rate of 20 pounds per acre furnished by Government. Lightly rake into topsoil to depth of 1/4 inch to 1/2 inch. Hydroseeding will be allowed upon submittal of a plan, equipment to be used, and approval by the Contracting Officer.
- C. Mulching: Apply uniform cover of wood fiber mulch at minimum rate of 1,500 pounds per acre.
- D. Water: Apply with fine spray after mulching to saturate top 4 inches of soil. Continue watering during the maintenance period to establish germination of the seeds and establishment of the grass.
- E. Netting: Apply mats in accordance with manufacturer recommendation on slopes 3H:1V and steeper.

3.04 FIELD QUALITY CONTROL

- A. The Park will assume responsibility of field quality control at the conclusion of the Contract scope of work.

END OF SECTION

SECTION 33 05 13 MANHOLES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
2. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A48/A48M, Standard Specification for Gray Iron Castings.
 - c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. A536, Standard Specification for Ductile Iron Castings.
 - e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - f. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
 - g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
 - h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - i. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - j. C150/C150M, Standard Specification for Portland Cement.
 - k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - l. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - m. C443, Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
 - n. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - o. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 - p. C990, Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants.
 - q. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

- r. C1311, Standard Specification for Solvent Release Sealants.
- s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- t. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
- u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- v. F594, Standard Specification for Stainless Steel Nuts.

1.02 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings including details of construction, reinforcing and joints, anchors, lifting, external straps, erection inserts, and other items cast into members.
- 2. Product Data:
 - a. Concrete mix design.
 - b. Manhole frame to structure seals.
 - c. Manhole frame to structure anchor bolt.
 - d. Rubber gaskets and sealants.
 - e. External joint wrap.

B. Informational Submittals:

- 1. Experience Record:
 - a. Precast concrete production capabilities.
 - b. Evidence of current PCI plant certification.
- 2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
- 3. Test Reports: Precast manufacturer's concrete test cylinders.
- 4. Manufacturer's recommended installation instructions.
- 5. Field quality control report.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

- 1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years' experience producing precast concrete products of quality specified.
- 2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 GENERAL

- A. Characteristics listed below cover the materials of construction and service conditions for manhole lid and frame adjustments to grade:
1. Physical Characteristics: Manufactured with openings to meet manhole riser, manhole lid and frame dimensions and heights to allow adjustments to within 1/4 inches.
 2. Functional Characteristics:
 - a. Made of materials that have been proven to be resistant to the following exposures and conditions:
 - 1) Gaseous environment in sanitary sewers.
 - 2) Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
 - 3) Temperature ranges, variations, and gradients in construction area.
 - 4) Variations in moisture conditions and humidity.
 3. Performance Characteristics:
 - a. General:
 - 1) Materials shall be compatible with each other and manhole materials.
 - 2) Designed to provide a 20-year service life.
 - b. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.
 - c. Structures:
 - 1) Shall meet requirements of ASTM C478, this specification and the following:
 - a) Loading: AASHTO HS-20.
 - b) Design: In accordance with ACI 301.
 - 2) Concrete:
 - a) Cement: Meet requirements of ASTM C150/C150M.
 - b) Compressive strength:
 - (1) Minimum 4,000 psi.
 - (2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.
 - c) Water/Cement Ratio by Weight:
 - (1) 0.5 maximum.
 - (2) 0.56 maximum, with addition of water reducing agent (in accordance with ASTM 494, Type A).
 - d) Reinforcement: Grade 60, unless otherwise specified.

2.02 PRECAST MANHOLE CONCRETE GRADE RINGS

A. Physical Characteristics:

1. Manhole Extensions:
 - a. Concrete grade rings; maximum 6 inches high.
 - b. Fabricate in accordance with ASTM C478.
 - c. Coat inside exposed surfaces with a bituminous coating.
2. Joint Seal Suppliers and Products:
 - a. Butyl Gaskets:
 - 1) Butyl rubber with dense polymer structure.
 - 2) Tacky outer surface.
 - 3) Flexible rope.
 - b. External Wrap:
 - 1) EPDM Rubber.
 - 2) Non-hardening butyl adhesive.

B. Functional Characteristics: None.

C. Performance Characteristics:

1. Manhole Extensions: Fabricate in accordance with ASTM C478.
2. Coating: Bituminous material designed to protect concrete from hydrogen sulfide corrosion.
3. Joint Seal:
 - a. Butyl Gasket:
 - 1) Conforms to ASTM C990 and AASHTO M198.
 - 2) Resists vapor permeation through the joint.
 - 3) Highly compressible, adhesive.
 - 4) Temperature and aging resistant.
 - b. External Wrap:
 - 1) Provides a watertight seal around manhole, catch basin, or concrete pipe joint.
 - 2) Meets requirements of ASTM C877, Type III and ASTM C923.

