STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION

NEW MEXICO STATE DEPARTMENT OF TRANSPORTATION

2007 EDITION
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101.1 ACTIVE VOICE, IMPERATIVE MOOD

The New Mexico Department of Transportation has rewritten this edition of the *Standard Specifications for Highway and Bridge Construction* with an emphasis on the active voice. In a sentence written in the active voice, someone acts on something. For example: “The engineer will take a sample.” A similar sentence in the passive voice—“A sample will be taken”—would be unclear about who was responsible for taking the sample.

This edition of the *Standard Specifications* also makes use of the imperative mood. The imperative mood is used when the party issuing an instruction and the party receiving it are already understood. In these *Standard Specifications*, the Department is stating its requirements or directions for Work to the Contractor; such statements have the same force as if they contained the word “shall.” In an imperative sentence such as, “Pour the concrete,” the Department is indicating that it requires the Contractor to pour the concrete. Before an award of a Contract, imperative statements are directed to the Bidder. After a Contract has been awarded, imperatives are directed to the Contractor.

The Department will identify parties other than the Bidder or Contractor to whom it gives a responsibility in these *Standard Specifications*. In phrasings where the responsible party has already been clearly identified or in factual statements when it is not important to do so, the Department may use the passive voice.

101.2 ABBREVIATIONS

When the following abbreviations are used in the Plans, the specifications, other Contract documents, and Department correspondence, their meaning is as follows:

<table>
<thead>
<tr>
<th>Acronym or short form</th>
<th>Full name or meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ACI</td>
<td>American Concrete Institute</td>
</tr>
<tr>
<td>AI</td>
<td>Aggregate Index</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AWG</td>
<td>American Wire Gauge</td>
</tr>
<tr>
<td>AWPA</td>
<td>American Wood Preservers' Association</td>
</tr>
<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
</tr>
<tr>
<td>CBC</td>
<td>concrete box culvert</td>
</tr>
<tr>
<td>CCD</td>
<td>closed circuit detection</td>
</tr>
<tr>
<td>CD</td>
<td>Compact Disc</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CMP</td>
<td>corrugated metal pipe</td>
</tr>
<tr>
<td>CN</td>
<td>control number</td>
</tr>
<tr>
<td>CPM</td>
<td>Critical Path Method</td>
</tr>
<tr>
<td>CTR</td>
<td>certified test report</td>
</tr>
<tr>
<td>EA</td>
<td>Entrance Angle</td>
</tr>
<tr>
<td>ESAL</td>
<td>equivalent single axle loading</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
</tr>
<tr>
<td>HDPE</td>
<td>high density polyethylene</td>
</tr>
<tr>
<td>HFE</td>
<td>high-float emulsion</td>
</tr>
<tr>
<td>HID</td>
<td>high-intensity discharge</td>
</tr>
<tr>
<td>HMA</td>
<td>hot-mix asphalt</td>
</tr>
<tr>
<td>HMWM</td>
<td>high molecular weight methacrylate</td>
</tr>
<tr>
<td>IES</td>
<td>Illuminating Engineering Society</td>
</tr>
<tr>
<td>IMC</td>
<td>intermediate metallic conduit</td>
</tr>
<tr>
<td>ITE</td>
<td>Institute of Transportation Engineers</td>
</tr>
<tr>
<td>JMF</td>
<td>job mix formula</td>
</tr>
<tr>
<td>LCD</td>
<td>liquid crystal display</td>
</tr>
<tr>
<td>LL</td>
<td>Liquid Limit</td>
</tr>
</tbody>
</table>
### Table 101.2:1
**Acronyms and Abbreviations**

<table>
<thead>
<tr>
<th>Acronym or short form</th>
<th>Full name or meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSDS</td>
<td>Material Safety Data Sheet</td>
</tr>
<tr>
<td>MTR</td>
<td>mill test report</td>
</tr>
<tr>
<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>NCHRP</td>
<td>National Cooperative Highway Research Program</td>
</tr>
<tr>
<td>NEC®</td>
<td>National Electrical Code®</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
<tr>
<td>NMDA</td>
<td>New Mexico Department of Agriculture</td>
</tr>
<tr>
<td>NMED</td>
<td>New Mexico Environment Department</td>
</tr>
<tr>
<td>NMSA</td>
<td>New Mexico Statutes Annotated</td>
</tr>
<tr>
<td>NMSSPWC</td>
<td>New Mexico Standard Specifications for Public Works Construction</td>
</tr>
<tr>
<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
</tr>
<tr>
<td>NTSC</td>
<td>National Transmission Standards Committee</td>
</tr>
<tr>
<td>OA</td>
<td>Observation Angle</td>
</tr>
<tr>
<td>OGFC</td>
<td>open-graded friction course</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>PCG</td>
<td>portland cement concrete</td>
</tr>
<tr>
<td>PCCP</td>
<td>portland cement concrete pavement</td>
</tr>
<tr>
<td>PCI</td>
<td>Prestressed Concrete Institute</td>
</tr>
<tr>
<td>PCT</td>
<td>Process Control Technician</td>
</tr>
<tr>
<td>PE-P</td>
<td>penetrating emulsified prime</td>
</tr>
<tr>
<td>PI</td>
<td>Plasticity Index</td>
</tr>
<tr>
<td>PTL</td>
<td>Private Testing Laboratory</td>
</tr>
<tr>
<td>PVC</td>
<td>polyvinyl chloride</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>QC</td>
<td>Quality Control</td>
</tr>
<tr>
<td>QCT</td>
<td>Quality Control Technician</td>
</tr>
<tr>
<td>QLA</td>
<td>Quality Level Assurance</td>
</tr>
<tr>
<td>RAP</td>
<td>reclaimed asphalt pavement</td>
</tr>
<tr>
<td>SSPC</td>
<td>Society of Protective Coating (formerly Steel Structures Painting Council)</td>
</tr>
<tr>
<td>SWPPP</td>
<td>Storm Water Pollution Prevention Plan</td>
</tr>
<tr>
<td>TERO</td>
<td>Tribal Employment Rights Organization</td>
</tr>
<tr>
<td>TTCP</td>
<td>Technician Training and Certification Program</td>
</tr>
<tr>
<td>TV</td>
<td>target value</td>
</tr>
<tr>
<td>UBC™</td>
<td>Uniform Building Code™</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories</td>
</tr>
<tr>
<td>UV</td>
<td>ultraviolet</td>
</tr>
<tr>
<td>VMA</td>
<td>voids in mineral aggregate</td>
</tr>
<tr>
<td>VTM</td>
<td>voids in total mix</td>
</tr>
</tbody>
</table>

### 101.3 SYMBOLS

Within the specifications and Contract, reference to the English system of measurement symbols is a reference to the U.S. Customary (Inch-pound) system.

Some of the symbols for units of measurement used in the specifications and in the Bid Form are defined as shown in Table 101.3:1, “Measurement Symbols.” The symbols for other units of measurement used in the specifications are as defined in the various specifications and tests referenced in the specifications.
Table 101.3:1
Measurement Symbols

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<tr>
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<th>Unit name</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>microinch</td>
<td>µin</td>
</tr>
<tr>
<td></td>
<td>mil (0.001 inch)</td>
<td>mil</td>
</tr>
<tr>
<td></td>
<td>inch</td>
<td>in</td>
</tr>
<tr>
<td></td>
<td>foot</td>
<td>ft</td>
</tr>
<tr>
<td></td>
<td>yard</td>
<td>yd</td>
</tr>
<tr>
<td></td>
<td>mile</td>
<td>mi</td>
</tr>
<tr>
<td></td>
<td>square inch</td>
<td>in²</td>
</tr>
<tr>
<td></td>
<td>square foot</td>
<td>ft²</td>
</tr>
<tr>
<td></td>
<td>square yard</td>
<td>yd²</td>
</tr>
<tr>
<td></td>
<td>square mile</td>
<td>mi²</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>pinter</td>
<td>pt</td>
</tr>
<tr>
<td></td>
<td>quart</td>
<td>qt</td>
</tr>
<tr>
<td></td>
<td>gallon</td>
<td>gal</td>
</tr>
<tr>
<td></td>
<td>cubic inch</td>
<td>in³</td>
</tr>
<tr>
<td></td>
<td>cubic foot</td>
<td>ft³</td>
</tr>
<tr>
<td></td>
<td>cubic yard</td>
<td>yd³</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>ounce</td>
<td>oz</td>
</tr>
<tr>
<td></td>
<td>pound</td>
<td>lb</td>
</tr>
<tr>
<td></td>
<td>ton, short (2,000 lb)</td>
<td>ton</td>
</tr>
<tr>
<td><strong>Mass (weight)</strong></td>
<td>degree Fahrenheit</td>
<td>°F</td>
</tr>
<tr>
<td></td>
<td>millisecond</td>
<td>ms</td>
</tr>
<tr>
<td></td>
<td>second</td>
<td>s</td>
</tr>
<tr>
<td></td>
<td>minute</td>
<td>min</td>
</tr>
<tr>
<td></td>
<td>hour</td>
<td>h</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>miles per hour</td>
<td>mph</td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td>pound-force per square</td>
<td>psi</td>
</tr>
<tr>
<td></td>
<td>inch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>watt</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>kilowatt</td>
<td>kW</td>
</tr>
<tr>
<td></td>
<td>milliampere</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>ampere</td>
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</tr>
<tr>
<td></td>
<td>volt</td>
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<tr>
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<td>lumen</td>
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<td>footcandle</td>
<td>fc</td>
</tr>
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<td>**Power, energy and</td>
<td>horsepower</td>
<td>hp</td>
</tr>
<tr>
<td>electricity**</td>
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<tr>
<td></td>
<td>pounds-force</td>
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<td></td>
<td>1,000 pounds-force</td>
<td>kip</td>
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<tr>
<td><strong>Force</strong></td>
<td>pound-force</td>
<td>lbf</td>
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<td></td>
<td>1,000 pounds-force</td>
<td>kip</td>
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<tr>
<td><strong>Torque</strong></td>
<td>pound-force foot</td>
<td>lb•ft</td>
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<tr>
<td><strong>Viscosity, dynamic</strong></td>
<td>centipoises</td>
<td>cP</td>
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<tr>
<td></td>
<td>poise</td>
<td>P</td>
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<tr>
<td><strong>Viscosity, kinematic</strong></td>
<td>centistokes</td>
<td>cSt</td>
</tr>
<tr>
<td><strong>Flow</strong></td>
<td>gallons per minute</td>
<td>gpm</td>
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<tr>
<td><strong>Concentration</strong></td>
<td>parts per million</td>
<td>ppm</td>
</tr>
<tr>
<td><strong>Inductance</strong></td>
<td>Henries</td>
<td>H</td>
</tr>
<tr>
<td><strong>Frequency, concrete</strong></td>
<td>vibrations per minute</td>
<td>vpm</td>
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<tr>
<td><strong>consolidation</strong></td>
<td></td>
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<tr>
<td><strong>Sound</strong></td>
<td>Decibel, A-Scale</td>
<td>dbA</td>
</tr>
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</table>

**101.3.1 Engineer's Estimate Symbols**

The measurement symbols shown on the Engineer's Estimate differ from those found in the rest of Project documents. Table 101.3.1.1, "Symbols for Engineer's Estimate," lists and defines the symbols.
### Table 101.3.1:1
**Symbols for Engineer’s Estimate**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Unit of Measure or Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>EACH</td>
<td>Each</td>
</tr>
<tr>
<td>ALOW</td>
<td>Allowance</td>
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<tr>
<td>L.F.</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>MILE</td>
<td>Mile</td>
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<tr>
<td>S.F.</td>
<td>Square Foot</td>
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<tr>
<td>S.Y.</td>
<td>Square Yard</td>
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<tr>
<td>SYIN</td>
<td>Square Yard Inch</td>
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<tr>
<td>ACRE</td>
<td>Acre</td>
</tr>
<tr>
<td>C.Y.</td>
<td>Cubic Yard</td>
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<tr>
<td>LB</td>
<td>Pound</td>
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<tr>
<td>TON</td>
<td>Ton</td>
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</tbody>
</table>

### 101.4 TERMS AND DEFINITIONS

If the following terms are used in the Plans, the specifications, other Contract documents, and Department correspondence, the intent and meaning shall be interpreted as follows:

**Act of God.** An unusual, sudden, and unexpected manifestation of the forces of nature, the effect of which could not have been prevented by reasonable human foresight, pains, and care.

**Addendum.** A change in the Plans or Specifications issued after the Advertisement and before the opening of the Bid.

**Advertisement.** (Also called Invitation for Bids.) A public announcement inviting Bids for Work to be performed or Materials to be provided.

**Apparent Low Bidder.** The Bidder who submits at a Bid Opening a Total Bid Amount that is numerically lower than the Total Bid Amount submitted by other Bidders, but whose Bid may later be subject to rejection, recalculation or other modification that may change the order of Bidders.

**Assistant District Engineer.** The Engineer in charge of the construction operations in a designated portion of a Department District. Also refer to District Construction Engineer.

**Award.** The written acceptance by the Department of a contract Bid.

**Base Course.** The layer or layers of specified Material placed on a Subbase or a Subgrade normally used to support a Surface Course.

**Baseline Schedule.** A fixed project schedule that is the standard by which project performance is measured.

**Basis of Payment.** The terms under which Work is paid, as a designated Pay Item in accordance with the quantity measured and the Pay Unit.

**Bid.** The offer of a Bidder, on the prescribed form, to perform the Work at the prices quoted.

**Bidder.** An individual, partnership, firm, corporation, joint venture, or their authorized representative submitting a Bid.

**Bid Form.** The approved form on which the Department requires Bidders to prepare and submit Bids.

**Bid Guaranty.** The security provided with a Bid to guarantee that the Bidder will enter into the Contract if the Department accepts its Bid.
Bid Item (Contract Item, Pay Item). A specifically described unit of Work for which a Bidder provides a Bid Item Unit Price and Bid Item Price. The Bid Items become Contract Items when the Contract is executed. The Contract Items become Pay Items when calculating partial payments.

Bid Item Price. The price established by the Contractor for each individual Bid Item on the Bid Form; the product of the Bid Item quantity, provided on the Bid Form, and the Bid Item Unit Price.

Bid Item Unit Price. The price established by the Contractor for each unit of an individual Bid Item on the Bid Form.

Bid Opening. A public reading of the properly submitted Bids, on a date established by the Invitation for Bids.

Bid Package. The Bid documents submitted by a Bidder in accordance with Section 102, “Bidding Requirements and Conditions.”

Bid Schedule. Schedule of Bid Items, also referred to as Proposal Schedule

Borrow Pit. A source outside the Roadway Prism from where suitable Material used primarily for Embankment is obtained.

Breakaway. The ability of a system to yield at a predetermined impact force.

Bridge. A Structure having a length — as measured along the center of the Roadway — of more than 20 ft between undercopings of abutments or extreme ends of openings for multiple boxes, and carrying a pathway or Roadway over a depression or obstacle. It includes all appurtenances necessary to its proper use. The length of a bridge structure is the distance along the line of survey stationing back-to-back of backwalls of abutments, if present, or end-to-end of the bridge floor, and in no case less than the total clear opening of the structure. The bridge Roadway width is that clear unobstructed width of bridge deck available for vehicle use measured normal to the centerline of the bridge.

Cabinet Secretary. The individual in charge of the Department. Also referred to as the Secretary.

Calendar Day. Each and every day shown on the calendar, beginning and ending at midnight.

Certificate of Compliance. A certificate provided by the Contractor proving that the relevant Material is in accordance with the Contract.

Change Order. A written order to the Contractor detailing changes to the specified Work quantities, or modifications in the scope of the original Contract. The change order can consist of a Supplemental Agreement, or Field Sheet.

Chill Factor. The chill factor is the ambient temperature (in °F) (in degrees Fahrenheit) minus wind velocity (in miles per hour).

Commercial Material Source. A Material source that has been utilized by a private producer in a commercial operation from which substantial Material has been sold within the last 24 months before the date of the letting.

Completion Dates. Contracts may have the following completion dates as defined herein:
- Substantial Completion Date
- Physical Completion or “Completion” Date
- Mandatory Completion Date
Construction Maintenance Easement (CME). A real property interest in land acquired by the Department in conjunction with a Highway, Street, or Road project to provide permanent access to private property to perform specific construction and maintenance functions.

Construction Zone. The area within the Right of Way from the first traffic control sign announcing the road work to the last sign announcing the end of road work within which the Contractor shall perform construction activities.

Contract. The written agreement between the Department and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the Work and the Basis of Payment.

The contract includes the Advertisement, bid contract form and Contract Bond, Standard Specifications, Supplemental Specifications, Special Provisions, Addenda, Notice To Contractors, general and detailed Plans, Standard Drawing serials, and Notice to Proceed—also any Change Orders and agreements that are required to complete the construction of the Work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

Contract Bonds. The approved payment and performance bonds — executed by the Contractor and the Contractor’s Surety or sureties — guaranteeing complete execution of the Contract and all Change Orders pertaining thereto, and the payment of all debts pertaining to the construction of the Project.

Contractor. The individual, partnership, firm, corporation, or joint venture contracting with the Department for performance of the Work.

Contract Time. The time specified in the Invitation For Bids for completion of the Contract. This time may be defined as a specified fixed date, a given number of Working Days, or a given number of Calendar Days — or a combination of the above. The contract time may be amended by mutual written agreement to include authorized time extensions as the performance of the Contract requires.

County. The county in which the Work herein specified is to be done.

Cultural Resource. Any prehistoric or historic period artifact, site, building, structure, material remain, or traditional use area resulting from, or associated with, human cultural activity. Historically important cultural resources are those eligible for inclusion on the National Register of Historic Places.

Cultural Resource Professional. An individual with at least four years of full-time paid experience in Cultural Resource investigations, including analyzing and preparing documentation needed to meet the requirements of section 106 of the National Historic Preservation Act. The individual must be properly permitted to meet the requirements of the NM State historic preservation officer or appropriate tribal preservation officer.

Culvert. Any Structure not classified as Bridge or casing that provides an opening under a Roadway.

Day. Calendar Day unless otherwise noted.

Deleterious Material. Unsuitable material harmful to final product.

Department. The New Mexico Department of Transportation as constituted under the laws of the State of New Mexico for the administration of transportation work. Any reference to contract documents, Plans, Special Provisions, Standard Drawings, Forms, Change Orders, and any other pertinent written communication in which the terms “New Mexico State Highway Department” or “New Mexico State Highway and Transportation Department” appears shall be the same as the term New Mexico Department of Transportation or its designated agent.
Detour. A temporary route for traffic around a closed portion of a road.

Disadvantaged Business Enterprise (DBE). As defined in title 49 Code of Federal Regulations part 26 and 18.28.2.7 New Mexico Administrative Code (NMAC).

District. A subdivision of the State for the purpose of executing the Department’s construction, maintenance, and administrative activities.

District Engineer. The Engineer in charge of a Department District.

District Construction Engineer. The Engineer in charge of the District construction operations who may also be known as the Assistant District Engineer.

Divided Highway. A Highway with separated Roadways for traffic, generally in opposite directions.

Embankment. The portion of a Roadway that is below the Subbase, Base Course, and Surface Courses and that is built up in layers consisting principally of soil and broken rock or a combination thereof.

Engineer. The designee of the Cabinet Secretary of the Department.

Entrance Angle (EA). The angle between the reference axis and the axis of incident light (Counter-clockwise rotation of the reference axis relative to the axis of incident light is considered positive.)

Environmental Program Manager. The individual in charge of the Environmental Section of the Department.

Environmental Resource. The physical and biological components of the human and natural environment.

Environmental Specialist. An individual with at least four years of full-time paid experience in environmental investigations, including analyzing and preparing documentation needed to meet the FHWA approval requirements for the National Environmental Policy Act and related legislation.

Equipment. All machinery, tools, and equipment, together with the necessary supplies for upkeep and maintenance, necessary for the construction and completion of the Contract.

Extra Work. Extra work means either 1) an item of Work ordered under the Contract for which there is no Bid Item Unit Price or 2) an increase or decrease of 25% in the original contract quantity of a Major Contract Item. (See Section 104.2, “Significant Changes in the Character of Work.”) Such Work shall be performed as directed and will be paid for only on one of two grounds as provided in Section 109.5, “Payment for Changes, Differing Site Conditions, and Extra Work,” by negotiated price agreement or by Force Account.

Fabricator. An individual, partnership, firm, corporation, or joint venture with whom the Contractor subcontracts to fabricate or supply Structural Steel or other structural items.

Field Sheet. A Contract Change Order to increase or decrease the quantities of existing items or make other changes within the scope of the Contract, which does not require a Contractor’s signature.

Force Account. The Basis Of Payment for the directed performance of Work, with payment based on the actual cost of labor, Equipment, and Materials, and including various constant additives.
Fractured Face. At least one-half of the projected particle area exhibits a rough, angular, or broken texture with well defined edges.

General Office (G.O.). The Department’s main headquarters.

Hazardous Materials. Any substance, product, waste, or other Material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to all applicable laws as amended, or any other federal, state, or local statute law, ordinance, resolution, code, rule, regulation, order, or decree regulating, relating to, or imposing liability or standards of conduct concerning any hazardous, toxic, or dangerous waste, substance, or material.

Highway, Street, or Road. A general term denoting a public way for purposes of vehicular or pedestrian travel.

Holiday. Holidays recognized by the State of New Mexico are as follows, unless otherwise provided by the legislature:

1. 1st day of January (New Year’s Day);
2. 3rd Monday in January (Martin Luther King Jr. Day);
3. 3rd Monday in February (Presidents’ Day);
4. Last Monday in May (Memorial Day);
5. 4th day of July (Independence Day);
6. 1st Monday in September (Labor Day);
7. 2nd Monday in October (Columbus Day);
8. 11th day of November (Veteran’s Day);
9. 4th Thursday in November (Thanksgiving Day);
10. 25th day of December (Christmas Day).

If any holiday above falls on a Saturday or Sunday, the previous Friday or following Monday, respectively, shall be considered a holiday.

Incentive/Disincentive Provision. Predetermined adjustments to the Contract price for each day that Work is completed ahead of or behind specified milestones, phases, or contract Completion Dates.

Incidental. Occurring or likely to occur at the same time or as a result of other items of Work as specified in the Contract for which no separate or additional payment will be made.

Inspector. The Project Manager’s authorized representative assigned to make detailed inspections of contract performance.

Invitation for Bids. See Advertisement.

Job Mix Formula (JMF). The combined aggregate gradation and the percentage of each Material component in the mix.

Laboratory. A testing laboratory of the Department or any other testing laboratory that may be designated by the Engineer.

Landscape Architect. The Cabinet Secretary’s designee for landscape architecture.

Lighting and Signal Engineer. The Engineer in charge of the Department’s signal and lighting design.

Luminaire. A lighting device designed to illuminate the surface of a specific area from a mounting on a standard, including the housing, optical control, lamps, and necessary ballasts.

via processing of video images and provides detector outputs to a traffic controller.

**Maintaining Agency.**  Public entity such as a city or County responsible for the electrical energy costs and maintenance of the approved and accepted signal and lighting system.

**Major Contract Item.**  Any item, excluding mobilization, having a Bid Item Price of 10% or more of the Total Bid Amount for the Contract, minus the amount bid for mobilization.

**Mandatory Completion Date.**  The date on which the Project shall be completed.  This may be either Substantial Completion or Physical Completion as specified in the Contract.  If neither is specified, it shall mean “Substantial Completion.”

**Materials.**  Any substances specified for use in the construction of the Project and its appurtenances.

**Median.**  That portion of a Divided Highway separating the Traveled Way for traffic in opposing directions.

**Method of Measurement.**  The method in which a Pay Item is measured to conform with the Pay Unit.

**Nominal Maximum Sieve.**  One sieve size larger than the first sieve that retains 10% or more of a given Material.

**Notice to Proceed.**  (Work Order)  Written notice to the Contractor to proceed with the Contract Work including, when applicable, the beginning date of Contract Time.

**Notice to Contractors.**  An addition to the Contract package, made prior to its issuance to the Contractor, indicating changes to the Plans and Specifications.

**Observation Angle.**  The angle between the axis of incident light and the observation axis.

**Partial Suspension.**  The suspension of work on some, but not all Contract Items.

**Pavement Structure.**  The combination of Subbase, Base Course, and Surface Course placed on a Subgrade to support and distribute the traffic load to the Roadbed.

**Pay Adjustment.**  An adjustment to a payment for a specific portion of the Work based on the quality of the Work performed by the Contractor and accepted by the Department.  Other Department documents may refer to this term as price adjustments, price reductions, or pay reductions.

**Physical Completion.**  All the Work is physically completed on the Project and it is accepted by the Project Manager.  All documentation required by the Contract and by law does not necessarily need to be furnished by this date.

**Pit Agreement.**  An agreement with a property owner to provide borrow or surfacing Material for Highway construction or maintenance.

**Plans.**  The approved contract drawings showing profiles, typical cross sections, Working Drawings, or exact reproductions that show the location, character, dimensions, and general or specific details of the Work to be done.

**Post Construction Plans.**  Final drawings reflecting Work and quantities performed under the Contract.

**Profile Grade.**  The line obtained from the trace of a vertical plane intersecting the top of the surfacing at the locations shown on the Plans and determined in accordance with the criteria set forth in the standard serials and drawings.  Profile grade means either the
elevation or the gradient of such trace according to the context. The location of the profile grade will be designated by the Department and shown on the Plans. The profile grade may be used to designate the gradient and elevation of other construction features such as tops of curb, channels, Sidewalks, etc.

Project. The specific section of the Highway or property on which construction is to be performed as specified in the Contract.

Project Manager. The Department's representative who is delegated the responsibility for administration of the Project.

Quality Level Assurance (QLA). Is equivalent to QC/QA.

R-value. The measurement of the response of a compacted sample of soil or aggregate to a vertically applied pressure under specific conditions.

Required Documents for Bid Submittal. Those documents specified in the Bid Package required for Bid submittal.

Responsible Bidder. A Bidder who submits a Responsive Bid and who has furnished, when required, information and data to prove that his financial resources, production or service facilities, personnel, service reputation and experience are adequate to make satisfactory delivery of the services, construction or items of tangible personal property described in the Invitation For Bids as defined in NMSA 1978 § 13-1-82.

Responsive Bid. A Bid which conforms in all material respects to the requirements set forth in the Invitation For Bids. Material respects of a Bid include but are not limited to price, quality, quantity or delivery requirements as defined in NMSA 1978 § 13-1-84.

Right of Way. A general term denoting land or property, or interest therein, usually in a strip, acquired for or devoted to transportation purposes.

Roadbed. The graded portion of the Highway with top and side slopes prepared as a foundation for the Subgrade, Pavement Structure, and Shoulders.

Roadway. A general term denoting the Traveled Way and the Shoulders.


Secretary. See Cabinet Secretary.

Shoulder. The portion of the Roadway contiguous with the Traveled Way for accommodation of stopped vehicles, for emergency use, and for lateral support of Base and Surface Courses.

Sidewalk. That portion of the Roadway primarily constructed for use by pedestrians.

Signal Assembly. A housing containing the required illuminated traffic signal indications (vehicular and pedestrian) mounted on a standard.

Small Business. As defined in Section 632 of the Small Business Act.

Special Provisions. Additions and revisions to the Standard and Supplemental Specifications covering conditions applicable to an individual project.

Specialty Items. Work not usually performed by Highway Contractors and so designated in the Contract.

Specifications. A general term applied to all written provisions and requirements pertaining to performance of the Work.
Specific Intensity. Candlepower of the returned light at the chosen Observation and Entrance Angles for each lumen per square meter, foot-candle of illumination at the reflector on a plane perpendicular to the incident light.

Standard. In traffic lighting, a pole-type structure that supports and positions signal and lighting devices, including arms, mounting hardware, and lowering and Breakaway devices as required.

Standard Drawings. Detailed drawings for specific items of Work approved for repetitive use.

Standard Specifications. The Department's book of specifications approved for general application and repetitive use.

State. The State of New Mexico acting through its authorized representatives.

State Bridge Engineer. The Engineer in charge of the Department's Bridge Design Section.

State Concrete Engineer. The Engineer in charge of the Concrete Unit of the State Materials Bureau.

State Geotechnical Engineer. The Engineer in charge of the Geotechnical Unit of the State Materials Bureau.

State Materials Engineer. The Engineer in charge of the State Materials Bureau.

Structures. Bridges, Culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end-walls, buildings, sewers, service pipes, underdrains, foundation drains, and other such features that may be encountered in the Work.

Structural Steel. Steel shapes, plates, H-piling and sheet piling. Shapes are pipes, structural tubing and all hot-rolled flanged sections. Hot-rolled flanged section are rails and mill products having AISC shape designations of W, S, M, C, MC, HP, L, WT, ST and MT.

Subbase. The layer or layers of specified Material thickness placed on a Subgrade to support Surface Courses.

Subcontractor. An individual, partnership, firm, corporation, or joint venture to whom the Contractor subcontracts part of the Contract or who meets the requirements of a subcontractor under Section 108.1, “Subcontracting.”

Subgrade. The portion of the Roadbed prepared as a foundation for the Pavement Structure.

Substantial Completion. The point at which the Project is complete such that it can be safely and effectively used by the public without further delays, disruption, or impediments as requested by the Contractor and approved by the District Construction Engineer. For conventional Bridge and Highway Work, it is the point at which all the following Work is complete for the safe and efficient use of the public (or as otherwise defined in the Contract):

1. Bridge deck;
2. Parapet;
3. Pavement structure;
4. Shoulder;
5. Permanent signing;
6. A minimum of one application of striping;
7. Traffic barrier; and
8. Safety appurtenances.

**Substructure.** All of that part of the Bridge Structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, together with the backwalls, wingwalls, and wing protection railings.

**Superintendent.** The Contractor’s agent authorized in writing to be in responsible charge of the Project.

**Superstructure.** The entire Bridge Structure except the Substructure.

**Supplemental Agreement.** Written agreement signed by the Department and the Contractor to perform Work beyond the scope of the original Contract but in conjunction with it.

**Supplemental Specifications.** Approved additions and revisions to the Standard Specifications.

**Supplier.** An individual or firm who manufactures or supplies Materials to be incorporated into a construction project but who performs no actual work on the project site.

**Surety.** The corporation, partnership, or individual, other than the Contractor, executing a bond furnished by the Contractor.

**Surface Course.** Layer or layers of a Pavement Structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate.

**Surfacing Pit.** A source from which suitable Material for the production of Surface Course aggregate is obtained.

**Suspension and Debarment.** The disqualification of a Bidder or Contractor from bidding or performing construction work for a period of time determined by Department Regulations.

**System Master.** In traffic lighting, an electronic device normally installed in a controller cabinet capable of supervising an interconnected network of local controllers, providing coordinated traffic movement. System masters in turn may be controlled by a computerized traffic control closed-loop system.

**Temporary Construction Permit (TCP).** A temporary interest in land acquired in conjunction with a Highway project to provide for the temporary use of private property for the duration of the construction to perform construction activities in which the improvements are not intended to be permanent.

**Termini.** A general term used to describe the Project Limits, and including the beginning and end of the Project, its Right of Way, pit sites, haul roads, and temporary and permanent construction or maintenance easements.

**Titles (or Headings).** The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

**Total Bid Amount.** The sum of all the Bid Item Prices on the Bid Form.

**Total Original Contract Amount.** The total amount bid as compensation for the contract.

**Town, City, or District.** Subdivisions of the State used to designate or identify the location of the proposed Work.

**Traffic Lanes.** See Traveled Way.
Traffic Services Engineer.  The District Engineer’s representative for traffic engineering.

Traffic Signal.  The complete installation of a traffic control system at an intersection, including the illuminated signal indications, supports, electrical controls, and distribution system.

Traveled Way.  The portion of the Right of Way designated for the movement of vehicles, exclusive of Shoulders and Auxiliary Lanes.

Unbalanced Bid.  (A) Materially. A Bid that generates a reasonable doubt that awarding the contract to the Bidder submitting a mathematically unbalanced Bid will result in the lowest ultimate cost to the Department.  (B) Mathematically.  A Bid containing lump sum or unit Bid Items that do not reflect reasonable actual costs plus a reasonable proportionate share of the Bidder’s anticipated profit, overhead costs, and other indirect costs.

Value Engineering Cost Proposal.  A Contractor-provided alternative to the work methods or materials specified in the Contract that establishes a better or approved-equal product or result without affecting the functional purpose of the Work being revised, and that produce a net savings to the Department.

Work.  The providing of all labor, Materials, Equipment, and other Incidentals necessary for the successful completion of the Project, the successful completion of Pay Items, and the carrying out of the duties and obligations imposed by the Contract.

Working Day.  Every day except Saturdays, Sundays, and Holidays.  Based on a review of weather conditions and the actual Work performed by the Contractor, the Project Manager will determine (between the end of the day and noon of the next day) if the Department will charge a working day.  If the Contractor was able to effectively prosecute Work on a critical path item for six or more hours on a Saturday, Sunday, or Holiday, a working day will be charged.

Working Drawings.  Contractor-furnished documents including, but not necessarily limited to:

1. Stress sheets;
2. Shop drawings;
3. Bending diagrams for reinforcing steel;
4. Plans for erection, false work, framework, cofferdams, and other items; and
5. Such other similar data required for the successful completion of the Work.
102.1 INVITATION FOR BIDS  
The Department will issue Invitations for Bid for the construction of Projects on the date set for Project Advertisement. The Department will mail Invitations for Bid to interested parties. The Invitation for Bids will indicate the following:  
1. The Project number;  
2. The Contract Time;  
3. The locations, length, and description of the Work;  
4. The date, time and place for the Bid Opening; and  
5. Information concerning the cost and availability of Plans and Required Documents for Bid Submittal.

102.2 PREQUALIFICATION OF BIDDERS  
The Invitation for Bids may require Prequalification of Bidders as a condition for submitting a Bid as authorized by the New Mexico Procurement Code, NMSA 1978, sections 13-1-134 and 13-1-82. If required by the Invitation for Bids, Bidders shall become Prequalified in accordance with the requirements of the Department’s Prequalification regulations, 18.27.5 NMAC. The failure of a Bidder to become Prequalified, when Prequalification of Bidders is mandated by the Invitation for Bids, will render its Bid non-responsive and the Bid will be rejected.

102.3 SUSPENSION AND DEBARMENT  
The Department may suspend or debar a Bidder in accordance with NMSA 1978, § 13-1-177 to 13-1-180 and the Department’s Suspension and Debarment rules as per 18.28.4 NMAC. A Suspended or Debarred Bidder shall be ineligible to bid, subcontract or supply Materials on Department projects during the period of its Suspension or Debarment.

102.4 BID PACKAGE  
The Department will make available to prospective Bidders a Bid Package consisting of the Required Documents for Bid Submittal. The Required Documents for Bid Submittal is comprised of the documentation required for Bid submittal as specified in the Contract’s index of documents, including but not limited to the following: Bid Form, Bid Schedule and Bid Guaranty.  
1. Only the Required Documents for Bid Submittal are to be submitted. All forms in this package are considered a part thereof and must not be detached or altered when the Bid is submitted.  
2. All requirements for electronic submittals will be specified in the Department's Invitation for Bids. When specified in the Invitation for Bids, submit a Bid in electronic format.

102.5 REFUSAL OR REJECTION OF BIDS  
The Department may refuse to issue, receive, or open a Bid, or may reject a Bid, for the following reasons:  
1. A Bidder lacks competency, financial stability, or adequate machinery, plants or other Equipment;  
2. A Bidder is responsible for uncompleted Work that in the judgment of the Department might reasonably be expected to hinder or prevent the prompt completion of additional Work;  
3. A Bidder fails to pay, satisfactorily settle, or provide security for the payment of claims for labor, Equipment, Materials, supplies, or services legally due on previous or ongoing contracts;  
4. A Bidder fails to Pre-qualify under Section 102.2, “Prequalification of Bidders;”  
5. A Bidder defaults under previous contracts;  
6. A Bidder performs previous work unsatisfactorily, or fails to comply with Section 108.3, “Prosecution and Progress;”  
7. The Department issues a notice of Suspension or Debarment to the Bidder;  
8. A Bidder submits more than one Bid for the same Work under its own name, or under a different name;  
9. Evidence exists of collusion among Bidders or prospective Bidders, in the preparation of a Bid for a Department construction project;
10. A Bid Item Unit Price results in an Unbalanced Bid to the potential detriment of the Department. The Department may require the Apparent Low Bidder to detail in writing how its prices were determined, and to justify the basis for its prices.

102.6 INTERPRETATION OF QUANTITIES
The quantities appearing in the Bid Schedule, Plans, or other Contract documents are approximate only and are prepared for the comparison of Bids. Payment to the Contractor will be made only for the actual quantities of Work performed and accepted, or Materials furnished, in accordance with the Contract.

102.7 EXAMINATION OF PLANS, SPECIFICATIONS, SPECIAL PROVISIONS, AND SITE OF WORK
1. The Department will prepare Plans and Specifications in accordance with acceptable engineering standards, and will give such directions as will enable any competent Contractor to construct the Work. The Bidder is expected to examine carefully the site of the proposed Work, including Materials pits and haul roads and required to examine carefully the Bid Package, Standard Specifications, Special Provisions, and standard and serial drawings, before submitting a Bid. The submission of a Bid shall be considered prima facie evidence that the Bidder has made such examination and accepts the conditions to be encountered in performing the Work and the requirements of the Contract. The Bidder must so certify on the Bid Form for the Bid to be considered a Responsive Bid;
2. When available, boring logs and other records of subsurface investigations including Borrow, surfacing Material, and other Materials pits may be inspected by the Bidders. Bidders are informed that such information is for Department design and estimating purposes only. Such information is made available to Bidders so that they and the Department have identical access to subsurface information. The Department does not guarantee the accuracy of such subsurface investigation documentation, and the Department furnishing such subsurface investigation documentation does not relieve the Bidder from performing its own site investigation and determining how subsurface conditions may affect the methods and cost of the Work.

102.8 PREPARATION OF BID
1. Submit the Bid as provided in the Bid Package, and complete the blank spaces in the Required Documents for Bid Submittal. For each Bid Item, the Bidder shall state in numerals, either in ink or digital format, the Bid Item Unit Price for which the Bidder proposes to perform each Bid Item;
2. Specify a Bid Item Unit Price for each Bid Item, except when a Bid Item Unit Price is established by the Department. The Bid Item Unit Price will be conclusively presumed to include any insurance or overhead expenses necessary to complete that Bid Item;
3. Show the Bid Item Prices by multiplying the respective Bid Item Unit Prices and quantities, and also show the Total Bid Amount in the space provided on the Bid Schedule. The Total Bid Amount will be the sum obtained by adding the Bid Item Prices;
4. Make changes to any entry on the Required Documents for Bid Submittal by marking through the entry in ink and making the correct entry adjacent thereto in ink. Initial the change in ink;
5. Show the amounts for the respective Bid Item Unit Prices to a maximum of three decimal places. Truncate additional decimal places in excess of three;
6. Exclude the applicable state GRT and local option tax. The Department will pay the applicable tax;
7. Exclude any Indian business tax, TERO tax, and other tax imposed by a tribal government. The Department will pay the tax or will exercise its prerogative to challenge the tribal government’s authority to impose the tax. If the Department exercises its prerogative to challenge the tribal government’s authority to impose the tax, the Department will reimburse the Contractor for such tax only if a court of competent jurisdiction rules the tribe has authority to impose the tax. The Department will reimburse the Contractor only if the final decision of the litigation, or other final disposition of the litigation, results in a determination that the tribe has
jurisdiction to impose the tax. The Department shall be subrogated to the rights of the Contractor to claim a refund of, or to contest, any such tax imposed on the Work to the extent any alleged obligation of the Contractor or the Department to pay such tax arises under this section or through the Contractor’s performance of this Contract;
8. Submit Required Documents for Bid Submittal signed by the president, vice-president, owner, or other representative of the Bidder authorized in writing to bind the Bidder.

102.9 INNOVATIVE CONTRACT INCENTIVES
The Department may include innovative contract incentives in the Special Provisions, Notice to Contractors, or Addenda.

102.10 IRREGULAR BIDS
A Bid will be deemed irregular and will be rejected in the event a Bidder:
1. Submits its Bid on forms different than the Required Documents for Bid Submittal;
2. Does not sign its Bid Form in accordance with Section 102.8, "Preparation of Bid," and thereby fails to bind the Bidder to its Bid;
3. Alters the Required Documents for Bid Submittal;
4. Omits any material portion of the Bid Package when submitting its Bid;
5. Submits a Bid containing irregularities, such as unauthorized additions and conditional or alternate proposals that tend to make the Bid incomplete, indefinite, or ambiguous;
6. Adds provisions reserving its right to accept or reject an Award, or reserving its right to refuse to enter into a Contract after an Award;
7. Omits both a Bid Item Unit Price and a Bid Item Price for each Bid Item;
8. Fails to initial (in ink) changes to Bid Item Unit Prices or Bid Item Prices in accordance with Section 102.8, “Preparation of Bid;”
9. Fails to deliver the Bid in accordance with Section 102.12, “Delivery of Bids;”
10. Fails to provide in its Bid the certification required by Section 102.7, “Examination of Plans, Specifications, Special Provisions, and Site of Work.”

102.11 BID GUARANTY
Submit with the Bid, a Bid Guaranty in the amount of at least 5% of the Total Bid Amount. The Bid Guaranty shall be in the form of one of the following:
1. Bid bond;
2. Certified check; or
3. Postal or Bank money order.

102.12 DELIVERY OF BIDS
Submit the Bid in a sealed envelope and plainly mark with the project number, control number, location of the project, and the name and address of the Bidder. If sent by United States Mail or private carrier, mail in accordance with the Invitation for Bids. The Department must receive the Bid before close of business the day before the Bid Opening. In the alternative, a Bid may be hand-delivered by the Bidder prior to the Bid Opening to the official designated by the Department to open and read Bids at the Bid Opening. Alternatively, the Bidder may submit its Bid electronically in accordance with the Invitation for Bids.

102.13 REVISION OF BIDS
A Bidder may revise its Bid after submitting it to the Department, provided such revision in writing, Telefax or electronically in portable document format (PDF) is received by the Department before the Bid Opening in accordance with Invitation for Bids.
A Bidder may revise electronic Bids anytime before Bid Opening.

102.14 WITHDRAWAL OF BIDS
A Bidder may withdraw its Bid after it has been deposited with the Department and before the time set for Bid Opening by requesting to do so in person, in writing, by Telefax, or electronically in PDF. Once a Bid Opening has commenced at the time and place designated in the Invitation for Bids, a Bidder may not withdraw its Bid, except that an opportunity will be given prior to the opening and reading of the Bids on each project for a Bidder to withdraw the
Bidder’s own Bid for that Project and for any other projects which have not yet been opened and read. Withdrawn Bids shall not be resubmitted.

Alternatively, the Bidder may withdraw its Bid electronically in accordance with the Invitation for Bids.

102.15 BID OPENING

Bids will be opened and read publicly in the presence of one or more witnesses at the time and place designated in the Invitation for Bids. The amount of each Bid and each Bid Item, and such other relevant information as may be specified by the Department, together with the name of each Bidder, will be recorded, and the record and each Bid will be open to public inspection.

102.16 ENGINEER'S ESTIMATE

The Department will prepare in advance of the Bid Opening an Engineer's Estimate for the Project that will contain the Department's cost estimate for the Project. This Engineer's Estimate will be confidential and will not be disclosed to, or be subject to inspection by, members of the public prior to the Bid Opening. When all Responsive Bids for the Project are received and read during the Bid Opening, the Engineer's Estimate for the Project will be publicly disclosed.
103.1 CONSIDERATION OF BIDS
After the Department opens and reads the Bids, it will check the extended unit prices and the sum of the extended unit prices and item lump sums for accuracy and compare the resulting Total Bid Amounts. The results of this comparison will be available to the public.

If the Bid Item Unit Price is omitted, the Bid Item Price will be divided by the estimated quantity, thereby establishing a Bid Item Unit Price. If both the Bid Item Unit Price and the Bid Item Price are omitted, the Bid will be rejected.

If a discrepancy exists between a Bid Item Unit Price and its extension, the Bid Item Unit Price shall govern. If two Contractors submit identical lowest Total Bid Amounts, the Department shall determine the successful Bidder by the flip of a coin.