2.03 CAST-IN-PLACE MANHOLE SNOWPLOW APRONS

- A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.
- B. Reinforcing Steel: As specified in Section 03 21 00, Steel Reinforcement.

2.04 MANHOLE FRAMES AND COVER ADJUSTING RINGS AND INSERTS

- A. Physical Characteristics: Plane or grind bearing surfaces to ensure flat, true surfaces.
 - 1. Manhole Frame Adjusting Ring: Custom made with openings to meet manhole riser, manhole lid and frame dimensions.
- B. Functional Characteristics:
 - 1. Castings:
 - a. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
 - b. Cast Iron: ASTM A48/A48M Class 35B.
 - c. Ductile Iron: ASTM A536, Grade 60-40-12.
 - 2. Watertight Cover Gasket: Molded from high-quality rubber such as nitrile or EPDM.
- C. Performance Characteristics: None.

2.05 GASKETS:

- A. Physical Characteristics: None.
- B. Functional Characteristics:
 - 1. Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:
 - a. Sanitary sewage.
 - b. Corrosion or rotting under wet or dry conditions.
 - c. Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at installation site.
 - d. Biological environment in soils and sanitary sewers.
 - e. Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
 - f. Temperature ranges, variations, and gradients in construction area.
 - g. Variations in moisture conditions and humidity.
 - h. Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
 - i. Vibrations because of traffic loading.
 - j. Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.
- C. Performance Characteristics: Meet requirements of ASTM C443.

2.06 MORTAR

- A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part Portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.
- B. Admixtures:
 - 1. May be included; do not exceed the following percentages of weight of cement:
 - a. Hydrated Lime: 10 percent.
 - b. Diatomaceous Earth or Other Inert Material: 5 percent.

2.07 BACKFILL AROUND MANHOLE

- A. Fill for roadways as specified in Section 31 23 23, Fill and Backfill.

2.08 SOURCE QUALITY CONTROL

- A. Inspection:
 - 1. Material Quality:
 - a. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
 - b. Sections rejected after delivery shall be removed and replaced.
 - c. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Contracting Officer.
 - d. If structure cannot be repaired it shall be removed and replaced entirely at Contractor's expense.
 - 2. At the time of inspection the sections will be carefully examined for compliance with ASTM C478 and with manufacturer's drawings. Sections will be inspected for general appearance, dimensions, scratch strength, blisters, cracks, roughness, and soundness. Surface shall be dense and close textured.
 - 3. Imperfections may be repaired, subject to approval of Contracting Officer, after demonstration by manufacturer that strong and permanent repairs result.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to Installation Inspect Materials:

1. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Contracting Officer.
3. Remove and replace structure that cannot be repaired.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 23 16, Excavation.

B. Backfill: As specified in Section 31 23 23, Fill and Backfill.

3.03 INSTALLATION OF PRECAST MANHOLES

A. External Joint Wraps: Install in accordance with manufacturer's instructions.

B. Extensions:

1. Provide on manholes in streets or other locations where there is a change in existing grade.
2. Install to height not exceeding 12 inches.
3. Lay grade rings in mortar with sides plumb and tops level.
4. Seal joints with mortar as specified for sections and make watertight.

3.04 MANHOLE FRAMES AND COVERS

A. Install concrete grade rings or ductile iron inserts as required to set covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

B. Set frames in three equally spaced beads of butyl sealant that run full circumference of frame.

C. Anchor frame to manhole with specified bolts.

D. Install interior manhole frame to structure seals in accordance with manufacturer's instructions. Seal shall cover grade rings.

3.05 FIELD QUALITY CONTROL

- A. Watertight fit visually inspected by Contracting Officer.

END OF SECTION

SECTION 33 41 01
STORM DRAIN PIPING

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section and supplemental Data Sheets:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M36, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
 - b. M190, Standard Specification for Asphalt- Coated Corrugated Metal Culvert Pipe and Pipe Arches.

1.02 SUBMITTALS

- A. Informational Submittals:
 - 1. Manufacturer's Certification of Compliance.
 - 2. Manufacturer's data sheets and installation instructions.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

- A. Corrugated Metal Pipe (CMP) Culvert:
 - 1. General:
 - a. Physical Characteristics:
 - 1) Internally label each section of pipe with the manufacturer's name or trademark, nominal diameter, and manufacture date. Include the pipe class, gauge, and coating according to the pipe material type.
 - 2) Place the pipe so that the location of the label is above the spring line of the pipe.
 - b. Performance Characteristics:
 - 1) Provide pipe according to the size, material or interior roughness, and joint type specified.
 - a) Meet the joint requirements of AASHTO PP63 for silt-tight and leak-resistant joints.
 - b) Determine the strength and thickness of the pipe required based on the cover over the pipe. Refer to the Drawings.