Mathematical errors in Bid Item Prices or Total Bid Amount will be corrected by the Department during the review of Bids.

The Department reserves the right to reject any or all Bids, to waive technicalities, or to advertise for new Bids if, in the judgment of the Department, the best interests of the public would be promoted thereby.

103.2 AWARD OF CONTRACT
When required by the Department, the Bidder shall submit written answers to the Bidder Information Questionnaire. The Department will determine if the Apparent Low Bidder is a Responsible Bidder using the answers to this questionnaire. The Department will base its decision on whether the Bidder demonstrates adequate financial resources, production or service facilities, personnel, service reputation, and experience to make satisfactory delivery of the construction described in the Invitation for Bids.

Except as described in Section 103.3, “Bidding Dispute Resolution Procedures,” the Department will award the Contract within 30 Days after the opening of Bids to the lowest Responsible Bidder. This Bidder may agree to a later award time if requested to do so by the Department.

Unless the Department determines to reject all Bids the Department will notify the lowest Responsible Bidder in writing that its Bid has been accepted and that it has received preliminary Award of the Contract. The Department will enclose the Contract to be executed and returned to the Department.

103.3 BIDDING DISPUTE RESOLUTION PROCEDURES
In the event of a Bidding dispute, the following procedure shall control the Award of the Contract:

1. A Bidder disputing the Bidding or pre-award process must file a written protest with the Cabinet Secretary within 15 Days after knowledge of the facts or occurrences giving rise to the protest. Failure to file a timely protest shall constitute a waiver of the Bidder’s right to protest;

2. When a timely protest is filed, the Cabinet Secretary will not proceed further with the Award until the dispute is resolved, as detailed below, unless the Cabinet Secretary determines that the Award of the Contract is necessary to protect the best interests of the public;

3. When a timely protest is filed, the Bids of both the Apparent Low Bidder and the next Apparent Low Bidder shall be automatically extended an additional 15 Days. The Department will Award the Contract within 45 Days of the Bid Opening;

4. Within 7 Days of receiving a timely Bid protest, the Cabinet Secretary or the Cabinet Secretary’s designated hearing officer will mail letters notifying all parties to the grievance to appear with all necessary material evidence for an informal hearing in the Department’s General Office or elsewhere as identified. Such letters will be mailed by certified mail; return receipt requested and will include a copy of the written protest;

5. Within 7 Days of the initial hearing date, the Cabinet Secretary or the Cabinet Secretary’s designated hearing officer will render a determination and mail a determination letter stating the reasons for the action taken and informing the losing party of its right, under NMSA 1978 § 13-1-183, to file an appeal in Santa Fe District Court within 30 Days of receiving the adverse determination;

6. Simultaneously with mailing the determination letter, the Department will mail an Award letter to the lowest Responsible Bidder stating that the Award is conditioned
upon the unsuccessful party not appealing, under NMSA 1978 § 13-1-183, to the
Santa Fe District Court within 30 Days of receiving the determination letter. The
Award letter, if it is mailed within 45 Days of the Bid Opening, will bind the lowest
Responsible Bidder to accept the Contract or to reject the Contract and forfeit the
Bid Guaranty it has provided;

7. If an appeal is filed under NMSA 1978 § 13-1-183, the Department may extend the
date of the Award letter to a later date as agreed upon by the Department and the
lowest Responsible Bidder. When such an extension cannot be agreed upon or for
any other reason, the Department may cancel the Award and advertise for new Bids
when it is in the best interest of the Department.

103.4 CANCELLATION OF AWARD
The Department may cancel the Award of any Contract at any time before the execution
of the Contract by all parties without incurring liability where such cancellation is in the best
interests of the Department.

103.5 RETURN OF BID GUARANTY
Immediately following the opening and checking of Bids, the Department will return all Bid
Guaranties submitted in the form of a check, except for those of the two lowest Bidders. The
Department will return the Bid Guaranty of the unsuccessful of the two lowest Bidders, if
submitted in the form of a check, within 10 Days of the Contract Award. The Department will
return the retained Bid Guaranty of the successful Bidder, if in the form of a check, after the
successful Bidder has furnished satisfactory Contract bonds and the Contract has been
executed. The Department will return Bid Guaranties in the form of Bid bonds only upon the
request of an unsuccessful Bidder.

103.6 REQUIREMENT OF CONTRACT BONDS
Return the signed Contract with Contract Bonds. The value of each bond shall equal the
Total Original Contract Amount. The Department must approve the surety and the form of the
Contract Bonds.

103.7 EXECUTION AND APPROVAL OF CONTRACT
The successful Bidder shall sign and return the Contract and provide Contract Bonds and
lists of subcontractors and Suppliers within 15 Days of receiving the Contract. If the
Department fails to execute the Contract within 30 Days of receiving the signed Contract and
Contract Bonds from the successful Bidder, the Bidder may withdraw the Bid without penalty.
No Contract shall be effective until it has been fully executed by the Department and the
Contractor.

103.8 FAILURE TO EXECUTE CONTRACT
Failure by the successful Bidder to return the signed Contract and Contract Bonds within
15 Days of receiving the Contract shall constitute just cause for cancellation of the Award and
the forfeiture of the Bid Guaranty which shall become the property of the Department, not as a
penalty but as liquidation of reasonable damages sustained. The Department may then
Award the Contract to the Bidder with the next lowest Responsive Bid, re-advertise the Work,
or take other actions as the Department may decide.
104.1 INTENT OF THE CONTRACT
The intent of the Contract is to provide for the construction and completion in every detail of the Work described in accordance with the Plans, Specifications, and Contract terms except for Materials supplied by the Department in accordance with Section 106.8, “Department-Provided Material.”

104.2 SIGNIFICANT CHANGES IN THE CHARACTER OF THE WORK
The Department reserves the right to make, in writing, modifications in quantity and alterations to the Work. Such changes will not invalidate the Contract nor release the Contractor’s Surety, and the Contractor shall perform the Work as altered.

If modifying the quantities or altering the Work significantly changes the character of the Work, the Project Manager will make an adjustment to the Contract which excludes anticipated profit. The Project Manager and the Contractor shall agree upon the adjustment prior to the Contractor’s performance of the Work. If an agreement is not reached, the Project Manager will determine a fair and equitable adjustment.

If the modifications or alterations do not significantly change the character of the Work, the Department will pay for the altered Work in accordance with the Contract Bid Items.

“Significant change” applies only to modifications or alterations that:
1. Materially change, in kind or nature, the character of the Work; or
2. Increase a Major Contract Item more than 125% of or decrease such an item below 75% of the original contract quantity. Compensation shall apply only to the following:
   2.1 The actual Work performed above 125% of the original quantity of the Major Contract Item; or
   2.2 The actual Work performed below 75% of the original quantity of the Major Contract Item;
3. Affect Work performed under a Department-approved subcontract. The Department will make adjustments if, prior to the Work, the Contractor demonstrates that the change adversely affects the subcontractor’s work or payment.

The Department will not consider customary increases or decreases in quantities necessary to complete the Work changed by the Contractor’s schedule of operations, his or her planning of the Work, or unscheduled mobilizations.

104.3 DIFFERING SITE CONDITIONS
The Contractor and the Project Manager shall provide the other with prompt written notice of the following conditions encountered on the Project during the progress of the Work:
1. Latent physical conditions differing materially from those shown in the Contract; or
2. Unknown conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in the Work.

The party providing notice shall do so before the conditions are disturbed or as soon thereafter as practicable and before the affected Work continues.

The Project Manager will decide, within a reasonable period of time after written notification, whether the conditions materially differ and cause an increase or decrease in the cost or time required to perform the Work. The Project Manager will notify the Contractor of this decision.

The Project Manager will adjust the Contract for such conditions. The adjustment will be in accordance with Section 109.5, “Payment for Changes, Differing Site Conditions, and Extra Work,” and will include the costs of delays but exclude anticipated profits.

If a party’s failure to provide prompt written notice results in additional costs to the other party which could have been mitigated, the Department will adjust the Contract accordingly.

104.4 EXTRA WORK
The Contractor shall perform Extra Work at the Department’s direction and in accordance with the Specifications. The Department will pay for Extra Work in accordance with Section 104.2, “Significant Changes in the Character of Work” and Section 109.5, “Payment For Changes, Differing Site Conditions, and Extra Work.”
104.5 MAINTENANCE OF TRAFFIC

Provide, erect, and maintain barricades, warning signs, flaggers and pilot cars in accordance with the version of the MUTCD current at the time of letting, the traffic control plan and Division 700, “Traffic Control Devices.” Provide flaggers with proper training and Equipment in accordance with the MUTCD. Keep flagging Equipment clean and in good repair. Keep the existing Roadway open with a minimum of inconvenience to the traveling public or provide an approved alternate route.

The Contractor’s Equipment shall enter and leave the open Roadway in the direction of public traffic, except with the approval of the Project Manager. The Contractor shall not endanger the traveling public when moving Equipment on or across the open Roadway.

The Project Manager may direct the Contractor to maintain the pavement surface of open Traffic Lanes adjacent to the work zone within the limits of the Project traffic control. The Department will pay for this Work in accordance with Section 109.5, “Payment For Changes, Differing Site Conditions, and Extra Work” and will either be negotiated or paid by Force Account.

The Department is responsible for snow removal on sections of Roadway open to the traveling public. The Contractor is responsible for snow removal on sections of the Roadway not open to the traveling public, as necessary for protection of the Work. The Project Manager will coordinate snow removal with the Contractor and the maintenance patrol.

Furnish warning devices, take protective measures provided in this section, and complete Shoulder Work, drainage Structures, or other features of the Work. If the Contractor fails to do so, the Project Manager will notify the Contractor in writing and give the Contractor a reasonable amount of time to make corrections. If the Contractor does not make a reasonable effort to make corrections in this period, the Project Manager may make corrections or terminate the Contract in accordance with Section 108.9, “Default of Contract.” The Contractor shall reimburse the Department for the costs of such corrections.

Provide reasonable vehicular and pedestrian ingress and egress to adjoining properties during the duration of the Contract. Advise and schedule access modifications with local business owners and residences and the Project Manager at least 24 hours in advance.

Open partially completed sections of the Roadway to traffic under the following conditions:

1. At the Project Manager’s direction;
2. As shown on the Plans; or
3. If requested by the Contractor and approved by the Project Manager.

Such an opening shall not constitute a full or partial acceptance of the Work or a waiver of any Contract provisions. The Project Manager will provide written instructions stating any sections not shown on the Plans which are to be opened.

If the Project Manager directs the opening of a Roadway section because of an unforeseen need that is not the fault of the Contractor, the Department will negotiate a Change Order for additional compensation or additional time, if any, qualifying under Section 104.2, “Significant Changes in the Character of the Work.”

If a Roadway section is opened at the request of the Contractor, the Contractor shall remain liable for the section until final acceptance of the Project and must repair, at its own expense, any resultant damage to the section except differing site conditions which shall be paid as Extra Work under Section 104.2, “Significant Changes in the Character of the Work,” and Section 109.5, “Payment For Changes, Differing Site Conditions, and Extra Work.”

104.6 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK

The Contractor may use stone, gravel, sand or other material meeting Contract requirements and found in an excavation required by the Contract. The Department will pay for the excavation at the Bid Item Unit Price for Excavation and will pay for the pay item for which the Contractor uses the material.

If the excavated material would have been used to construct Embankments or Bridge approaches or for other purposes, any of which would have been required to complete the Contract, the Contractor shall replace the excavated material with acceptable Material at no additional cost to the Department. The Department will not charge the Contractor for the use of the excavated material. The Contractor shall obtain written authorization from the Project Manager before excavating material that is within the Right of Way but outside the grading limits, as shown by the slope and grade lines. Prior to granting approval, the Project Manager will verify that the requirements of Section 107, “Legal Relations, Environmental
Requirements, and Responsibility to the Public” have been met. If not previously cleared environmentally, meeting these requirements will be the responsibility of the Contractor.

Unless otherwise provided, the Contractor may temporarily use the material from existing Structures in the erection of a new Structure but shall not, without the approval of the Project Manager, cut or otherwise damage such materials.

104.7 FINAL CLEANUP

Before final acceptance, clean waste (including concrete and asphalt chunks, loose rock, excess materials, and temporary Structures) from the Roadway and pit sites and ground used in connection with the Work. Leave all parts of the Work in an acceptable condition. To avoid the requirement of removal of Equipment from private property before final acceptance, make appropriate arrangements with private property owners.

Re-vegetate Borrow Pits, haul roads, and all occupied ground in accordance with Section 632, “Seeding” and the Contract. Acceptance by the Project Manager of a letter of intent from the landowner for future use may exempt haul roads or other areas from this requirement.

Strip Borrow Pits and Surfacing Pits when indicated on the Plans and stockpile topsoil. After construction operations are complete, place stockpiled materials uniformly over the stripped area to form a seedbed for planting. Spread stockpiled waste that is not covered by a land owner agreement over the stripped area prior to placing the topsoil. The Department will consider striping, stockpiling, and replacement of topsoil and spreading of stockpiled waste to be incidental to completion of the Work unless a Contract Item for them exists in the Bid. Do not allow Borrow Pits and Surfacing Pits to change the general pattern of existing drainage. Unless Borrow Pits or Surfacing Pits are suitable to develop as ponds or lakes and the property owner has notified the Department in writing that such development is planned, where practicable leave all pits well drained.

When excavation is complete, contour grade pits, except quarry pits, to blend with the natural topography of the surrounding area or in accordance with the Contract or agreements with the property owners.

Pits located on state or federal land are governed by the appropriate requirements of their agency. The above requirements do not apply to a commercial source.

104.8 VALUE ENGINEERING COST PROPOSAL (VECP)

When the Total Original Contract Amount exceeds $100,000, the Contractor may submit a VECP which does not impair any of the following:

1. Service life;
2. Economy of operation;
3. Ease of maintenance;
4. Desired appearance;
5. Safety;
6. Environmental requirements; or
7. Any other essential functions and characteristics of the Project.

The Department will not consider proposed changes to the intent of the Contract.

The Contractor shall provide sufficient information for a VECP to stand on its own merit and require minimal verification as determined by the Department.

104.8.1 Content Requirements

Provide, at a minimum, the following information in a VECP:

1. A statement identifying the submittal as a VECP;
2. A description of the Work to be performed under the Contract and under the VECP;
3. An engineering analysis including drawings, computations, and other documents necessary for an evaluation by the Department;
4. A list of the Contract requirements that must be changed if the Department adopts the proposal and a recommended way to make these changes;
5. A detailed estimate of the Contractor’s cost to perform the Work under the existing Contract and under the proposal, including the cost of developing and implementing the change;
6. A list of the pay items affected by the proposal and the resulting difference in quantities;
7. An assessment of the effects that the adoption of the proposal will have on other Department costs, including future maintenance and operation;
8. A deadline, if any, for the Department to accept the proposal; and
9. A statement of the effect that adoption of the proposal will have on the Contract
Time and the schedule.

104.8.2 Procedural Requirements
The following requirements and procedures apply to VECP:
1. In order to expedite the processing of a VECP and to minimize costly studies by the
Contractor and Department, the Contractor may submit to the Department, on a
Department form, a summary of the VECP. The Department will evaluate the
summary for merit and submit a recommendation to the Contractor. A favorable
recommendation to the Contractor shall not be construed as acceptance of all or
any part of the submittal;
2. The Department will not accept a VECP if it is similar to a change in the Plans or
Specifications the Department is considering for the Project at the time the proposal
is submitted or if the proposal is based upon or similar to the Standard
Specifications, Special Provisions, standard drawing serials, or procedures the
Department adopted after the Advertisement for the Contract;
3. The Department will execute a Change Order with the necessary Contract
modifications if it accepts a VECP;
4. If the Department approves a VECP, only the Contractor who initially submitted the
proposal will be eligible for payment in accordance with Section 104.8, “Value
Engineering Cost Proposals (VECP).” In this case, the approved VECP will apply
only to those contracts which were awarded to the Contractor before submission of
the VECP and for which the proposal was submitted;
5. The Department will deduct from the net savings the costs it incurs implementing
the accepted VECP and the changes;
6. The Department will be the sole judge of the estimated net savings resulting from an
approved VECP. In determining the estimated net savings, the Department may
disregard the Bid Item Unit Price if, in his or her judgment, the prices are not a fair
measurement of the Work performed or deleted. The Department will also
determine the net savings by considering actual JMFs, shrink and swell factors and
other actual design criteria used;
7. The Contractor’s share of an approved VECP is 50% of the net savings;
8. The Contractor’s share of 50% of the net savings shall be full compensation for
effecting all changes pursuant to the Change Order resulting from an approved
VECP;
9. The Department will not pay for the actual costs of implementing an approved VECP
if these costs exceed the Contract amount originally committed;
10. When the District Engineer determines the actual net savings, the Department will
execute a Change Order for a lump sum payment of the Contractor’s share. The
Project Manager may approve a schedule for partial payments;
11. In preparing a VECP, the Contractor shall perform an independent examination of
the affected work site. The Department will rely exclusively upon the accuracy of
the engineering data upon which the VECP is based and will not be required to
perform additional investigations, crosschecks, or site examinations. The
Department’s acceptance or adoption of a VECP shall not be construed to alleviate
or reduce the Contractor’s full and absolute liability if the implementation of the
proposal fails to satisfactorily perform. Except as set forth in Section 105.18.2,
“Final Acceptance,” the Contractor’s liability will not extend beyond the Department’s
final written acceptance.
SECTION 105: CONTROL OF WORK

105.1 RESPONSIBILITY AND AUTHORITY OF THE DEPARTMENT
The Department has the authority to:
1. Manage the Contract;
2. Alter the Plans;
3. Modify the Contract by Change Order;
4. Supervise and terminate the Contract as expressly provided in other sections of the
   Standard Specifications; and
5. Wholly or Partially Suspend the Work for justifiable causes (e.g., weather).
   The Department has the authority to wholly or partially Suspend the Work and to withhold
   partial payments if the Contractor:
   6. Fails to correct unsafe conditions;
   7. Fails to carry out provisions of the Contract;
   8. Fails to carry out directions of the Project Manager; or
   The Contractor shall not receive additional compensation or time for these failures.

The Project Manager may also wholly or Partially Suspend the Work for reasons beyond
the control of the Contractor or not connected to the construction of the Project when the
Project Manager deems such a suspension to be in the best interests of the public.

The Department will pay for additional Work caused by such a suspension pursuant to
Section 104.2, “Significant Changes in the Character of Work,” and will adjust any Contract
Time for such a suspension pursuant to Section 108.6, “Determination and Extension of
Contract Time.”

The Contractor may request a suspension of the Work wholly or partially, but shall not
suspend the Work without written approval from the Project Manager.

105.2 PLANS AND WORKING DRAWINGS
Perform the Work in accordance with the details shown on the Plans prepared by the
Department and the approved Working Drawings prepared and submitted by the Contractor.
The Contractor shall have the sole responsibility for verifying pertinent dimensions in the field
before submitting such Working Drawings to the Department.

The Project Manager will review the Working Drawings although the Project Manager’s
review does not relieve the Contractor of the responsibility for the satisfactory completion of
the Work. The Contractor shall obtain written approval of the Working Drawings from the
Project Manager before beginning Work covered by the drawings and shall not alter or amend
such drawings without the prior written approval of the Project Manager. The Contract price
shall include the cost of furnishing all Working Drawings.

The Department will provide 10 sets of approved Plans to the Contractor and, upon the
Contractor’s request, additional sets for the cost of printing, assembling and mailing the
documents. The Department will provide all Department-directed and approved changes to
the Plans, and the Contractor shall maintain a current set of Post Construction Plans which
includes all such changes. The Department has the right to inspect the Post Construction
Plans.

105.3 COMPLIANCE WITH PLANS AND SPECIFICATIONS
The Contractor shall perform the work and provide materials in substantial compliance
with the lines, grades, cross sections, dimensions, and material requirements as specified by
the Contract. If work does not comply with the Contract, the Project Manager will determine if
the non-complying work is acceptable. If accepted, the Project Manager will document the
basis of acceptance by Contract Change Order, and provide an adjustment in the Contract
price for work or materials, as necessary. If the work or materials do not comply with the
Contract and the Project Manager determines they are unacceptable, the Contractor shall
remove, replace, or correct the work or materials at no additional cost to the Department.
105.4 COORDINATION OF CONTRACT DOCUMENTS

The following documents are essential parts of the Contract and are intended to be complementary. In case of a discrepancy, the documents will govern in the following order of importance:

1. Addenda;
2. Required Documents for Bid Submittal;
3. Notice to Contractors;
4. Invitation for Bids;
5. Special Provisions;
6. Plans other than Standard Drawings;
7. Supplemental Specifications;
8. Standard Specifications; and

Dimensions given on the Plans or that can be calculated govern over scaled dimensions.

The Contractor shall, upon discovery, promptly notify the Project Manager of errors or omissions in the Plans, contradictions within these documents or contradictions between these documents and the worksite. The Project Manager will resolve the discrepancy in writing before the Contractor proceeds further.

Failure of the Contractor to promptly notify the Project Manager of an apparent discrepancy shall be deemed a waiver of the Contractor’s right to claim for a price adjustment for Extra Work resulting from the discrepancy. In addition, the Contractor may be fully liable for damages suffered by the Department resulting from the Contractor’s failure to provide said notice of a discrepancy.

The Project Manager and the Contractor may agree that the Contractor will obtain drawings, modifications, or other documents necessary to correct the error or omission. The Department will pay for this Work pursuant to Section 104.2, “Significant Changes in the Character of the Work.”

105.5 COOPERATION BY CONTRACTOR

Monitor the Work at all times, facilitate the progress of the Work, and cooperate completely with Department personnel and other contractors. Regardless of the amount subcontracted, the Contractor shall have on the Project at all times during the course of the Work, a competent Superintendent who:

1. Reads and understands the Contract documents as listed in Section 105.4, “Coordination of Contract Documents;”
2. Possesses substantial experience in the type of Work being performed;
3. Possesses full authority to execute the orders of the Project Manager without delay and to promptly supply such Materials, Equipment, tools, labor, and incidentals as may be required by the Work;
4. Can be contacted at an office maintained by the Contractor on the jobsite or at a convenient location nearby; and
5. Attends the pre-construction conference.

The Department will provide an experienced Project Manager with an adequate staff and crew to keep pace with the Contractor’s progress and will maintain an office at a convenient location.

Recognize the Project Manager as the Department’s contact for all matters relating to the Project and submit all documentation or notice required by the Contract to the Project Manager.

105.6 COOPERATION WITH UTILITIES

The Department will notify all utility companies, all pipeline owners, or other parties who seemingly are affected by the proposed construction and will endeavor to have all the necessary adjustments of utility fixtures, pipelines, and other appurtenances within or adjacent to the limits of construction made before the Award of the Contract or as soon as practicable thereafter. The Contractor will cooperate with all such relocations and adjustments performed by others during the course of the Contract.

Upon request, the Department will make available to the Contractor all information received from utility companies, pipeline owners and other parties that the Department has notified concerning the proposed construction. This Department-furnished information does not abrogate the Contractor’s responsibility for any further verifications and utility inquiries.
necessary to properly address permanent and temporary utility appurtenances in the
performance of the Work.

The following items which are to be relocated or adjusted will be moved by others at no
expense to the Contractor unless otherwise provided for in the Special Provisions or in the
Plans:

1. Potable and non-potable waterlines;
2. Sanitary sewer or storm drain lines;
3. Electric or communication lines;
4. Gas or petroleum product lines;
5. Irrigation systems and appurtenances;
6. Pumping, generation, microwave, metering, and substation facilities;
7. Individual property service and metering connections;
8. Utility manholes;
9. Galleries, conduits, and cables;
10. Switching equipment;
11. Valve boxes;
12. Highway, Street, or Road lighting; and

If the utilities or others fail to relocate or adjust utility items and the Contract does not
impose the responsibility for the relocation or adjustment on the Contractor, the Department
may require the Contractor to effect the relocation or adjustment. The relocation or
adjustment will be covered by a Change Order, if necessary, and the Contractor shall perform
such Work at Bid Item Unit Prices, or if none exist, at negotiated prices or on a Force Account
basis in accordance with Section 104, “Scope of Work,” and Section 109.5, “Payment for
Changes, Differing Site Conditions, and Extra Work.”

The Contractor may receive additional time under Section 108.6, “Determination and
Extension of Contract Time,” for delays caused by the failure of a utility owner or others to
make a timely relocation or adjustment or for delays caused by utilities not identified by the
Contract.

The Contractor may receive additional compensation under Section 109.11,
“Compensation for Project Delays,” for the cost of delays resulting from the failure of a utility
owner or others to make a timely relocation or adjustment.

If public or private utility lines or pipelines or other appurtenances unknown to the
Department and the Contractor are encountered during the Work, the Contractor shall
immediately suspend construction operations at the site of the utility in question until the
Department and the utility owner negotiate and complete the required relocation or
adjustment.

The Contractor shall be responsible for resolving all problems resulting from the
Contractor’s failure to make inquiries or notify all known utility companies, pipeline owners or
other parties of any work or conflicts. In this instance the Contractor will not be allowed
adjustments for delays or extra expense.

105.7 COOPERATION BETWEEN CONTRACTORS

The Department reserves the right at any time to contract for and have performed other
work on or near the Project. When the Department anticipates multiple contractors working
within the same project limits, the Bid documents will include sufficient information to allow
Bidders to reasonably estimate the impact of the concurrent work. If the Department employs
multiple contractors and conflicts occur which could not have been reasonably anticipated at
the time of the Bid Openings, the Department will allow an equitable adjustment in the
Contract Time and price.

The Contractor shall:

1. Conduct and sequence the Contractor’s Work without unnecessarily interfering with
   or hindering the progress of other contractors’ work;
2. Cooperate with contractors working on the same Project as directed;
3. Integrate the sequence of the Contractor’s Work with the activities of other
   contractors;
4. Arrange the Work and place and dispose of the Materials being used so as not to
   unreasonably interfere with the operation of other contractors; and
5. Protect and hold harmless the Department for all damages or claims as per
   Section 107.19, “Responsibility for Damage Claims.”
If the Contractor and one or more other contractors are unable to agree upon the sequence of Work or other matters, the Contractor shall petition the Project Manager in writing for a decision. The Project Manager will allow a reasonable time for all parties to respond and, after reviewing the information received, will issue a decision binding on all parties within 7 Days of receiving such information.

105.8 AUTHORITY AND DUTIES OF THE PROJECT MANAGER
The Project Manager is a designee of the Cabinet Secretary with authority commensurate with that of the Secretary and has the following responsibilities:
1. Immediate charge of the details of the Project;
2. Administration and satisfactory completion of the Project; and
3. Authority to reject defective Material and construction quality;
Submit project issues to the Project Manager who will resolve all questions regarding:
4. The quality and acceptability of Materials provided;
5. Work performed;
6. Rate of progress of the Work;
7. Interpretation of the Plans and Specifications;
8. Acceptable performance of the Contract requirements; and
The decision of the Project Manager will be in writing and delivered to the Contractor’s Superintendent as soon as reasonably possible.

105.9 DUTIES OF THE INSPECTOR
The Department authorizes its inspectors to:
1. Inspect the Work;
2. Inspect the preparation, fabrication or manufacture of Materials; and
3. Reject Work or Materials not in conformance with the Contract until any issues can be referred to the Project Manager for a decision.
The Contractor shall refer questions at issue to the Project Manager for a decision.
The Department does not authorize its inspectors to:
4. Alter or waive the provisions of the Contract;
5. Issue instructions contrary to the Plans and Specifications;
6. Act as the foreman for the Contractor; or
7. Suspend the Work, except for safety reasons.

105.10 INSPECTION OF WORK
 Allow the Department access to the Work and provide information and assistance required to make a complete and detailed inspection of Materials and Work.

The Project Manager may direct the Contractor to remove or uncover portions of the finished Work, at any time before final acceptance of the Work. The Contractor shall restore the portions of the Work to the standard required by the specifications after the Project Manager's examination. If the examined Work is acceptable, the Department will pay for the removal and restoration as Extra Work under Section 104, “Scope of Work,” and Section 109.5, “Payment For Changes, Differing Site Conditions, and Extra Work.”

However, if the examined Work is unacceptable, the Contractor shall remove and restore the Work at no additional cost to the Department.

The Department may order Work done or Materials used without inspection by an authorized Department representative to be removed and replaced at no additional cost to the Department. If the Department representative failed to inspect Work done or Materials used after receiving the required notice, the Contractor will not be responsible for costs for removal and replacement. When a unit of government, political subdivision, or a railroad corporation is to pay a portion of the cost of the Work covered by the Contract, its representatives will have the right to inspect the Work. This inspection will not make the unit of government or political subdivision or the railroad corporation a party to the Contract and will not interfere with the rights of either party.

105.11 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK
The Department considers Work that does not conform to the requirements of the Contract to be unacceptable, unless it is determined acceptable under the provisions of Section 105.3, “Compliance With Plans and Specifications.”
Section 105: Control of Work

Remove unacceptable Work resulting from causes existing before the final acceptance of the Work and replace in an acceptable manner. The Project Manager will set the time limit for the replacement Work.

The Contractor shall not perform Work before the Department establishes lines and grades. The Department will not pay for the following under the provisions of the Contract:
1. Work performed contrary to the Project Manager’s direction;
2. Work performed beyond the lines and grades on the Plans; or
3. Work performed without authority.

The Department may order the Contractor to remove or replace such Work, at no additional cost to the Department.

Upon failure of the Contractor to comply with the removal and replacement of unacceptable or unauthorized Work within the time specified by the Project Manager, the Project Manager shall have authority to cause unacceptable Work to be remedied or removed and unauthorized Work to be removed by others with the costs to be deducted from monies due or to become due to the Contractor.

105.12 LOAD RESTRICTIONS

Observe legal load restrictions when hauling Equipment or Material on public roads outside of the project or on Roadways within the project. The Project Manager may approve exceptions, in writing. The Contractor is liable for damage that may result from moving Equipment, even with the issuance of a special permit.

Do not use Equipment or haul loads that will cause damage to Structures, Roadway, or any other construction, regardless of legal load allowances.

Do exceed legal loads on treated base or pavement under construction. The Department will not allow loads over PCC construction before the minimum curing period has expired or specified strength is obtained.

If the Project Manager determines that hauling operations are causing undue damage to existing Roadways or Structures, the Project Manager will issue a written order to the Contractor to stop operations causing the damage. Within 7 Days of the notice, the Project Manager will decide on one of the following solutions:
1. Change the haul route;
2. Reduce the allowable load limit; or
3. Allow the operations to continue with the requirement that the Contractor repair all damaged areas when and where they occur. The Department will pay for this Work in accordance with Section 105.13.1, “Corrective Actions and Methods of Payment.”

The Project Manager may decide to use two or more of these requirements simultaneously.

105.13 HAUL ROADS

If the Contract establishes Material sources and haul roads and the Contractor elects to use others, the Department will not pay the Contractor for corrective actions required to repair damage to existing Roadway and Structures resulting from the Contractor’s sources and hauling operations.

If the Contract specifies that the Contractor establish Material sources and haul roads or when the Contractor uses those specified in the Contract, and the Department determines that preservation or restoration of the existing Roadway or Structures is necessary, see Section 105.13.1, “Corrective Actions and Methods of Payment.”

If the Contractor’s own Material sources are used but transported on some Contract-specified haul roads, and the Department determines that preservation or restoration of the existing Roadway or Structures is necessary, the corrective action and method of payment will be as follows:
1. The Contractor shall repair haul roads not established by the Contract at no additional cost to the Department;
2. The Department will pay for repairs to Contract-established haul roads in accordance with Section 105.13.1, “Corrective Actions and Methods of Payment.”

The Project Manager will determine the extent of the corrective action.

105.13.1 Corrective Actions and Methods of Payment

If the Project Manager changes the haul route, the Department will modify the Contractor’s payment per the following equation
\[ P = R \times t \times (d_1 - d_0) \]  

where  
- \( P \) is the payment modification (in dollars)  
- \( R \) is the rate (in dollars per ton mile determined in accordance with Section 109, “Measurement and Payment.”)  
- \( t \) is the weight of Material hauled from the new stockpile area (in tons)  
- \( d_0 \) is the original haul distance measured from the Roadway access point to the original stockpile area  
- \( d_1 \) is the new haul distance measured from the Roadway access point to the new stockpile area  

If the Project Manager reduces the allowable load limit, the Department will pay the Contractor in accordance with the following equation:

\[
P = \frac{QF \times R \times d \times (LA - LR)}{LA}
\]

where  
- \( P \) is the additional payment (in dollars)  
- \( R \) is the rate (in dollars per ton mile determined in accordance with Section 109, “Measurement and Payment.”)  
- \( QF \) is the total quantity of Material hauled at the reduced load limit (in tons)  
- \( LA \) is the allowable load limit (in tons)  
- \( LR \) is the reduced load limit (in tons)  
- \( d \) is the haul distance (in miles)  

If the Project Manager allows operations to continue, the Department will pay the Contractor for the Material used to make the repairs at the Bid Item Unit Price, or in accordance with Section 109, “Measurement and Payment.” If an item is not part of the Contract, the Department will negotiate a new unit price. If a Structure or existing Roadway must be repaired, the Department may pay the Contractor for hauling repair Materials using a rate requested and justified by the Contractor and approved by the Project Manager.

105.14 RESERVED

105.15 MAINTENANCE DURING CONSTRUCTION

Maintain the Work during construction and until the Department accepts the Work, except as otherwise provided in Section 104.5, “Maintenance of Traffic,” and Section 105.18, “Acceptance.” This maintenance shall consist of continuous, daily work with adequate Equipment and forces so that the Roadway and Structures are kept in satisfactory condition.

In the case of a Contract for placing a course on a previously constructed course or Subgrade, the Contractor shall maintain the previous course or Subgrade during all construction operations, including when the Plan requires the Contractor to place traffic on the unfinished Roadway.

Include all costs of maintenance work during construction and before the project is accepted in the Bid Item Unit Prices for the various pay items. The Department will not pay the Contractor an additional amount for this work except in accordance with Section 104.5, “Maintenance of Traffic,” and Section 105.18, “Acceptance.”

105.16 FAILURE TO MAINTAIN ROADWAY OR STRUCTURE

If the Contractor fails to maintain the Project in accordance with Section 105.15, “Maintenance During Construction,” the Project Manager will notify the Contractor of the failure. If the Contractor does not begin maintenance after such notice, the Project Manager may begin maintenance of the Project. The Department will deduct the cost of this maintenance from compensation due, or to become due, the Contractor.
105.17 SUSPENSION OF WORK ORDERED BY THE PROJECT MANAGER

If the Work is suspended or delayed by the Project Manager in writing for an unreasonable time (not originally anticipated, customary, or inherent to the construction industry), the Contractor may submit to the Project Manager a claim for additional compensation and Contract time in accordance with Section 105.20, “Administrative Remedy.” The request shall set forth the reasons and support for such adjustment.

Upon receipt, the Project Manager will evaluate the Contractor’s request. If the Project Manager agrees that the cost and time required for the performance of the Contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its Suppliers, or subcontractors at any approved tier, and not caused by weather, the Project Manager will make an adjustment in accordance with Section 109.11, “Compensation for Project Delays” and modify the Contract in writing accordingly. The Project Manager will notify the Contractor of the decision.

The Department will not make a Contract adjustment under this clause if the Contract performance would have been suspended or delayed by any other cause. The Department will not make a Contract adjustment under this clause if a Contract adjustment is provided or excluded under any other term or condition of this Contract.

105.18 ACCEPTANCE

105.18.1 Partial Acceptance

The Contractor may request that the Project Manager inspect a portion of the Project (e.g. a Structure, a section of road, etc) at any time during the Work. If the Project Manager finds that portion to be in accordance with the Contract, the Project Manager may accept that portion as complete, and the Contractor may be relieved of further responsibility for that portion unless the Department discovers latent defects before final acceptance of the Work. Such partial acceptance does not void or alter the Contract.

The Department will accept permanent traffic safety and control devices installed in accordance with the Contract (with all ancillary components) and being used by the public upon installation but before Completion of the remaining Work.

Permanently installed items accepted on this basis are limited to the following:
1. Guardrail;
2. Impact attenuators;
3. Traffic Signals;
4. Signs;
5. Lighting;
6. Raised pavement markers;
7. Concrete wall barrier;
8. Concrete Bridge parapet;
9. Bridge railing;
10. Guard cable;
11. Guardrail anchorages;
12. Permanent pavement markings; and
13. Fence.

All required performance tests and guarantees shall remain applicable. The Department or the Contractor will repair or replace any damage, theft, or vandalism to these items after acceptance in accordance with Section 104.4, “Extra Work.” If the damage to an item requires only partial repair or replacement and the Contractor performs the Work, the Department will pay the Contractor in accordance with Section 109.4, “Compensation for Altered Quantities.” The Contractor shall repair or replace items damaged due to the Contractor’s negligence, at no additional cost to the Department.

The Contractor shall erect these items in a logical construction sequence. The Department will not accept prematurely constructed items until they can be used for their intended purposes.

105.18.2 Final Acceptance

The Contractor shall provide written notification to the Project Manager of the projected Completion date. The Project Manager will inspect the Project on this date to verify that all Work items are complete. After such verification, the final inspection by the Project Manager and the District Construction Engineer will be scheduled and conducted within 14 Days. If the Project Manager and the District Construction Engineer are satisfied that the Contract is
complete, that inspection will constitute the final inspection. The Project Manager will provide written notification of this acceptance to the Contractor within 9 Days.

If the inspection reveals Work that is unsatisfactory, the Project Manager will give the Contractor written instructions for correction and set the time limit for the Contractor to comply with these instructions. Upon the Contractor’s correction of the Work, the Project Manager will make an additional inspection and notify the Contractor of the findings as soon as reasonably possible.

The Department will accept the project as soon as practicable after completion and inspection of the Work. Acceptance is final and conclusive, except for the following situations:

1. Latent defects;
2. Fraud;
3. Gross mistakes that amount to fraud; or
4. The Department’s warranty or guaranty rights.

105.19 CLAIMS FOR ADJUSTMENT

Make claims for additional compensation and time in accordance with Section 108.6, “Determination and Extension of Contract Time.”

The Contractor is barred from filing claims after the Project Manager has determined the Work ordered is Extra Work. Payment will be made in accordance with Section 109.5, “Payment For Changes, Differing Site Conditions, and Extra Work.”

To make a claim, notify the Project Manager in writing of the intention to make a claim before beginning the Work on which the claim is based, or in the case of termination of Contract under Section 108.10, “Termination of Contract; No Fault of Contractor,” within 30 Days of the effective termination date.

The Contractor waives the right to claim for additional compensation if notification is not given and the Project Manager is not afforded proper facilities to keep account of actual cost. The Project Manager may waive this requirement in writing with adequate justification.

Notice by the Contractor and the Project Manager’s accounts of the cost, shall not be construed to prove or validate the claim. If the Project Manager finds that the claim is valid, the Project Manager will draft and submit a Change Order for approval. The approved claim will be paid in accordance with Section 104, “Scope of Work,” and Section 109, “Measurement and Payment.”

105.20 ADMINISTRATIVE REMEDY

The Department may dismiss a Contractor’s claim made in accordance with Section 105.19, “Claims for Adjustment,” for failure to comply with the following time limitations and procedures for claims:

1. The Contractor shall submit the claim in writing to the Project Manager and include justification for the claim and the amount requested no later than 60 Days after final acceptance as defined in Section 105.18.2, “Final Acceptance.” The Contractor shall provide the following supporting documentation for the claim:
   1.1. Description of the issue;
   1.2. Location where the issue arose;
   1.3. Time and date the issue was identified and the dates impacted;
   1.4. Clear explanation why the issue requires additional compensation or a change to the Contract, including references to the relevant portions of the Contract;
   1.5. Copies of all correspondence related to the issue;
   1.6. Schedules and invoices identifying the labor, Materials, and Equipment used or proposed to be used;
   1.7. Amount of claim up to the time of filing in terms of time and compensation.

2. Subcontractor claims will not be considered, except when submitted and certified by the Contractor as the Contractor’s claim.

The District Engineer or designee has 30 Days from the date the claim is received by the Project Manager, or additional time agreed upon by both parties in writing, to review and render a decision. If the District Engineer or designee does not make a written decision within the 30 Days or the agreed upon time, the claim will be deemed denied by the District Engineer or designee. The parties may engage in informal mediation to resolve the claims at the District level. This mediation does not relieve the Contractor from exhausting the provisions of the New Mexico Public Works Mediation Act (NMSA 1978, § 13-4C-1 et seq.), before seeking judicial relief in a court of law.
Within 10 Days of receiving from the District Engineer or designee a written denial of its claim or a written notice that the attempted mediation of its claim was unsuccessful, the Contractor may deliver a written request for the Cabinet Secretary to reconsider the claim. The Cabinet Secretary will provide a written decision on the request or will refer the claim to the Department’s Claims Board within 15 Days of receipt of the request.

If the claim is referred to the Department’s Claims Board, the Cabinet Secretary will provide a written decision within 15 Days of receipt of a recommendation on the claim from the Claims Board.

If the Contractor is not satisfied with the Cabinet Secretary’s decision regarding the Contractor’s request for reconsideration, the Contractor may, within 30 Days of receiving the decision, either proceed with litigation in a court of competent jurisdiction or deliver a written request to the Cabinet Secretary to convene an arbitration panel. The Contractor's proceeding with litigation or requesting an arbitration panel shall operate as a waiver by the Contractor of recovery under any written decision issued by the Cabinet Secretary. The Contractor’s acceptance of the Change Order pursuant to a written decision by the Cabinet Secretary operates as waiver of the Contractor’s right to proceed with further litigation or arbitration regarding said claim. A Contractor may request arbitration only if the total amount for all submitted project claims does not exceed $250,000, or if the Department and Contractor agree to submit the claims to arbitration. By electing either litigation or arbitration, the Contractor waives the right to redress under the other.

105.20.1 Arbitration

The arbitration panel consists of three members. In the arbitration request, the Contractor shall submit the name of a panelist. The Contractor’s panelist shall:
1. Not be an employee of the Contractor;
2. Have education or experience in Highway construction methods and techniques; and
3. Agree to serve on the panel.
Within 10 Days of receiving the arbitration request, the Cabinet Secretary will submit the name of a panelist. The Cabinet Secretary’s panelist shall:
4. Not be an employee of the Department;
5. Have education or experience in Highway construction methods and techniques; and
6. Agree to serve on the panel.
Within 15 Days after the Cabinet Secretary Panel appointment, the two panelists will choose a third panelist. The third panelist shall:
7. Not be an employee of either the Department or the Contractor;
8. Have education or experience in Highway construction methods and techniques.
If the two panelists are unable to agree, a district court judge from the First Judicial District will choose the third panelist from a list of four prospective panelists, two each provided by the Department and the Contractor, in accordance with the New Mexico Uniform Arbitration Act (NMSA 1978 § 44-7A-1, et seq.).

Application to the court for this appointment shall be made by either or both parties within 10 Days of the impasse. The panel will hold the hearing in Santa Fe County, unless otherwise approved by the Department, no later than 60 Days after the panel is selected. If the panel fails to meet this deadline, it retains jurisdiction to hear and resolve the issues in dispute.

Each party will pay the expenses and fees of its chosen panelist and attorney. Both parties will share equally the expenses and fees of the third panelist. If both parties agree, they will share court reporter costs. If not, the party requesting the transcription will pay the full cost.

The proceedings and the decision of the panel will be in accordance with the New Mexico Uniform Arbitration Act (NMSA 1978, § 44-7A-1 et seq.). The decision is final and binding and may be vacated, confirmed, or appealed only in accordance with the New Mexico Uniform Arbitration Act (NMSA 1978, § 44-7A-1 et seq.). The Contractor shall not be entitled to prejudgment interest, post-judgment interest, or attorney fees on any award made to the Contractor, whether in litigation or arbitration.
SECTION 106: CONTROL OF MATERIALS

106.1 CONTRACTOR-FURNISHED AGGREGATE AND BORROW SOURCES

Provide Materials that meet the quality requirements of the Contract, and shall notify the Project Manager of proposed sources of Materials before delivery to the Project. The Project Manager may approve Materials at the source prior to delivery. If the Project Manager finds that the sources of previously approved Materials do not produce acceptable Materials, the Contractor shall provide acceptable Materials from other sources, or make changes to the existing source to provide acceptable Materials.