- c) Maintain the same type of pipe material, joint, strength, and thickness throughout the entire length of pipe.
- d) Submit the material and manufacturer literature for Contracting Officer review and approval.
- c. Functional Characteristics: None.

B. Steel End Section:

- 1. Physical Characteristics: None.
- 2. Performance Characteristics:
 - a. End Section: Galvanized steel sheeting according to AASHTO M218.
 - b. Smooth Tapered Sleeve, When Required: Galvanized steel sheeting according to AASHTO M218.
 - c. Refer to the Drawings.
- 3. Functional Characteristics: None.

C. Corrugated-steel Pipe and Fittings:

- 1. Physical Characteristics: None.
- 2. Performance Characteristics: Furnish pipe, special sections (such as elbows, branch connections, and prefabricated flared end sections) and coupling bands conforming to AASHTO M36 and either AASHTO M218, AASHTO M274, or AASHTO M289 for the dimensions and thicknesses specified.
- 3. Functional Characteristics: None.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

- 1. Pipe invert may deviate from line or grade up to 1/2 inch for line and 1/4 inch for grade, provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.
- 2. Bed pipe to form continuous and uniform bearing and support for pipe barrel between joints. Do not rest pipe directly on pipe joint.
- 3. Prevent entry of foreign material into gasketed joints.

B. Excavation and Backfill:

1. Perform the work described under Section 31 23 23, Fill and Backfill, and Section 31 23 23.15, Trench Backfill.
2. Keep trenches free from water.
3. Grade and prepare the bottom of the trench to provide a firm and uniform bearing throughout the entire length of the pipe.
 - a. Do not use blocking to bring the pipe to grade.
 - b. Shape the pipe foundation and bedding to have recesses to fit any projecting hubs or bells.
4. Remove and relay or replace pipe that is out of alignment, not joined properly or damaged before placing backfill.

C. Furnish prefabricated steel end sections compatible with the adjoining pipe.

D. Prepare a smooth foundation free of rock and debris, capable of uniformly supporting the end section.

E. Follow manufacturer's recommendations for connecting pipes and for connecting pipe to end sections, concrete headwalls, catch basins, and similar structures.

1. Do not allow pipes of different types of metal to contact each other.

F. Place the end section at the same alignment and slope as the adjoining pipe.

G. Embed the toe plate for steel end sections.

H. Connect the end section to the adjoining pipe according to Metal End Section Detail on Sheet 05C5003.

1. Use a 3/8-inch polychloroprene flat gasket when connecting to a dissimilar metal. Refer to ASTM D1056.

I. Backfill and grade slopes to match the end section.

3.02 POST INSTALLATION PIPE INSPECTION

A. Inspect pipes after installation of pipe, placement of backfill and before placing pavement or finished grade for deflection.

B. Inspection is not required for pipes less than 20 feet in length.

- C. Notify the Contracting Officer at least 24 hours before performing an inspection. Clean and flush the pipe with water immediately before the inspection.
1. Remove and dispose material and debris from pipes.
 2. Observe and document the following:
 - a. Deflection:
 - 1) Take the following measurements every 10 feet along the length of the pipe to the nearest 1/4 inch:
 - a) Vertically from the crown to invert.
 - b) Horizontally at the spring line.
 - c) Two measurements, each diagonally at 45 degrees to the pipe springline.
 - b. Joint Gaps: Measure the widest separation at each joint to the nearest 1/4 inch.
 - c. Damage.

3.03 FIELD QUALITY CONTROL

A. General:

1. Each pipe is accepted for payment after verifying that the following criteria have been met:
 - a. Alignment.
 - b. Deflection.
 - c. Joint gap.
 - d. Damage.
2. Proposed resolutions for nonconforming pipes require the seal of a licensed professional engineer competent in the structural design of the pipe material being evaluated.

- B. Alignment: Do not exceed the installation horizontal and vertical alignment tolerances in Table 1.

Table 1 Installation Alignment Tolerances		
Design Grade	Horizontal	Vertical* Inch/100 feet
>1%	Not to exceed the pipe manufacturer's requirements	1-1/2
0.5% - 1%		1
<0.5%		1/2
* Increase tolerance by 50 percent for pipes with silt tight joints.		

- C. Deflection: Do not exceed a 5 percent shape change from the nominal diameter.
1. Proposals for acceptance of pipes with a deflection greater than 7.5 percent will be rejected.
- D. Joint Gap: Do not exceed the joint separation, measured along the length of pipe, in Table 2.
1. Repair or replace joints that show visible signs of soil or water infiltration.

Table 2 Joint Gap Tolerances	
Nominal Diameter (inches)	Separation (inches)
12 to 36	0.75
42 to 48	1.00

- E. Damage:
1. Pipes are to be free from:
 - a. Punctures.
 - b. Loss or delamination of coatings.

END OF SECTION