Bear the costs of exploring and developing sources.

Requests for approval of sources of Material are subject to environmental acceptability requirements. Submit Environmental Resource studies and Cultural Resource studies to the Project Manager and to the Environmental Program Manager.

Environmental acceptability requirements do not apply to Commercial Material Sources, but do apply to Materials within a Commercial Material Source that the Contractor obtains with its own forces or forces belonging to its Subcontractor.

The Department may reject sources, or specific areas within sources, due to environmental, social, or cultural concerns. The Department will list rejected sources in the Bid Package. If the Department does not list rejected sources in the Bid Package and then rejects a source, or an area within a source, on which the Contractor relied to prepare its Bid on the Project, the requirements of Section 104.2, “Significant Changes in the Character of the Work,” shall apply.

If the Contractor purchases Material from a Material source established for another project by another Contractor working under contract to the Department, and if the Material source must be expanded beyond the area where environmental and Cultural Resource approvals have previously been obtained pursuant to Section 107.14.1, “Environmental and Cultural Resource Studies and Approvals,” then the requirements for environmental acceptability shall apply to the additional area and requirements of Section 107.14.1, “Environmental and Cultural Resource Studies and Approvals” must be completed.

Prior to delivery of Materials to the project from an aggregate or borrow source, provide the following documentation to the Project Manager:

1. Location of source;
2. Copies of lease agreements, purchase orders, or Pit Agreements the Contractor has made with the pit owner or Supplier;
3. Evidence of environmental acceptability, which includes completing the environmental and Cultural Resource requirements of Section 107.14.1, “Environmental and Cultural Resource Studies and Approvals.” Such evidence shall, where appropriate, also include completing the environmental and Cultural Resource management recommendations. The requirements of Section 104.2, “Significant Changes in the Character of the Work,” shall apply if the time needed to obtain regulatory approval after acceptable submittal exceeds 30 Days;
4. Plans for restoration, including contouring and re-vegetation if necessary;
5. Testing results from a Department-approved Laboratory (after approval of source).

The Environmental Program Manager will notify the Project Manager and the Contractor of the determination within 30 Days of receipt of the submittal.

Repair at the Contractor’s expense all damage to environmental or Cultural Resources caused by failure to meet the requirements for environmental acceptability or abide by Department directives issued to protect resources identified during the environmental and Cultural Resources evaluation. The nature and extent of such repairs shall be determined after consultations between the Contractor, Department representatives, and the regulatory authorities with management jurisdiction over the subject resources.

106.2 SUPPLIER PLANT INSPECTION

The Department may inspect Materials at the Supplier’s plant. In this event, the Contractor shall:

1. Cooperate, and ensure the cooperation of its Materials Supplier;
2. Guarantee unrestricted entry (at reasonable times) to areas where the relevant Material is being manufactured or produced;
3. Arrange for the necessary facilities to adequately inspect the production or fabrication of the Material;
4. Ensure adequate safety measures for the inspection.
The Department may retest Materials, before or during use in the Work, and reject Materials that, when retested, do not meet the requirements of the Contract, even if the Materials were tested and accepted at the plant.

106.3 SAMPLES, TESTS, AND CITED SPECIFICATIONS

If the Project Manager has not provided written permission for the use of untested or unapproved Materials, the Contractor shall assume the risk for such Work. The Project Manager may direct the Contractor to remove unapproved or untested Materials that are tested and found unacceptable, at no additional cost to the Department. The Department will perform tests in accordance with standards, methods, or specifications, current on the Advertisement date. Unless otherwise specified, the Department will take samples and perform tests at its own expense. The Department will provide test results to the Contractor.

106.4 CERTIFICATES OF COMPLIANCE

Submit Certificates of Compliance to the Project Manager before using Material in the Work, and shall ensure each Certificate of Compliance contains the following information:

1. The project number;
2. The name of the Contractor;
3. The date;
4. The specification satisfied;
5. An item number (if applicable);
6. A description of the item supplied;
7. The quantity;
8. The shipment number;
9. The heat number, lot number, or batch number (depending on the type of Material);
10. The seal number (if applicable);
11. The manufacturer of Material; and
12. The printed name, signature, and job title of the company official who certified the document;

Additionally, supply with each Certificate of Compliance:

13. Written verification that the described Material is in accordance with the Contract;
14. Written verification that MTRs, manufacturers’ Certificates of Compliance, and other relevant documents are available to the Department; and
15. Written verification that manufacturing processes associated with the production of steel and iron Materials are in accordance with Section 106.12, “Preference for Domestic Materials,” or special waivers have been granted.

Electric items meeting UL approval and underground utility Materials meeting ASTM or AWWA specifications that are so certified or stamped will require no further certification, unless requested in writing by the Project Manager.

Materials inspected and stamped during the manufacturing process by a representative of the Department will require no further certification.

Materials that appear on pre-approved lists maintained by the Department will require the manufacturer’s certification, literature, and shop drawings before fabrication and installation.

Materials not permanently incorporated into the Work will not require a Certificate of Compliance unless otherwise stated in the Contract, but the Contractor shall still only supply Materials that are in accordance with the Contract.

The Contractor may provide Material purchased in bulk or left over from previous projects by submitting Certificates of Compliance for Materials.

Replace or repair Materials damaged in transit or during handling at no additional cost to the Department.

106.5 FOREIGN MATERIALS

Unless otherwise specified in the Contract, deliver Materials manufactured outside the United States to approved locations within the state, where they shall remain until sampling and testing are complete.

Arrange for testing that the Department is not able to perform, at no additional cost to the Department, and shall test foreign Materials within the state in the presence of the Department.
Provide a Certificate of Compliance for each lot of foreign Material in accordance with Section 106.4, “Certificates of Compliance,” and, if required, provide with the Certificate of Compliance, certified MTRs for each lot, and clearly identify to which lot they apply.

For structural Material requiring MTRs, the Department will only accept Material from foreign and domestic manufacturers that have established adequate in-plant quality control to the satisfaction of the Project Manager.

The Project Manager may inspect the plant or require the Contractor to submit detailed written proof of adequate quality control.

The Department will not accept structural Materials that do not have Certificates of Compliance and MTRs (if required).

106.6 STORAGE OF MATERIALS
Store Materials to preserve quality and fitness for the Work and to protect against vandalism or theft. Be responsible for the replacement or repair of Materials affected by inadequate protection. Upon written approval by the Project Manager, the Contractor may use parts of the Right of Way for storage of Material and Equipment. Provide and assume liability for additional space and shall restore storage sites to the original condition, all at no additional cost to the Department.

106.7 HANDLING AND TRANSPORTING MATERIALS
Handle Materials in a manner that preserves their quality and fitness for the Work. Transport aggregates from the storage site to the Work site in vehicles constructed and operated to prevent loss or segregation of Materials. Ensure the transportation of Materials is in accordance with state and federal regulations, and prevents leakage of, scattering of, or damage to Materials.

106.8 DEPARTMENT-PROVIDED MATERIALS
The Department will list Department-provided Materials in the Contract. The Department will deliver Department-provided Materials to the Contractor at the Contract-defined locations.

The Pay Item in which the Contractor uses the Materials includes the cost of handling and installing the Materials after delivery. The Contractor is responsible for Materials once delivered. The Department will deduct from monthly partial payments the cost of shortages, deficiencies, and damage that may occur after delivery, as well as demurrage charges.

106.9 MATERIALS DESIGNATED BY TRADE NAME
The Contract may require Material or Equipment by trade or manufacturers’ names. The Department will accept the substitution of Materials or Equipment of equal quality provided the proposed substitute is fully documented and submitted to the Project Manager, and prior written approval of the Project Manager is given.

The Contractor shall provide information necessary to establish the comparable quality of the proposed substitute Materials or Equipment, at no additional cost to the Department.

106.10 EQUIPMENT GUARANTEES AND WARRANTIES
Obtain and assign to the Department manufacturer and producer guarantees or warranties for Materials and Equipment. Warrant, for six months after Material or Equipment is installed and operational, that mechanical and electrical equipment without a manufacturer or producer guarantee are free from defects or imperfections in workmanship and Materials. Repair malfunctions or defects that develop during the six-month period.

Supply manuals for equipment incorporated in the Work providing the following information:

1. Operational procedures;
2. Complete nomenclature;
3. Wiring diagrams;
4. Schematics showing test voltage and procedural methods;
5. Functional description of circuits;
6. Parts lists;
7. Cross-references to standard part numbers;
8. Names and addresses of sources for testing procedures where appropriate
9. Flow diagrams; and
10. Other relevant data.
Submit to the Project Manager the most current MSDSs for chemical Materials upon delivery of the Materials to the project. The MSDS shall contain the following information:

1. **Product identification:**
   1.1. Name, address, and phone number of chemical manufacturer;
   1.2. Trade name of the product; and
   1.3. Chemical name and formula of the product;

2. **Hazardous ingredients:**
   2.1. Substances present in the product that are listed as hazardous in the Hazard Communication standard (29 C.F.R. § 1910.1200);
   2.2. Exposure limits for the hazardous ingredient;

3. **Physical hazard data:**
   3.1. Fire and explosion data;
   3.2. Proper extinguishing equipment;

4. **Health hazard information:**
   4.1. Estimate of the hazard of the product;
   4.2. Routes of entry of the product;
   4.3. Acute and chronic health effects of exposure;
   4.4. Emergency first-aid procedures;

5. **Reactivity data;**

6. **Spill and leak procedures;**

7. **Personal protective equipment necessary for safe handling of the chemical;**

8. **Special precautions.**

**106.12 PREFERENCE FOR DOMESTIC MATERIALS**

The Contractor shall provide Materials in accordance with the *Buy America Requirements* (23 C.F.R. § 635.410) on federal-aid projects.

The Contractor shall bear the burden of proof and the cost to prove the origin and place of manufacture of steel products and Materials.

The Department will allow “minimal usage” of foreign steel products and Materials provided the cost of the foreign Materials does not exceed 0.1% of the Total Bid Amount, or $2,500, whichever is greater.

The Department may allow Bidders on Highway construction projects to submit a Bid to provide either foreign or domestic Structural Steel. The Department will Award the Contract to the Bidder that submits the lowest Total Bid Amount based on providing domestic Structural Steel unless that Bid exceeds the lowest Total Bid Amount based on foreign Structural Steel by more than 25%. 
107.1 LAWS TO BE OBSERVED
Keep fully informed of all federal and state laws, all local laws, ordinances and regulations, and all orders and decrees of bodies or tribunals having jurisdiction or authority which in any manner control pollution or impacts to the environment, affect those engaged or employed on the Work, or which in any way affect the conduct of the Work. At all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and protect and indemnify the State and its officers, employees and agents against all claims or liability arising from or based on the violation of such laws, ordinances, regulations, orders, or decrees, by the Contractor, or its officers, employees or agents.

Before the start of Work, contact the municipal or state agency responsible for air, noise, and water quality control regulations to determine the standards that shall be followed during construction.

107.2 PERMITS, LICENSES, AND TAXES
Procure permits and licenses; pay charges, fees, royalties, and appropriate taxes; and give notices necessary and incidental to the due and lawful prosecution of the Work.

107.3 COMPLIANCE WITH PAYMENT OF TAXES
The Contractor shall pay all lawful taxes imposed by the state of New Mexico or other political entities.

The successful Bidder, upon returning the executed Bid Package, and after receiving the Preliminary Award of Contract Notice, shall provide to the Department both the Bidder’s Taxation and Revenue Department tax identification number and the Bidder’s Motor Transportation Division account number. If either of these numbers is unavailable, the Contractor shall submit a letter of explanation. A Notice to Proceed will not be issued until the Contractor submits both numbers or a satisfactory letter of explanation.

107.4 GROSS RECEIPTS, INDIAN BUSINESS ACTIVITY, AND TRIBAL EMPLOYMENT RIGHTS ORGANIZATION TAXES
107.4.1 New Mexico Gross Receipts Tax
The Department will pay the Contractor for applicable New Mexico Gross Receipt Tax (GRT) and local option tax (including tax increases or decreases effective after the Contract date), and the Contractor shall pay applicable taxes to New Mexico Taxation and Revenue Department. The Contractor shall show the GRT and local option tax as a separate amount added to each request for payment.

107.4.2 Tribal Taxes
All Bids submitted shall exclude any Indian business tax, TERO tax, and other tax imposed by a tribal government. The Department will pay the tax or will exercise its prerogative to challenge the tribal government’s authority to impose the tax. If the Department exercises its prerogative to challenge the tribal government’s authority to impose the tax, the Department will reimburse the Contractor for such tax only if a court of competent jurisdiction rules the tribe has authority to impose the tax. The Department will reimburse the Contractor only if the final decision of the litigation, or other final disposition of the litigation, results in a determination that the tribe has jurisdiction to impose the tax. The Department will be subrogated to the rights of the Contractor to claim a refund of, or to contest, any such tax imposed on the Work to the extent any alleged obligation of the Contractor or the Department to pay such tax arises under this section or through the Contractor’s performance of this Contract.

107.5 PATENTED DEVICES, MATERIALS, AND PROCESSES
Provide a suitable legal agreement with the patentee or owner to cover the use of any patented or copyrighted designs, devices, Materials, processes, or trademarks. Indemnify and save harmless the Department, its officers, employees or agents, from any and all claims (including costs, expenses and damages the Department may be obliged to pay) for Contractor’s infringement on such patents, copyrights, and trademarks during prosecution or after completion of the Work.
107.6 **RESTORATION OF SURFACES OPENED BY PERMIT**

The Department reserves the right to construct or reconstruct utility services in the Highway, Street, or Road or to grant permits to municipal or County authorities, corporations, firms, or individuals to perform such work. The Contractor shall allow parties bearing permits granted by the Department for such work to make openings in the Highway, Street, or Road. The Department will address time extension requests due to work by others in accordance with Section 108.6 “Determination and Extension of Contract Time.”

When directed by the Project Manager, the Contractor shall make all necessary repairs due to such openings in the Highway, Street, or Road. The Department will pay for such repairs in accordance with Section 104.2, “Significant Changes in the Character of Work,” and Section 109, “Measurement and Payment.”

107.7 **FEDERAL AID PROVISIONS**

When the FHWA or other federal agency is obligated to reimburse the Department for all or any portion of the cost of a Project, observe federal law applicable to such reimbursement. In such situations, federal requirements supersede conflicting provisions of state and local laws, rules, or regulations. The Work shall be subject to inspection by the appropriate federal agency. Such inspection shall not make the U.S. Government a party to this Contract, nor shall the U.S. Government interfere with the rights of the Contract parties.

107.8 **SANITARY, HEALTH, AND SAFETY PROVISIONS**

Provide and maintain sanitary accommodations for use by Contractor and Department employees, in accordance with State and local boards of health, or other legal entity with jurisdiction.

Comply with federal, State, and local health rules and regulations. Ensure that working conditions are sanitary, non-hazardous, and not dangerous to the health or safety of workers or authorized visitors on the Project. Admit to the Project credentialed inspectors from OSHA or other agency responsible for health and safety administration.

107.9 **PUBLIC CONVENIENCE AND SAFETY**

Provide for the convenience and safety of the general public, for reasonable access by local residents and businesses, and for the protection of persons and property, in accordance with Section 104.5, “Maintenance of Traffic.”

107.10 **RAILROADS**

If the Project affects railroad lines, observe the requirements of the following Sections and the insurance requirements in accordance with Section 107.25, “Insurance Requirements.” For the purpose of this Section, the term "Immediate Construction Site" shall mean the area of the Project within railroad right of way.

107.10.1 **Department/Contractor Financial Responsibilities**

The Department may be responsible for the costs of the engineering, inspection, and protection of the railroad right of way within the Immediate Construction Site unless otherwise required by the Contract. Work accomplished by the Contractor or its subcontractors or agents outside the Immediate Construction Site, but within railroad right of way, shall be the financial responsibility of the Contractor.

107.10.2 **Notice to the Railroad**

Do not begin Work in the immediate construction site before accomplishing the following:

1. Notify the owner of the railroad right of way in writing 30 Days prior to the anticipated date to begin Work, the anticipated type of Work, and the anticipated length of time required to complete the Work;

2. Verify that the owner of the railroad right of way has arranged to provide necessary flaggers or other railroad personnel to protect railroad property at the Immediate Construction Site and minimize interference with the safe and timely operation of railroad equipment;

3. Receive approval from the owner of the railroad right of way and Department for any changes or modifications during construction that affect safety or the railroad’s operations;
4. Provide the Department with a copy of written agreements or directives, if any, between the owner of the railroad right of way and the Contractor modifying the Work to protect the railroad right of way;

5. Take protective measures as necessary to keep railway facilities, including track ballast, free of sand, debris, and other foreign objects and materials resulting from his operations. Any damage to Railway facilities resulting from the Contractor operations will be repaired or replaced by the owner of the railroad right of way and the cost of such repairs or replacement shall be paid for by the Contractor;

6. During demolition, removal and construction of the Work, the Contractor shall not drop or lower Material or debris onto the railroad’s property within 50 feet measured from the centerline of an adjacent track or measured from the edge of a railroad maintenance roadway or measured from any railroad improvement or measured from a railroad work or staging area;

7. Furnish the owner of the railroad right of way for approval, five copies of plans and two sets of calculations for any shoring or cribbing proposed to be used over, under or adjacent to the owner of the railroad right of way’s tracks. The use of such shoring or cribbing shall conform to the standard side clearances required by the PRC. In case the use of such shoring will impair said clearance the Contractor shall ensure that application is made to the PRC, if required, for approval of such impairment during the period of construction of the Project.

107.10.3 Cooperation with Owner of Railroad Right of Way

Cooperate with the owner of the railroad right of way. Actions by parties beyond the control of the Department, including the actions of owners of railroad right of way, and circumstances beyond the control of the Department, such as unforeseen railroad emergencies, that delay completion of the Project shall result in the Department awarding additional Contract Time but not additional compensation to the Contractor. Actions within the control of the Department, which are not the subject of a concurrent delay to completion of the Project by the Department and the Contractor, shall result in the Department awarding both additional Contract Time and additional compensation to the Contractor. A concurrent delay to the completion of the Project by the Department and the Contractor shall result in the Department awarding additional Contract Time but not additional compensation to the Contractor.

Regardless of the requirements of the Contractor’s construction schedule, the owner of the railroad right of way reserves the right to reallocate its labor forces assigned to complete railroad work in the event of an emergency when the owner of the railroad right of way believes such reallocation is necessary to provide for the immediate restoration of railroad operations or to protect persons or property on or near any other property owned by the owner of the railroad right of way. Neither the Department nor the owner of the railroad right of way will be liable for any additional costs or expenses of the project resulting from any such reallocation of the labor forces by the owner of the railroad right of way. The Department reserves the right to amend the Contract with the Contractor as may be necessary, subject to advising and coordinating with the owner of the railroad right of way.

Coordinate the Work each day with the owner of the railroad right of way’s operations, prior to commencing any construction activity.

Provide any notice concerning these requirements in writing. Such notices shall be deemed sufficiently given when sent by electronic means including proof of receipt, or certified mail, return receipt requested to the owner of the railroad right of way and the Department.

107.10.4 Storage of Materials or Equipment

Do not store Material, park or use Equipment, or interfere with the nearest railroad track or overhead line within the following clearance limits, unless the owner of railroad right of way provides written permission:

1. Within 10 ft horizontally from the centerline of track, 23 ft 3 in vertical above top of rail;

2. Construction or maintenance of electric wires:
   2.1. For lines carrying less than 750 V, 27 ft vertically above top of rail;
   2.2. For lines carrying 750 V, 28 ft vertically above top of rail;
   2.3. For lines carrying 15 kV to 20 kV, 30 ft vertically above top of rail;
   2.4. For lines carrying more than 20 kV, 34 ft vertically above top of rail.
When the Contractor must maintain or operate Equipment inside the above tolerances, notify the owner of the railroad right of way of said activities, and allow the owner of railroad right of way to provide personnel and devices to protect its property.

Notify and obtain approval from the owner of railroad right of way whenever there is excavation below the elevation of the track, any activity which may result in settlement or movement of railroad property, or whenever the owner of railroad right of way believes the railroad facilities may be endangered, so as to allow the owner of railroad right of way an opportunity to provide personnel and devices to protect its property.

107.10.5 Movement Across Tracks
If, for the convenience of the Contractor, it becomes necessary to move an oversized load across the railroad tracks, obtain written permission from the owner of railroad right of way, if required by the owner of the railroad right of way. Obtain a private crossing agreement if required by the owner of railroad right of way. Install all crossings, and provide flagging and protective devices at no additional cost to the Department. Ensure all agreements are in writing; furnish a copy to the Project Manager before beginning any Work under such agreements.

107.10.6 Cleanup
Before requesting final acceptance of Work accomplished on railroad property, remove all tools, implements, and other Materials, and obtain written release from the owner of railroad right of way showing that the property is clean, clear, and in a condition acceptable to the owner of railroad right of way. If unable to obtain a release from the owner of railroad right of way after diligent effort, provide the Project Manager with written evidence of efforts to obtain the release.

107.10.7 Post Construction Plans
When requested by the owner of the railroad right of way, furnish one set of Post Construction Plans, prepared in U.S. customary units to the owner of the railroad right of way. The format of the Post Construction Plans shall be discussed and agreed to at the preconstruction meeting. The Post Construction Plans shall include plan and profile, structural bridge drawings and specifications, and drainage plans. All improvements and facilities shall be shown.

107.11 ENVIRONMENTAL AND CULTURAL RESOURCES APPROVAL
The Department will obtain the environmental and Cultural Resource approvals for the Project before construction. The Department will describe in the Contract any special environmental and Cultural Resource requirements developed to protect resources.

107.12 ENVIRONMENTAL AND CULTURAL RESOURCE DISCOVERIES
Terminate operations in the immediate area of environmental or Cultural Resources not identified in the Contract. Continue Work in other areas while the Project Manager, Environmental Program Manager, and regulatory authorities complete appropriate mitigation actions. The requirements of Section 104.2, “Significant Changes in the Work,” shall apply if the time needed to obtain regulatory approval and complete appropriate mitigation actions exceeds statutory requirements.

107.13 CONTRACTOR’S RESPONSIBILITY FOR DAMAGE TO ENVIRONMENTAL AND CULTURAL RESOURCES
The Contractor shall restore or mitigate all damage to environmental or Cultural Resources caused by Contractor’s failure to abide by requirements included in the Contract as well as those areas covered under Section 107.14, “Contractor’s Responsibility for Environmental and Cultural Resource Protection” at no additional cost to the Department. The Department, in coordination with regulatory authorities, will determine the extent of restoration or mitigation. The Contractor shall pay any fine imposed on the Department by a regulatory agency for a regulatory violation caused by the Contractor. The Project Manager may suspend the Work in areas where environmental or Cultural Resource violations occur.
107.14 CONTRACTOR'S RESPONSIBILITY FOR ENVIRONMENTAL AND CULTURAL RESOURCE PROTECTION

107.14.1 Environmental and Cultural Resource Studies and Approvals

Before beginning soil-disturbing activities (in accordance with Section 106.1, “Contractor-Furnished Aggregate and Borrow Sources”), obtain the necessary study permits, and employ a qualified Environmental Specialist and a Cultural Resource Professional to conduct environmental and Cultural Resources studies at any disturbed site, including, but not limited to the following:

1. Camp sites;
2. Plant sites;
3. Crusher sites;
4. Stockpile sites;
5. Equipment yards;
6. Borrow Pits; and
7. Surfacing Pits.

Obtain the environmental and Cultural Resources approvals regardless of land ownership. For the environmental approval, use the Department-furnished checklist Categorical Exclusion form (or equivalent form furnished by the Department), which must be signed by the Contractor and the Environmental Specialist. For Cultural Resource reports, use the standard site investigation forms approved by the New Mexico Historic Preservation Division and the New Mexico Cultural Properties Review Committee. Ensure that the resource studies meet the standards of the Department, the State historic preservation officer, and any State, tribal, or federal land-managing agency or entity with jurisdiction. Ensure that the resource studies are in accordance with the National Environmental Policy Act of 1969 (42 U.S.C. § 4321 et seq.), the National Historic Preservation Act (16 U.S.C. § 470 et seq.), and the New Mexico Cultural Properties Act (NMSA 1978, § 18-6-1 to 18-6-17).

The Contractor may use previously-completed environmental and Cultural Resource studies, provided all other requirements of this Section are met.

Complete any other coordination required by environmental regulations.

The Contractor shall submit the documentation prepared for the environmental and Cultural Resource approvals to the Project Manager and the Environmental Program Manager. The Department will then submit the documentation to the appropriate agencies for approval, and will notify the Contractor when approvals have been obtained. Approvals may take 30 Days or more after the Contractor delivers the resource studies to the Department. The requirements of Section 104.2, “Significant Changes in the Work,” shall apply if the time needed to obtain approval exceeds any Federal or State statutory requirements containing time limits.

Comply with all conditions and commitments for protection of resources contained in resource agency permits and in the environmental and Cultural Resource approvals. The environmental approval is the FHWA-approved checklist categorical exclusion, or its equivalent. The Cultural Resource approval is the concurrence letter signed by the State historic preservation officer, or its equivalent.

107.14.2 Parking and Cleaning of Equipment

For projects that have received environmental and Cultural Resource approvals through programmatic categorical exclusions (e.g., pavement preservation and rehabilitation, guardrail replacements, bridge deck replacements, signalization upgrades, etc.), environmental and Cultural Resource studies will not have been completed by the Department. These projects will be noted as such in the Contract. For these projects, the Contractor shall take special care when parking and cleaning Equipment, as outlined in the following requirement.

The intent of the following requirement is to ensure the protection of sensitive environmental and Cultural Resources that may be present within the Right of Way and to encourage the Contractor to avoid damaging these resources when parking and cleaning Equipment. The Contractor shall ensure that parking and cleaning of Equipment within the Right of Way does not damage environmental and Cultural Resources, in one or a combination of the following manners:

1. Park and clean Equipment in previously disturbed areas only;
2. Identify all parking and cleaning locations in previously undisturbed areas, prior to construction, and complete the environmental and Cultural Resource approvals as described in Section 107.14.1, “Environmental and Cultural Resource Studies and Approvals;” or
3. Park and clean Equipment in previously undisturbed areas without completing the environmental and Cultural Resource approvals as described in Section 107.14.1, "Environmental and Cultural Resource Studies and Approvals," and assume all risk and liability for any damage to environmental or Cultural Resources resulting from these actions.

107.14.3 Aquatic Resources

The Department will apply for and obtain permits and certifications required for construction involving "waters of the United States" as defined by the U.S. Army Corps of Engineers. The Contractor shall comply with the terms of the permit obtained and shall be fully liable for consequences resulting from its failure to comply. The Department will provide a copy of the permits and certifications in the Contract.

Minimize vegetation removal, soil disturbance, erosion in the vicinity of live streams, water impoundments, wetlands, or irrigation supplies, and crossing of live streams with heavy Equipment. Do not refuel or perform maintenance activities on Equipment near watercourses, nor dump or bury demolition concrete, asphalt, or other Materials near watercourses, but these activities shall be conducted in proper containment areas. Comply with the New Mexico Water Quality Act (NMSA 1978, § 74-6-1 et seq.) and applicable permits and regulations in accordance with the federal Clean Water Act (33 U.S.C. § 1251 et seq.).

Comply with the requirements of Section 603, “Temporary Erosion and Sediment Control,” and the requirements of NPDES, and if performing Work along or adjacent to live streams, it shall do so in accordance with the federal Clean Water Act (33 U.S.C. § 1251 et seq.), the regulations and requirements of other authorities with jurisdiction.

107.14.4 Minimization of Soil Disturbance

Minimize damage to or removal of vegetation and trees, except as approved in Section 104.6, “Rights and Use of Materials Found in the Work.” Do not clear, grub, disturb, or excavate land beyond what is authorized by the Contract. Remediate or replace vegetation due to unnecessary clearing or damage, at no additional cost to the Department.

107.14.5 Air Quality Requirements and Dust Abatement

Perform dust abatement on the Project. Ensure that burning operations, dust-producing activities, and other operations that produce particulate matter comply with State and federal air quality regulations, as administered by the Air Pollution Control Bureau of the NMED, applicable local air quality regulations, and the federal Clean Air Act (42 U.S.C. § 7401 et seq.).

107.14.6 Noise Abatement

If specified in the Contract, the Contractor shall not operate Equipment that emits noise above 70 dbA, measured at a distance of 50 ft, in urban or populated rural areas during those hours specified, and shall comply with County or municipal ordinances if they are more stringent than the requirements in the Contract.

107.14.7 Disposal of Removed Asphalt Pavement Material

The intent of the following requirement is to ensure that removed asphalt pavement Material does not contaminate a natural watercourse or Waters of the United States or Surface Waters of the State (pursuant to the federal Clean Water Act, section 307; the federal Clean Water Act, section 404, General Condition #18; the federal Clean Water Act, section 401, Water Quality Certification; the NM Solid Waste Management Regulations, 20 NMAC 9.1; and the NM Water Quality Control Commission Regulations, 20 NMAC 6.2.2201).

Dispose of removed asphalt pavement Material, not including minor sweepings, belonging to the Department using one or more of the following methods:

1. Recycling and mixing it into Base Course, Subgrade or HMA of the new Roadway, with approval of the Project Manager; or
2. Burying it within the Right of Way or in any suitable location where requirements of Section 107.14.1, "Environmental and Cultural Resource Studies and Approvals" have been completed, with approval of the respective property owner. Do not bury the material within 50 ft of the recorded water table or watercourse. Place at least 2 ft of clean fill cover over the pavement material; or
3. Breaking down asphalt surfacing removed from the Project to a nominal 2 inch size, or smaller, and hauling and stockpiling the material to a location approved by the Project Manager.
4. If the material is to be permanently placed within the Shoulder or median, it shall be treated by using one of the following methods:
   4.1 Machine-compacted; or
   4.2 Sealed with an approved rejuvenating agent.

107.14.8 Disposal of Other Materials and Debris
Move items designated for removal without salvage, unsuitable construction materials, and debris from clearing and grubbing to an environmentally suitable disposal site secured and coordinated with the appropriate regulatory agencies. Do not place any items in wetland areas or areas that may impact endangered species or Cultural Resources. Obtain an environmental and Cultural Resource approval in accordance with Section 107.14.1, “Environmental and Cultural Resource Studies and Approvals.”

107.14.9 Underground Storage Tanks
Comply with applicable New Mexico and federal regulations governing the discovery and removal of underground storage tanks (UST). Report the discovery of USTs within the Right of Way (either temporary or permanent), pits, borrow areas, storage or Equipment yards within timelines required by the Underground Storage Tank Bureau of the NMED. Remove USTs in accordance with NMED UST regulations.

107.14.10 Hazardous Waste Material, and Reporting and Cleanup of Spills
Immediately report spills to the Project Manager or District Construction Engineer if on the Right of Way, or to the property owner if outside of the Right of Way. Clean up spills associated with the Work including gasoline, diesel fuel, motor oils, solvents, chemicals, toxic and corrosive substances, and other materials that threaten public health or the environment. Failure to report or respond to a pre-existing spill or spill not associated with the Work shall result in the Contractor bearing the full cost of remediation and cleanup. Submit requests in accordance with Section 104.2, “Significant Changes in the Work” if the time needed to obtain regulatory agency approval exceeds any federal or State statutory requirements containing time limits.

107.14.11 Prime Coat, Tack Coat, and Soil Sterilants
Do not contaminate soils outside the Roadway Prism when applying prime coat, tack coat and soil sterilants. Do not contaminate arroyos, irrigation supplies, wetlands, water impoundments, and live streams.

107.15 STATE AND FEDERAL LAND-MANAGING AGENCIES
While working within or adjacent to State or federal lands and forests, comply with all regulations of the State or federal authority having jurisdiction governing the protection of these areas, and observe all sanitary laws and regulations. Keep the areas in an orderly condition, dispose of all refuse, and obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures in accordance with applicable federal or State regulations.

107.16 PREVENTION OF FOREST AND GRASS FIRES
Prevent and suppress forest and grass fires, and require all employees and subcontractors to do likewise. Notify appropriate officials at the earliest possible moment of the location and extent of any fire seen by them. Comply with fire regulations applicable to the area of Work, and furnish and maintain firefighting Equipment and tools required in the Contract. Suspend fire-hazardous operations when necessary at the direction of the Project Manager and in accordance with Section 105.17, “Suspension of Work Ordered by the Project Manager.”

107.17 USE OF EXPLOSIVES
Exercise extreme care when use of explosives is necessary for the prosecution of the Work. Do not endanger life or property, including new Work. Use, handle, load, transport, and store explosives and blasting agents in accordance with applicable laws and ordinances, as well as title 29 CFR Part 1926 Safety and Health Regulations for Construction (OSHA) and
Clearly mark explosives and store them securely. If no local laws or ordinances apply, store explosives not closer than 600 ft from roads, buildings, camping areas, or places of human occupancy. Provide sufficient notice to any public utility and owner of railroad right of way having structures or facilities near the project, of the intention to use explosives, so that they may take steps to protect their property before detonation.

**107.18 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE**

Preserve public and private property. Protect land, governmental survey monuments, and property markers from disturbance or damage until the Project Manager has witnessed or otherwise referenced their location, and directed their removal.

Restore public or private property damaged directly or indirectly by any act, omission, neglect, or misconduct in the execution of the Work, or by defective Work or Materials, or by non-prosecution of the Work, at no additional cost to the Department. Return such property to a condition equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as directed by the Project Manager.

Maintain responsibility for damage until the Work is completed and accepted, or until the Department partially accepts the affected unit in accordance with Section 105.18.1, “Partial Acceptance,” or until the affected unit is opened to traffic in accordance with Section 104.5, “Maintenance of Traffic.”

**107.19 RESPONSIBILITY FOR DAMAGE CLAIMS**

Indemnify and hold harmless the Department and its officers, employees and agents against liability, claims, damages, losses or expenses, including attorney fees, to the extent that the liability, damages, losses or costs are caused by, or arise out of, the acts or omissions of the Contractor, or its officers, employees or agents.

**107.20 CONTRACTOR’S RESPONSIBILITY**

Until final acceptance of the Project by the Project Manager, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof, by the action of the elements or from other causes, whether arising from the execution or from the non-execution of the Work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to portions of the Work occasioned by the above causes before final acceptance and shall bear the expense thereof except as provided in Sections 104.5, “Maintenance of Traffic” and Section 105.18.1, “Partial Acceptance.”

Should the Contractor be delayed in the prosecution or completion of the Work by contractors on contiguous projects, fire, flood, epidemics, quarantine restrictions, strikes, freight embargoes, acts of public enemy, acts of governmental authorities other than the Department, Acts of God, or documented unavailability of construction Material, for which the Contractor is in no way responsible, then the time herein set for the completion of the Work shall be extended for a period equivalent to the Work time lost by reason of any or all of these causes, but the Contractor shall not be entitled to damages for such delay. The extended time period shall be determined and fixed by the Department, which determination shall be final.

In case of suspension of Work from any cause whatever, the Contractor shall be responsible, subject to the provisions of Section 104.5, “Maintenance of Traffic,” and Section 105.18.1, “Partial Acceptance,” for the Project and shall take such precautions as may be necessary to prevent damage to the Project, provide for normal drainage, and erect necessary temporary Structures, signs, or other facilities at his or her expense. During such period of suspension of Work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living Material in newly established plantings, including seeding and sod, furnished under the Contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

For physical damage to the Work resulting from unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to Acts of God, the public enemy, or governmental authorities, the Contractor will be paid pursuant to Section 104.2, “Significant Changes in the Character of Work,” and Section 109, “Measurement and Payment.”

**107.21 CONTRACTOR’S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES**

Do not begin Work in areas proximate to railroad, telegraph, telephone, or power company right of way or facilities, or other property where damage from the Work might result
Cooperate with the owners of underground or overhead utility lines to facilitate their removal or relocation, and conduct operations to avoid duplication of Work and unnecessary interruption of utility services.

promptly notify authorities of any interruption to water or utility services resulting from exposure, lack of support, or breakage. Provide continuous repair work to restore water service if interrupted. Do not perform Work near fire hydrants until provision for service has been approved by the local fire authority.

Contact the owner of the railroad right of way and/or the telecommunications companies to determine whether there is any fiber optic cable systems located within the Project boundaries that could be damaged or their service disrupted due to the construction of the Project. The Contractor shall pothole all lines either shown on the Plans or marked in the field in order to verify their locations. The Contractor shall use all reasonable methods when working in the owner of the railroad right of way rail corridor to determine if any other fiber optic lines may exist. Failure by the Contractor to notify, pothole or identify these lines shall be sufficient cause to stop construction at no cost to the State or owner of the railroad right of way until these items are completed. Costs for repairs and loss of revenues and profits due to damage to these facilities through negligent acts by the Contractor shall be the sole responsibility of the Contractor. The Contractor shall defend and indemnify and hold the State and owner of the railroad right of way harmless against and from all cost, liability and expense arising out of or in any way contributing to these negligent acts of the Contractor.

107.22 FURNISHING RIGHT OF WAY

The Department will secure necessary Right of Way before construction, except as noted in the Contract.

107.23 PERSONAL LIABILITY OF PUBLIC OFFICIALS

Department employees shall bear no personal liability in carrying out the provisions of the Contract or in exercising powers or authority granted to them by the Contract, it being understood that in such matters they act solely as agents and representatives of the Department.

107.24 NO THIRD-PARTY LIABILITY

The Department and the Contractor specifically agree that the provisions of this Contract do not make anyone a third-party beneficiary or authorize anyone not a party to this Contract to maintain an action for damages under this Contract.

107.25 INSURANCE REQUIREMENTS

Procure and maintain at no cost to the Department insurance as detailed below, using an insurance company authorized to do business in New Mexico. Insurance shall cover operations under the Contract, whether performed by the Contractor, the Contractor’s agents or employees, or Subcontractors. Keep insurance in full force and effect for the entire period of the Work, up to and including final acceptance, and the removal of Equipment and employees, agents and subcontractors.

107.25.1 Public Liability Insurance

1. Provide General Liability (Bodily Injury Liability and Property Damage Liability) insurance applicable in full to the subject project in the following minimum amounts:

   1.1 Bodily Injury Liability: $500,000 each occurrence; $1 million aggregate;
   1.2 Property Damage Liability: $500,000 each occurrence; $1 million aggregate;

2. The policy to provide this insurance must be written on a Comprehensive General Liability form or Commercial General Liability form, which must include the following:

   2.1 Coverage for liability arising out of the operation of independent contractors;
   2.2 Completed Operations Coverage; and
   2.3 Attachment of the Broad Form Comprehensive General Liability Endorsement;

3. If the Work includes the use of explosives, the Contractor’s insurance must include coverage for injury to or destruction of property arising out of blasting or explosion;

4. If the Contract includes Work next to an existing building or structure, the Contractor’s insurance shall include coverage for injury to or destruction of property
arising from the collapse of or structural injury to buildings or structures due to the following:

4.1 Excavation, including borrowing, filling, or backfilling in connection therewith;
4.2 Tunneling and cofferdam or caisson Work; or
4.3 Moving, shoring, underpinning, razing, or demolition of buildings or structures, or removal or rebuilding of structural supports thereof;

5. Coverage must include injury to or destruction of property arising out of damage to wires, conduits, pipes, mains, sewers or other similar property or any apparatus in connection therewith below the surface of the ground, if such injury or destruction is caused by or occurs during the use of mechanical Equipment for the purpose of excavating, digging, or drilling.

107.25.2 Automobile Liability Insurance
The Contractor shall provide or ensure that all vehicles used in performance of the Contract have liability insurance. The Contractor is not responsible for liability insurance for the Department or its agents. The Contractor shall provide limits of liability for automobile liability insurance in the following amounts:

1. Bodily injury liability: $500,000 each person; $1 million each occurrence;
2. Property damage liability: $1 million each occurrence.

107.25.3 Worker’s Compensation Insurance
Carry worker’s compensation insurance and otherwise fully comply with the New Mexico Worker’s Compensation Act (NMSA 1978, § 52-1-1 et seq.) and the New Mexico Occupational Disease Disablement Law (NMSA 1978, § 52-3-1 et seq.).

107.25.4 Department as Additional Insured
Name the Department and any third party so designated in the Contract as additional insured on the comprehensive general liability form or commercial general liability form furnished by the Contractor in accordance with Section 107.25.1, “Public Liability Insurance.” The certificate of insurance shall state that the coverage provided under the policy is primary over any other valid and collectible insurance. The additional insured endorsement shall conform to the most current version of the Insurance Services Office’s CG 2010, Additional Insured Endorsement Form. Provide to the Department a copy of the Contractor’s standard commercial general liability policy showing the Additional Insured Endorsement before the Department issues a Notice to Proceed.

107.25.5 Certificate of Insurance
Provide evidence of insurance coverage conforming to these Specifications with a certificate of insurance executed on the form provided by the Department, to be made part of the Contract. The certificate shall indicate compliance with these Specifications and shall certify that the coverage shall not be changed, canceled, or allowed to lapse without giving the Department 30 Days written notice. Provide a certificate of insurance to the Department on renewal of a policy or policies as necessary during the term of the Contract. The Department will not issue a Notice to Proceed until the Contractor meets these requirements.

107.25.6 Umbrella Coverage
The insurance limits cited in this Section are minimum limits. The Department does not intend that these Specifications define what constitutes adequate insurance coverage for the individual Contractor. The Department will recognize following form excess coverage (Umbrella) as meeting the insurance requirements of Section 107.25.1, “Public Liability Insurance,” should the limits of the Umbrella coverage meet the individual requirements of this Section.

107.25.7 Optimal Insurance
If required by the Contract, procure and maintain form and types of bailee theft insurance such as, but not limited to, builder’s risk insurance, contractor’s equipment insurance, and rigger’s liability property insurance. Provide bailee theft insurance in an amount necessary to protect the Department against claims, losses, and expenses arising from the damage, disappearance, or destruction of property of others in the care, custody, or control of the Contractor, including property of others being worked upon by the Contractor, its agents, employees or subcontractors.

Section 107: Legal Relations, Environment Requirements, and Responsibility to the Public
107.25.8 Railroad Insurance

If the Work affects railroad property, in addition to the above requirements, obtain a railroad protective liability policy in the name of the owner of the railroad right of way or railroad facilities involved. In addition, on those rails used by the National Railroad Passenger Corporation (NRPC), the Contractor shall obtain a railroad protective liability policy in the name of the NRPC.

Railroad liability insurance shall be in compliance with 23 CFR 646A. These limits of liability apply to the coverage as set forth in AASHTO’s Railroad Protective Liability Endorsement form, subject to the terms, conditions, and exclusions found in the form. The policy must afford coverage as provided in the standard Railroad Protective Liability Endorsement.

107.26 NO WAIVER OF LEGAL RIGHTS

Upon completion of the Work, the Department will make final inspection and notify the Contractor of acceptance. The Department reserves the right to correct measurements, estimates, certificates, or price adjustments made before or after completion of the Work, and to recover overpayment from the Contractor or its Surety.

The Department’s waiver of breach of part of the Contract does not constitute a waiver of any other breach.

The Contractor, without prejudice to the terms of the Contract, shall be liable to the Department for latent defects, fraud, or such gross mistakes as may amount to fraud, and for warranty and guaranty.

107.27 CONTRACTOR’S RESPONSIBILITY FOR THE TRAVELING PUBLIC

Minimize hazards to anyone transiting the Construction Zone on the open lanes of travel while performing the Work. Use the following steps to minimize hazards:

1. Keep Equipment, Materials, and workers out of the travel lanes;
2. Remove hazardous construction debris deposited on the travel lanes on a continuous basis;
3. Inspect and repair the travel lanes (Necessary repairs of damage not caused by the Contractor will be paid for in accordance with Section 109.5, “Payment For Changes, Differing Site Conditions, and Extra Work.”); and
4. Remove obstacles deposited by the public as they transit the Project. (This Work will be paid for in accordance with Section 109.5, “Payment For Changes, Differing Site Conditions, and Extra Work.”)

Immediately correct hazards reported by Project inspections, Department employees, or the public. Maintain a 24-hour contact number to initiate action quickly.

Assign an individual by the date of the preconstruction conference, readily available during normal working hours, to respond to claims from the public for losses alleged to have occurred within the Project, whether arising from Contractor or subcontractor action or inaction. Provide claimants with a written outline of the Contractor’s claims procedure, along with a written copy of the Contractor’s name, address, and telephone number together with the name and title of the individual assigned to handle claims from the public. Maintain a status report of claims filed, including the name, address, and telephone number of the claimant, the nature of the claim, pertinent findings regarding the claim, and a statement regarding the resolution of the claim. Provide the status report to the Project Manager upon request.

Establish a local contact number (with area code) for filing claims, and clearly post the number. In addition, post the name of the Contractor, address, and telephone number at each approach to the Project. The Contractor shall ensure that construction vehicles (Contractor, subcontractor, and privately owned) working on the Project have clean, unobstructed license plates, and shall mark vehicles legibly with the appropriate company name.
108.1 SUBCONTRACTING

The Contractor shall perform with its own organization at least 50% of the Work based on the Total Bid Amount. The Contractor’s organization shall include workers employed and paid directly and Equipment owned or rented by the Contractor but shall not include employees or Equipment of its subcontractor, assignee, or agent.

The Department will provide the required forms for a list of intended subcontractors and Material Suppliers in the Bid Package. The Contractor shall submit this list at the preconstruction conference and update the list as the Work progresses.

The Contractor shall submit to the Project Manager a request for subcontractor approval before subcontracting Work and shall not circumvent this requirement by placing a subcontractor’s employees on its payroll. The Department will treat a person or group generally operating as an independent contractor, as independent contractors for the purposes of this Section.

Independent truckers who haul on the jobsite or on nearby property devoted exclusively or almost exclusively to the Project and so close in location as to be reasonably included in the jobsite shall be considered subcontractors. Notwithstanding the foregoing, independent truckers who are truck owner/operators, as such term is used in the Department’s Disadvantaged Business Enterprise Program (18.28.2.21 NMAC), and who are placed on a Contractor’s certified payrolls, shall not be considered subcontractors.

Liability of the Contractor and the Contractor’s Surety under the Contract and the Contract Bonds shall not be waived or diminished by subcontracting or any other assignment of interest.

This Section does not apply to Contract items designated as Specialty Items by the Contract. A subcontractor may perform Work on these items, and the cost of the Work may be deducted from the Total Bid Amount before computing the Work required to be performed by the Contractor’s organization. The Contractor shall obtain the Project Manager’s written approval to subcontract Specialty Items prior to starting this Work.

Unless otherwise specified in a subcontract, the Contractor shall pay subcontractors the amounts due for undisputed acceptable Work within 10 Days of the Contractor’s receiving payment from the Department.

The Contractor’s failure to make timely subcontractor payments may result in the Department withholding future progress payments or rejecting the Contractor’s future Bids in accordance with Section 102.5, “Refusal or Rejection of Bids.” The Contractor’s repeated failure to make timely subcontractor payment may lead to Suspension or Debarment in accordance with Section 102.3, “Suspension and Debarment.”

108.2 NOTICE TO PROCEED

The Department will issue the Notice to Proceed within 30 Days after Contract execution, unless otherwise agreed to by the parties. The Notice to Proceed will identify the date the Department expects the Contractor to begin the construction and will start the Contract Time. The Contractor’s commencement of the Work without a Notice to Proceed may be deemed a waiver of this notice.

108.3 PROSECUTION AND PROGRESS

108.3.1 Baseline Schedule

The Contractor shall submit the Baseline Schedule in the format required by the Contract (CPM or bar graph). The Baseline Schedule shall be submitted in its entirety at or before the preconstruction conference.

The Project Manager will notify the Contractor in writing within 10 Days of the submittal of a Baseline Schedule if the schedule is accepted or not. If the Baseline Schedule is not accepted, the Contractor shall submit a revised Baseline Schedule or additional information to support the original Baseline Schedule. The Project Manager may withhold or discontinue payment to the Contractor until the Contractor’s Baseline Schedule is accepted.

The Department will use the Baseline Schedule to establish major construction operations, to determine Contract Time extensions, and to measure the progress of the Work.
108.3.1.1 Bar Graph Baseline Schedule

The Contractor shall submit the Baseline Schedule in bar graph form or in a format approved by the Project Manager. The Baseline Schedule shall list Contract features or Work activities in sufficient detail to show a reasonable and workable plan to complete the Project within the Contract Time. The Contractor shall show the following on the bar graph Baseline Schedule:

1. Each Work activity as a bar;
2. Each activity’s planned start and Completion Dates;
3. Each activity’s estimated cost and percent of Total Bid Amount;
4. The overall Project cost;
5. The planned Project Completion Date;
6. The monthly projected percent complete in time and dollars; and
7. A plot of the monthly projected percent complete (in dollars) superimposed on the bar chart.

If it becomes apparent to the Contractor or Department that it cannot meet the Baseline Schedule, the Contractor shall submit to the Project Manager for acceptance a revised Baseline Schedule showing the actual authorized time left for Project completion. The Project Manager will provide the Contractor with a decision within 10 Days of receiving the revised Baseline Schedule and may request a revised Baseline Schedule no more than once every 30 Days.

108.3.1.2 CPM Baseline Schedule

Provide a CPM Baseline Schedule with the following information:

1. A reasonable and workable plan to complete the Work within the Contract Time;
2. The order and relationships of activities and the sequence of the Work;
3. Activities described in a format prescribed by the Department so the Department can readily identify the Work and measure the progress of each activity;
4. The Project’s critical path, if one exists; and
5. The milestones specified in the Contract.

The CPM Baseline Schedule shall consist of network diagrams and associated bar graphs and shall include a tabulation of each activity shown on the detailed network diagrams. Provide, at a minimum, the following information on the CPM Baseline Schedule:

6. Activity description;
7. Early start date (each activity);
8. Late start date (each activity);
9. Original duration, in workdays (each activity);
10. Total float (each activity);
11. Sequence and interdependence of activities;
12. Workdays each week;
13. Contractor designated holidays;
14. Number of shifts per day;
15. Number of hours per shift; and
16. Scheduled Completion Date.

As requested by the Project Manager, the CPM Baseline Schedule shall include a report of projected Project completion, measured in dollars and time, on a monthly basis or at each progress payment cutoff date.

Float contained in the CPM Baseline Schedule is not for the exclusive use or benefit of either the Department or the Contractor. Float generated on critical path activities due to the acceleration of the Contractor’s performance shall be for the exclusive use of the Contractor. The Department will grant time extensions only to the extent that the activities on the critical path of the CPM Baseline Schedule in effect at the time of the delay are impacted.

108.3.2 CPM Updated Schedule

The Contractor shall submit an updated CPM schedule monthly, if any Work activity is started before the early start date or after the late start date. The Department will not make partial payments until receipt of the CPM updated schedule. Each activity in the CPM updated schedule shall contain the following information:

1. Activity description;
2. Anticipated start and finish dates;
3. Anticipated duration in workdays;
4. Anticipated float; and
5. Anticipated Work schedule for the next month.

The Contractor shall include in the CPM updated schedule a report of projected percent complete, measured in dollars and time.

The Project Manager may request that the Contractor shows actual progress data on the CPM updated schedule for items 2 through 5.

108.3.2.1 Revisions to CPM Schedule

If it becomes apparent to the Department or the Contractor that the Contractor cannot meet the Baseline Schedule, the Contractor shall submit to the Project Manager for approval a revised CPM Schedule and recovery plan. The accepted revised CPM schedule shall become the current accepted baseline progress schedule.

If the Contract duration or scope of Work substantially changes because of time extensions, Supplemental Agreements, or Extra Work, the Project Manager may require the Contractor to submit, for approval, a revised CPM updated schedule to reflect the changes. The accepted revised CPM updated schedule shall become the current accepted baseline progress schedule.

108.3.2.2 CPM Schedule Format

Prepare and submit one electronic copy in the format of the working program and two time-scaled color prints of the CPM baseline, monthly CPM updated schedule, and revised CPM updated schedules in accordance with Section 108.3.1.2, “CPM Baseline Schedule” using a project scheduling software that includes the following features:

1. Ability to display the schedule as a Gantt chart;
2. Ability to clearly display the critical path of scheduled activities apart from the non-critical scheduled activities;
3. Ability to calculate and display total float and free float for each activity;
4. Ability to clearly display the early start, late start, early finish and late finish dates for each activity; and
5. Ability to easily store and transfer the schedule as a file (or files) from one computer to another.

Supply the schedules to the Department in an electronic format acceptable to the Project Manager.

108.4 UNSATISFACTORY PROGRESS OF WORK

For Projects with bar graph schedules, when the dollars earned by the Contractor on the Project are 15% greater than the estimated dollars earned, as shown on the current accepted baseline progress schedule, the Project Manager may request, in writing, that the Contractor submit a revised progress schedule for approval by the next scheduled monthly submittal date. When the dollars earned by the Contractor on the Project are 15% less than the estimated dollars earned, as shown on the current accepted baseline progress schedule, the Project Manager may deem the progress of the Work unsatisfactory and will issue a notice to the Contractor of unsatisfactory performance.

When an activity on the critical path, as shown on the current accepted progress schedule, has exceeded its late start date by 7 Days, the Project Manager will deem the progress of Work unsatisfactory and will hold a meeting with the Contractor to address the schedule within 7 Days of the discovery. If a resolution cannot be determined within 5 Days, the Project Manager will issue a notice to the Contractor of unsatisfactory performance.

In the event a noncritical item becomes critical as determined by the Project Manager, the Contractor shall submit a revised CPM schedule.

When it becomes apparent that an activity on the critical path, as shown on the current accepted progress schedule, has exceeded its original duration by 10 or more Days, regardless of the Contract’s definition of Contract Time, the Contractor shall submit a revised progress schedule for approval within 5 Days of the discovery and the Project Manager shall issue a notice of unsatisfactory performance to the Contractor by certified mail and identify the unsatisfactory performance.

The notice will also allow a reasonable period of time, as determined by the Project Manager but not to exceed 30 Days from receipt of the notice, for the Contractor to bring the progress of the Work into compliance with the current accepted baseline progress schedule or to provide acceptable written justification for the delay.

The Contractor shall do the following things within the time specified in the notice to the Contractor of unsatisfactory performance:
1. Submit a revised baseline progress schedule and recovery plan to the Project Manager for review and approval. Demonstrate the proposed method to complete the Project within the remaining time specified in the current accepted baseline progress schedule; and

2. If the Contractor is unable to provide such a revised schedule, a late completion schedule shall be submitted indicating the time required to complete the Work. The Department’s approval of the late completion schedule will not operate as a waiver of the Department’s right to assess liquidated damages;

3. Take all necessary action to ensure completion of the Project at no additional cost to the Department within the remaining time specified in the accepted schedule. Actions may include but not be limited to the following:
   3.1. Additional overtime;
   3.2. Shift work;
   3.3. Additional workforce;
   3.4. Extended workweek;
   3.5. Additional Equipment; or
   3.6. A combination of these.

If the Work does not comply with the current accepted baseline progress schedule within the time specified in the notice to the Contractor of unsatisfactory performance, the Department may take the following actions:

4. Suspend or debar the Contractor in accordance with Section 102.3, “Suspension and Debarment;”

5. Withhold partial payments in the amount of the projected liquidated damages; or

6. Other administrative actions that the Project Manager deems appropriate and in the best interest of the public.

108.5 CHARACTER OF WORKERS, METHODS, AND EQUIPMENT

108.5.1 Character of Workers

Provide the resources necessary to complete the Work as specified. Ensure workers have the experience and skills to perform assigned Work. Remove employee(s) who performs the Work in an unskilled manner or who is intertemperate or disorderly. Rehire these employees only with the Project Manager’s written permission.

The Project Manager may suspend Work for failure to remove any employee(s) or to furnish suitable and sufficient personnel necessary to perform the Work.

108.5.2 Methods and Equipment

Use Equipment of the size and mechanical condition to produce the Work. Ensure that the Equipment does not damage the Roadway, adjacent property or other Highways, Streets, or Roads.

Request permission in writing to use methods or Equipment other than those specified; describe the proposed methods and Equipment to be used and the reasons for the change. Perform Work under original Basis of Payment and Contract Time. Discontinue use of alternate methods or Equipment when Work does not meet Contract requirements. Remove and replace or repair deficient Work at Contractor’s expense.

108.6 DETERMINATION AND EXTENSION OF CONTRACT TIME

The Department will provide the Contract Time in the Invitation for Bids and on the Bid Form.

If the Contract Time is on a Working Day basis, the Project Manager will provide the Contractor with a weekly statement showing the Contract Time, the number of days charged to the Contract for the preceding week, the accumulated days charged, and the number of days remaining to complete the Work. The Contractor shall have 7 Days after receipt of the statement to file a written protest of days charged. If the Contractor fails to timely file a written protest, the statement will be deemed accepted by the Contractor.

If the Contract Time is on a Calendar Day basis, it will consist of the number of Calendar Days stated in the Contract beginning with the effective date of the Notice to Proceed, or the actual starting date, if before the Notice to Proceed date, including all Saturdays, Sundays, Holidays and non-Working Days. The Department will not charge Calendar Days that occur during contract suspensions directed by the Project Manager and not the fault of the
During periods of partial Work suspension, the Department will use the following equation to calculate the number of Calendar Days or Working Days it will charge as Contract Time:

\[ N = \frac{D \times E}{O} \]  

where

- \( N \) is the number of calculated days charged during the suspension order
- \( D \) is the number of days of original Contract Time
- \( E \) is the amount earned on items not covered by the Partial Suspension order during the period of Partial Suspension
- \( O \) is the Total Original Contract Amount, excluding dollars the Contractor has earned for construction staking, mobilization, crushing, and stockpiling of Materials

The number of charged Calendar Days or Working Days will never exceed the total elapsed time during the Partial Suspension.

Upon lifting Partial or full Suspension of the Contractor's activities, the Project Manager will provide the Contractor with a statement showing the number of Calendar Days or Working Days charged for the Partial or full Suspension period and will identify the Calendar Days or Working Days remaining in the Contract. The Contractor shall have 7 Days after receipt of the statement to file a written protest of days charged. If the Contractor fails to timely file a written protest, the statement will be deemed accepted by the Contractor.

If the Contract contains a Mandatory Completion Date, the project must be Substantially Complete by that date. The Department will extend or amend the Completion Date only by mutual written agreement between the Contractor and the Department.

If the Completion Date or the number of Calendar Days or Working Days shown on the Invitation for Bids conflicts with the information shown on the Bid Form, the Contractor shall use the information on the Bid Form.

The Contractor shall interpret the Contract Time specified in the Contract in accordance with Section 102.6, “Interpretation of Quantities.” If completion of the Contract requires quantities of Work and Contract Time greater than those set forth in the Bid Package, the Department will calculate the extended Contract Time using the following equation:

\[ N = \frac{(C \times E)}{B} \]

where

- \( N \) is the number of calculated days of extended Contract Time
- \( C \) is the original Contract Time
- \( E \) is the estimated total contract amount
- \( B \) is the Total Bid Amount

On Working Day and Calendar Day Contracts, the Contractor may submit a written request to the Project Manager for an extension of time. The Contractor must submit the request before the expiration of the Contract Time and provide, in the written statement, reasons beyond the Contractor’s control for the extension of time. The Contractor cannot claim that the Contract specified an insufficient time as justification for an extension of time. If the Project Manager finds that the delay was beyond the control of and not the fault of the Contractor, the Project Manager may grant reasonable additional contract time.

If the Project Manager determines that Extra Work does not impact the Project’s critical path, the Department will provide justification for the denial of the Contractor’s request for additional time in accordance with this Section.

If Extra Work impacts the Project’s critical path and, therefore, requires a time extension, the Project Manager will negotiate and address the extension in a Change Order.

If the Project Manager rejects a time extension request, the Contractor may proceed in accordance with Section 105.20, “Administrative Remedy.”

When the Project Manager completes the final inspection in accordance with Section 105.18, “Acceptance,” the daily time charge will stop on the date the Contractor
completes all pay items, as determined by the Project Manager, or in accordance with Section 109.10, “Acceptance and Final Payment.”

108.7 FAILURE TO COMPLETE ON TIME
For each Calendar Day or Working Day, as specified, that the Work remains incomplete after the Contract Time expires, the Department will deduct an amount (in accordance with Section 108.8, “Liquidated Damages”) from dollars due the Contractor, not as a penalty but as liquidated damages. The Department will adjust the Contract Time for time extensions granted in accordance with Section 108.6, “Determination and Extension of Contract Time.”

The Department does not waive its rights under the Contract by allowing the Contractor to finish the Work after the expiration of Contract Time, including approved extensions.

108.8 LIQUIDATED DAMAGES
Time is an essential element of the Contract, and it is important that the Contractor pursue timely completion of the Work. The Department’s contract administration costs, including engineering, inspection, and supervision, will be increased as the time to complete the Work increases. The public is impacted and inconvenienced when a Project is incomplete and not available for use.

The Contractor agrees that the following schedule of liquidated damages, unless otherwise specified in the Contract, represents the reasonable projected value of inconvenience and monetary damage to the public if the Contractor does not complete the Project within the Contract Time and does not operate as a penalty to the Contractor:

<table>
<thead>
<tr>
<th>Total Original Contract Amount ($)</th>
<th>Charge ($) per Calendar Day</th>
<th>Charge ($) per Working Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤100,000</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>&gt;100,000–500,00</td>
<td>800</td>
<td>1,000</td>
</tr>
<tr>
<td>&gt;500,000–1,000,000</td>
<td>1,000</td>
<td>1,400</td>
</tr>
<tr>
<td>&gt;1,000,000–2,000,000</td>
<td>1,400</td>
<td>1,900</td>
</tr>
<tr>
<td>&gt;2,000,000–4,000,000</td>
<td>1,600</td>
<td>2,300</td>
</tr>
<tr>
<td>&gt;4,000,000–7,000,000</td>
<td>2,000</td>
<td>2,900</td>
</tr>
<tr>
<td>&gt;7,000,000</td>
<td>2,300</td>
<td>3,200</td>
</tr>
</tbody>
</table>

If the Contract Time is based on a specified Completion Date, the Department will use the schedule for Calendar Days. If the Contract Time is silent as to the basis of time, the Department will use the calendar for Work Days.

The Contractor agrees that the Department may withhold additional payments under the Contract or attach the Contractor’s Contract Bonds to cover the liquidated damages. The Department will continue to assess liquidated damages until the Project Manager issues the notice of completion and final acceptance in accordance with Section 105.18, “Acceptance.” When the Project Manager issues the notice of completion and final acceptance, assessment of liquidated damages will stop on the date that the Contractor completes all pay items, as determined by the Project Manager.

108.9 DEFAULT OF CONTRACT
The Department may declare the Contractor in default of the Contract if the Contractor:
1. Fails to perform the Work with sufficient resources (supervision, workers, Equipment, or Materials) to assure the completion of the Work;
2. Performs the Work unsuitably, or neglects or refuses to remove Materials or to correct rejected Work;
3. Discontinues the Work;
4. Fails to resume discontinued Work after the Department issues a request to resume Work;
5. Becomes insolvent or bankrupt;
6. Allows a final judgment, in a suit filed in connection with this Contract, to stand unsatisfied for 30 Days;
7. Makes an assignment, in connection with the Contract, for the benefit of its creditors; or
8. Fails to carry on the Work in an acceptable manner in accordance with the Contract.

The Project Manager will provide written notice to the Contractor and the Contractor's
Surety of delay, neglect, or apparent default. This notice will specify the Contract provisions that the Contractor violated and the corrective measures the Contractor shall take.

If the Contractor or Surety does not proceed with the corrective measures within 10 Days after receiving the notice, the Department, upon written notification from the Project Manager, has full power and authority, without violating the Contract, to declare the Contractor in default, to remove the corrective measures from the Contractor, and to demand compliance by the Surety of the terms, conditions, and obligations contained in the Performance Bond.

If the Department defaults the Contractor, the Surety shall complete the Work at its own expense pursuant to the Contract and receiving the balance of any funds owing to the Contractor. If the Surety fails to complete the Work, the Department may complete the Project with its forces or may obtain another contractor to complete the Work. The Department will deduct costs and charges that the Department incurs and the cost of completing the Work from contract funds due to or which may become due to the defaulting Contractor. If the total costs for completing the Work exceeds the amount that would have been payable under the Contract, the defaulting Contractor and the Surety shall be jointly and severally liable for the excess costs.

108.10 TERMINATION OF CONTRACT; NO FAULT OF CONTRACT

The Department may terminate, by written order, all or part of the Contract, after determining the following:

1. That the Contractor is prevented from proceeding with or completing the Work as originally contracted for reasons beyond the control of the Department or the Contractor; and

2. That termination would be in the public interest;

Reasons for termination may include, but are not limited to, the following:

3. Executive orders of the President of the United States relating to war or national defense;
4. A national emergency that creates a serious shortage of Materials;
5. Orders from duly constituted authorities relating to energy conservation; or
6. Restraining orders or injunctions obtained by third party citizen actions resulting from national or local environmental protection laws or where the issuance of the order or injunction is primarily caused by acts or omissions of persons or agencies other than the Contractor.

The Department may also void any contracts currently in force with debarred or suspended Contractors in accordance with the Section 102.3, “Suspension and Debarment.”

When the Department orders a Contract termination effective on a certain date, it will pay for the actual number of units or items of Work completed at the Bid Item Unit Price or as mutually agreed for items of Work partially completed or not started. For pay items eliminated by the termination, the Department will pay for items eliminated in their entirety in accordance with Section 109.7, “Eliminated Items.”

The Department may obtain from the Contractor, at a negotiated cost, acceptable unused materials obtained by the Contractor for but not incorporated into the Work. The Contractor shall deliver this material to a prescribed location or dispose of it as mutually agreed.

After the Contractor receives the termination notice from the Department, the Contractor shall submit any claim for additional damages or costs within 30 Days of the date of the Contractor’s termination or shall waive such claim. The Contractor shall submit the claim in accordance with Section 105.19, “Claims for Adjustment,” and Section 105.20, “Administrative Remedy.” The claim may include the following cost items:

7. Idle Equipment time;
8. Mobilization efforts;
9. Bidding and project investigative costs;
10. Overhead expenses attributable to project termination;
11. Legal and accounting charges involved in claim preparation;
12. Unpaid subcontractor costs;
13. Idle labor costs if Work is stopped in advance of termination date;
14. Guaranteed payments for private land usage as part of original Contract; or
15. Any other cost or damage for which the Contractor feels reimbursement is appropriate.
The Contractor shall make its cost records available for the Department to determine the validity and amount of each claim item. The Department will not consider the Contractor’s anticipated loss of profits as part of any settlement of the Contractor’s claims.

Full or partial Contract termination does not relieve the Contractor of its contractual responsibilities for the completed Work, nor will it relieve the Surety of its obligation for claims arising out of the completed Work.
109.1 MEASUREMENT OF QUANTITY

Work performed under the Contract shall be subject to the definitions of quantity in this Section. The Department will measure Pay Items in accordance with the Pay Units listed in the respective “Basis of Payment” provisions at the end of each Section within Divisions 200 through 900.

The Department cautions the Bidder to carefully read the Bid Package to determine units of measurement deviating from the following standard terms. If the Bid Package has a special reference to terms for measurement, the Bid Package will supersede the following terms and will control. Otherwise, the following terminology controls:

1. The distance between stations is 100 ft, measured longitudinally;
2. Longitudinal measurements are along and parallel to surfaces, not horizontal. For pay items measured by the square yard, the Department will make no deduction for fixtures in the Work with areas less than 1 yd²;
2.1 Transverse measurements for areas of Base Course and pavements are the neat line dimensions shown on the Plans based on the average width of the installed Material along the centerline of the Roadway;
2.2 Structures are measured according to the neat lines shown on the Plans or as provided by the Department;
2.3 For pay items measured by the foot, measurements are parallel to the base or foundation;
3. The volume of excavation is calculated by using the average end area method, the prism modular method, or other Project Manager approved methods;
4. A ton equals 2,000 lb; a “barrel” equals 376 lb of cement; a “sack” equals 94 lb of cement;
5. Accurate scales shall be used to measure and proportion Materials by weight. Scale tolerances shall be in accordance with state law;
6. The Contractor shall provide scales or use commercial scales;
6.1 Scales shall be sealed at least once every 12 months, each time the scales are relocated, or as needed;
6.2 Weighmasters (including Deputy Weighmasters), provided by the Contractor and certified by the NMDA, shall operate the scales. The certified weighmasters shall perform their duties in accordance with the regulations of the NMDA, Division of Standards and Consumers Services. The cost of the certified weighmasters, weighmasters’ scales, scale tickets, scale house, and verification of the scale’s accuracy is included in the Bid Item Price for the weighed Material;
6.3 Weigh empty vehicles used to haul Material paid by weight. Ensure vehicles bear legible identification marks. The Contractor shall provide the Project Manager with a written list of delivery vehicles showing identification marks, number of axles, and the distance between extreme axles. The Contractor shall provide this information before delivery of the Material and when the Contractor changes vehicles, combination vehicles, or axle length relationships;
6.4 The Department may convert weight to volume, or volume to weight, for payment purposes. The Project Manager will determine the factor(s) for conversion using an acceptable method and obtain the Contractor’s agreement before conversion;
6.5 The operator of each weighed vehicle shall obtain a scale ticket (certificate of correct weight) from the weighmaster and deliver the ticket to the Project Manager or designee at the point of delivery. The following information shall be included on the scale ticket:
   6.5.1 Project number;
   6.5.2 Date;
   6.5.3 Ticket number;
   6.5.4 Haul unit number;
   6.5.5 Gross weight;
   6.5.6 Tare weight;
   6.5.7 Net weight;
   6.5.8 Material type;
6.5.9 Certified weighmaster’s name;
6.5.10 Signature of weighmaster; and
6.5.11 Whether the driver was on or off the scale during weighing.

If the Weighmaster opts to tare all of the delivery trucks prior to loading and delivery, the tickets shall display the net weight as measured in the hopper. If requested by the Project Manager, the Contractor shall weigh the empty trucks at a certified scale.

7. Asphalt Materials are measured by the ton. The weight is based on net certified scale weights or weights calculated from certified volumes. The certified weights or volumes are subject to inspection and adjustment at the point of delivery;

8. Portland cement is measured by the ton, barrel, or sack in accordance with the Bid Package. The Department will use the net certified scale weight of portland cement as the basis of measurement, subject to inspection and adjustment at the point of delivery;

9. Timber and lumber (incorporated in the Structure) is measured by the foot, and measured on nominal widths and thickness and the length of each piece. The Department will accept lumber and timber conforming to the American Lumber Standards for rough and dressed sizes, as specified in the Contract;

10. Standard manufactured items, identified by unit weight or section dimensions, are measured using nominal weights or dimensions. The Department will accept manufacturing tolerances established by the industries involved, unless otherwise stated in the Contract.

109.2 APPROVED EQUIPMENT RENTAL RATES
Calculate Equipment rental rates using the following equation:

$$ W = \frac{X \times Y}{176} + Z $$

where
- $W$ is the hourly Equipment rental rate
- $X$ is the monthly rate
- $Y$ is the rate adjustment table factor (see the current Blue Book)
- $Z$ is the hourly operating cost (see the current Blue Book)

The rates in the Rental Rate Blue Book reflect current ownership and operation costs, based on the average hours of operation per year. The rates do not include operating personnel. The ownership cost represents the total cost of depreciation, interest, insurance, taxes, storage, etc., calculated to an hourly rate. Estimated operating cost per hour includes fuel, lubricants, tires, and other operating expendables, e.g. the percentage of mechanics' wages chargeable to preventive and field maintenance.

The current Blue Book applies to machinery or special Equipment (other than small tools) and transportation authorized by the Project Manager.

The Department will provide the agreed to rental rates in writing to the Contractor before affected Work begins; or, if no agreement is reached, the Blue Book rates, as described above, will be used for the actual time the Equipment is in operation. The Department will add 15% to the total Equipment rental rates. The Department will apply Equipment rental rates in accordance with the following criteria:

1. The manufacturer’s identification plates on the Equipment will be used to identify the Equipment and its capacities. If the Equipment does not have these plates, the Contractor shall provide written statements certifying the Equipment identification and capacity as shown on the Contractor’s Equipment inventory. The Contractor shall submit the type, capacity, and horsepower of each piece of Equipment, to correlate with the Blue Book schedule. The Blue Book reflects the maximum rates for Equipment of modern design and in good-working condition;

2. The Blue Book lists common pieces of Equipment. If the Blue Book does not list a piece of Equipment, use the Blue Book rental rate for a comparable piece of Equipment, may be used as approved by the Project Manager;

3. If the Contractor rents or leases a piece of Equipment from an outside agency and uses it in performing negotiated or Force Account Work, the Contractor shall provide to the Department the outside agency’s quotation. The Department will approve a
reasonable rental rate agreed upon (in advance) by the Contractor and the Project Manager. The hourly operating cost, as listed in the current Blue Book, shall be added to the approved rental rate;

4. If a piece of Equipment, not available on the Project, requires hauling onto the Project, the Contractor shall include the actual transportation cost (in and out). The Department will pay the transportation cost for each piece of Equipment once. Under unusual circumstances the Contractor may provide to the Department written justification for additional transportation costs;

5. If the Department provides written authorization for Equipment standby time, standby-time rental rates will be 50% of the calculated Equipment rental rate, without the operating cost. If agreed in advance in writing, the Department will pay for standby Equipment;

6. The regional difference percentage, as described in the Blue Book does not apply. However, the factors in the Rate Adjustment Tables of the Blue Book do apply;

7. Overtime, as described in Blue Book does not apply. The Department will pay for Equipment used on Extra Work at the regular hourly rate in accordance with the equation in this Section.

109.3 SCOPE OF PAYMENT
Receive and accept compensation in accordance with the Contract as full payment for performing the Work in an acceptable manner, and for risks, losses, damages, or expenses arising from the prosecution or nature of the Work. Unless otherwise specified, the Department will pay for the approved actual quantities of Material provided and Work performed.

The Department will only pay for Pay Items listed in the Contract in accordance with the “Basis of Payment” provisions. The Department will not pay separately for Work incidental to the completion of a Pay Item, or pay for the incidental Work under another Pay Item; except as provided in Section 104.6, “Rights in and Use of Materials Found on the Work.”

If the Department requires the Contractor to perform Corrective Work, the Contractor shall do so at no additional cost to the Department. Corrective Work is Work required by the Department to make previously unacceptable Work acceptable.

The Department may accept portions of the Work at an adjusted price in accordance with the relevant Pay Adjustment provisions in the Contract. The adjusted price only applies to the specific accepted portion of Work.

109.4 COMPENSATION FOR ALTERED QUANTITIES
The Department will pay the Contractor for the actual quantities of Material used in the Work and accepted by the Project Manager. If the accepted quantities of Work vary from the quantities in the Contract, the Contractor shall accept, as payment in full, payment based on the Bid Item Unit Prices. Except as specified in Section 104.2, “Significant Changes in the Character of Work,” and Section 104.3, “Differing Site Conditions,” the Department will not consider increased expenses, loss of expected reimbursement, or loss of anticipated profits or overhead suffered or claimed by the Contractor. Nor will the Department consider loss of expected reimbursements from unbalanced allocation of overhead among the Pay Items or from any other cause.

109.5 PAYMENT FOR CHANGES, DifferING SITE CONDITIONS, AND EXTRA WORK
The Department will pay the Contractor for Extra Work and Work resulting from significant changes in the character of the Work or differing site conditions in accordance with Section 104.2, “Significant Changes in the Character of Work,” Section 104.3, “Differing Site Conditions,” or Section 104.4, “Extra Work,” and by Change Order, based on one of the following payment methods:

1. Bid Item Unit Prices;
2. Negotiated unit prices;
3. Negotiated lump sum; or

If subcontractors perform Work as Extra Work, the Department will compensate the Contractor an additional 10% of the total cost of the subcontracted Work for profit and overhead.
109.6 FORCE ACCOUNT

If Work is paid by Force Account, the Department will pay the Contractor in accordance with the following Sections. If subcontractors perform Work by Force Account, the Department will compensate the Contractor an additional 10% of the total cost of the subcontracted Work for profit and overhead.

109.6.1 LABOR

The Department will pay the Contractor for labor, the wage rate for Force Account Work actually paid by the Contractor during the pay period ending before the issuance of the Change Order authorizing the Force Account Work. Such payment shall include Work by supervisors in direct charge of the Force Account Work. If there is no wage rate for a labor classification needed to perform the type of work required, the Department and Contractor will negotiate and document a new wage rate before beginning the Force Account Work.

Labor shall also include, and the Department will reimburse for, the following actual reasonable costs paid to (or on behalf of) workers:

1. Subsistence and travel allowances;
2. Health and welfare benefits;
3. Pension fund benefits; and
4. Other benefits required by collective bargaining agreements or other employment contract, applicable to the class of labor.

The Department will pay an additional 35% of the labor cost for overhead and profit.

109.6.2 BOND, INSURANCE, and TAX

The Department will pay the Contractor the actual cost of the following, plus 6%:

1. Property damage, liability, and worker’s compensation insurance premiums;
2. Unemployment insurance premiums or contributions;
3. Applicable payroll taxes (not including gross receipts taxes); and
4. Social Security taxes.

To recover actual costs, the Contractor shall provide satisfactory evidence of the rate(s) it has paid for bonds, insurance, and taxes. In lieu of supplying the above evidence and recovering actual costs, the Contractor may use a rate representing 30% of the labor costs for labor burden and 1% of the labor costs for bond.

109.6.3 Materials

The Department will pay the Contractor the actual cost of Materials accepted by the Project Manager and incorporated into the Force Account Work, including transportation charges paid by the Contractor (exclusive of Equipment rentals), plus 15% of the Material cost.

109.6.4 Equipment

For machinery or special Equipment (other than small tools), including fuel and lubricants and transportation costs, the Department will pay rental rates as determined in accordance with Section 109.2, “Approved Equipment Rental Rates,” unless otherwise agreed in writing.

109.6.5 Miscellaneous

The Department will not pay for the use of small tools, or other costs not specifically addressed.

109.6.6 Compensation

The Contractor shall compare and reconcile records with the Project Manager daily to determine the amount of Force Account Work completed by the Contractor as authorized by the Force Account Change Order.

109.6.7 Statements

The Department will not pay for Work performed by Force Account until the Contractor has furnished the Project Manager with itemized statements of the cost of the Force Account Work detailed as follows.

1. Name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman;
2. Designation, dates, daily hours, total hours, rental rate, and extension for each piece of Equipment;
3. Quantities of Materials, prices, and extensions;
4. Transportation of Materials; and
5. Cost of property damage, liability and worker’s compensation insurance premiums, unemployment insurance contributions, and Social Security tax.

Statements shall be supported by receipted invoices for all Materials used and for transportation charges. For in-stock Materials, the Contractor shall provide an affidavit certifying that such Materials were taken from the Contractor’s stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

The total payment made as provided above shall constitute full compensation for Force Account Work authorized in writing by the Department.

109.7 ELIMINATED ITEMS

Should Pay Items contained in the Contract become unnecessary for the reasonable completion of the Work, the Project Manager may direct the Contractor, in writing, to eliminate Pay Items from the Contract. This written notification will not invalidate the Contract. The Department will reimburse the Contractor for actual Work completed and all costs incurred, including mobilization of Materials and Equipment before the written notification. The total cost of mobilization for Materials and Equipment associated with that eliminated Work will then be increased by 15%. If Materials can not be returned, the Department will pay for said Materials and take ownership.

109.8 PARTIAL PAYMENTS

The Department will make partial payments at least once each month as the Work progresses, provided the Contractor complies with all material terms and conditions of the Contract. If the Contractor fails to comply with all material terms and conditions of the Contract, after written notice and reasonable opportunity to correct (for other than safety issues a reasonable time will be 30 Days), the Department may withhold partial payments until the Contractor complies. The Project Manager will prepare partial payments based on estimates of the value of the Work performed and Materials complete-in-place, and in accordance with Section 109.9, “Payment for Material on Hand.”

The Department will not make a partial payment when the total value of the Work completed since the last estimate is less than $1,000, unless the Contractor requests such payment in writing and the Project Manager approves.

The Department will make partial payments to the Contractor using the following method. The Department will pay 100% of the value of Work performed and Materials complete-in-place (consistent with Section 109.9, “Payment for Material on Hand”), until the sum of the partial payments made equals 95% of the Total Original Contract Amount as amended by Change Order. The Department will not make additional partial payments until the Contractor completes the Work in an acceptable manner, unless approved by the Project Manager.

When the Work has been completed, has been inspected and approved, and has been accepted by the Project Manager, the Project Manager may, with the consent of the Surety, make further partial payments in total not exceeding 100% of the value of the completed Work. The Project Manager will deduct from these partial payments an amount equal to the estimated cost of incidental Work remaining to be completed or the estimated damages that the Department would incur if the Contractor failed to complete the incidental Work, whichever is greater.

The Project Manager, with the consent of the Surety, may make a payment to the Contractor that includes all retained amounts (less disputed and estimated amounts to final and clean up the project).

The Department will pay the Contractor late payment charges as authorized by and in accordance with NMSA 1978, § 13-1-158.

109.9 PAYMENT FOR MATERIAL ON HAND

109.9.1 Delivered Cost Can Be Calculated

After measurement, the Project Manager may make partial payments to the Contractor for Material on hand not to exceed 95% of the delivered Material cost under the following conditions:

1. The Materials will be incorporated in the Work;
2. The Materials are delivered to the Project or to a storage place accepted by the Project Manager;
3. The delivered Materials meet the requirements of the Contract;
4. The Materials are purchased from a Supplier or a manufacturer and are not produced by the Contractor or a subcontractor;
5. The Contractor submits paid invoices, certified by the Supplier or manufacturer, to the Project Manager;
6. The Contractor submits a written request for the partial payment; and
7. Partial payments for Materials on hand do not exceed the Bid Item Price for Bid Items that will include these Materials.

If the Materials are stored off the Project, the Project Manager will deduct the cost for freight shipment to the Project from the partial payment.

109.9.2 Delivered Cost Cannot Be Calculated
If it is impractical to determine delivered cost of Material, the Project Manager may authorize partial payments as follows:

1. A partial payment not to exceed 75% of the Bid Item Price as amended by Change Order for the following Pay Items may be made if acceptable Material is stockpiled at approved locations for:
   1.1 Base Course;
   1.2 Subbase;
   1.3 Surface treatment aggregate; or
   1.4 Material prefabricated by the Contractor or subcontractor.
2. A partial payment not to exceed 60% of the Bid Item Price as amended by Change Orders for the following Pay Items may be made when the acceptable aggregate is stockpiled at approved locations for:
   2.1 Cement-treated base;
   2.2 Hot Mix Asphalt;
   2.3 Open-graded friction course;
   2.4 Aggregate for road-mix asphalt pavement;
3. A partial payment not to exceed 40% of the Bid Item Price as amended by Change Order for Hot Mix Asphalt (Complete) may be made if the acceptable aggregate for this Pay Item is stockpiled at approved locations;
4. A partial payment not to exceed $10 per cubic yard may be made for Portland cement concrete aggregate if stockpiled at approved locations.

109.10 ACCEPTANCE AND FINAL PAYMENT
The Department will conduct a post-construction conference within 30 Days of Substantial Completion. The Department and Contractor will address all outstanding items and issues, including time to complete the Project, and will agree on the schedule for final completion, inspection, and payment. Within five Days of the post-construction conference, the Contractor shall submit for approval by the Project Manager the Contractor’s proposed schedule for completion, final inspection and payment. Daily Contract Time charges will cease as of the date of Substantial Completion; however, if the Contractor does not complete all items of Work by the date specified in the agreement, time charges will resume until all Work is complete. The Department will not release retained amounts until both parties agree to the post-construction conference schedule for completion of the Project, final inspection and final payment. The Project Manager may withhold a portion of retained amounts to cover punch-list items and until final acceptance.

Upon final acceptance in accordance with Section 105.18.2, “Final Acceptance,” the Project Manager will prepare the Project’s final estimate. Regardless of disputed or pending claims, the Contractor will have the right to sign an alternate final estimate. With the Department’s approval of the final estimate under either the regular form or the alternate form, the Department will pay all remaining amounts due to the Contractor.

“Claims for Adjustment,” and Section 105.20, “Administrative Remedy,” the Contractor shall approve and return the Department’s final estimate within 30 Days of receipt. Failing that, the Department may accept the Work, pay the balance due on the final estimate, and close the Project.

The final payment will correct previous partial payments.

As a condition precedent to final payment, the Contractor shall furnish a Certificate of Payment of Claims from persons or firms, including the Contractor, who have filed claims for additional compensation, for labor performed, or for Material, supplies, or services furnished to the Contractor or its subcontractors.
When the Work has been completed, the Department will accept the Project.

109.11 COMPENSATION FOR PROJECT DELAYS

Except as otherwise agreed by the Contractor and the Department in writing, delay damages to the Contractor on the Project shall be governed by this Section. The term “delay” does not include time extensions granted by the Department for additional Work as defined in Section 109.4, “Compensation for Altered Quantities.”

1. The Department will compensate the Contractor for Project delays resulting from the neglect or default of the Department. The Contractor shall document costs resulting from the delay using actual records, and shall measure expenses using generally accepted accounting principles. Compensation will be paid by the Department for, and only for, the following categories of damage:

   1.1 Non-salaried labor expenses;
   1.2 Material costs;
   1.3 Equipment costs;
   1.4 Costs of extended job site overhead, including bonds;
   1.5 Plus an additional 10% of the total of items 1.1, 1.2, 1.3, and 1.4, to cover unabsorbed home-office overhead;

2. The Department will not compensate for, and the Contractor shall not be entitled to, the following categories of damage:

   2.1 Loss of anticipated profit;
   2.2 Labor inefficiencies;
   2.3 Home office overhead exceeding that provided in Section 109.11, “Compensation for Project Delays,” paragraph 1.1);
   2.4 Consequential damages, including but not limited to loss of bonding capacity, loss of bidding opportunities, and insolvency;
   2.5 Indirect costs or expenses; or
   2.6 Attorneys’ fees, interest, claim preparation expenses, or litigation costs.
Division Contents

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SECTION 201:  CLEARING AND GRUBBING

201.1 DESCRIPTION
This Work consists of clearing, grubbing, scalping, removing, and disposing of vegetation and debris. This Work includes protecting vegetation designated to remain. Scalping includes the removal of material such as brush, roots, sod, stumps, and the residue of agricultural crops.

201.2 MATERIALS
201.2.1 Paint
Use Department approved asphalt base paint designed for tree surgery.

201.3 CONSTRUCTION REQUIREMENTS
201.3.1 General
The Department will establish Right of Way lines, construction limits, and designate trees, shrubs, plants, and other items to remain. Remove surface debris, trees, stumps, roots, organic matter, and other obstructions. When approved by the Project Manager, the Contractor may leave undisturbed stumps and other solid objects within the Roadway Prism that do not extend more than 6 in above existing ground and will be at least 4 ft below the finished Subgrade elevation.

Remove hazardous objects and debris from the project. Backfill and compact stump holes and other holes in accordance with Section 203.3.5, “Embankments.”

Remove low-hanging branches from trees or shrubs designated to remain. Trim overhanging tree branches to provide a clearance 20 ft above the Roadway surface. Paint the cut or scarred surfaces of trees and shrubs designated to remain in accordance with Section 201.2.1, “Paint.”

Confine operations including dragging, piling, and burning of debris to Department approved areas.

201.3.2 Salvageable Timber
Fell and cut timber (to the specified length) in accordance with the Contract. Stack cut logs as directed by the Project Manager.

201.3.3 Scalping
Scalp before excavation or placement of Embankment. Remove organic material under pipe Culvert bedding, regardless of Embankment height.

201.3.4 Removal and Disposal of Material
Remove from the Right of Way materials that cannot be safely or adequately disposed of or burned within the Project and dispose at locations outside the project.

Obtain written permission from the owners of property used for debris material disposal.

Burn materials:
1. In accordance with applicable laws and regulations;
2. Under the constant care of competent watchmen;
3. Without damage to items designated to remain on the Right of Way, surrounding property, or vegetative cover.

The Roadway and adjacent areas shall have a neat and finished appearance after any removal and disposal of material. Do not accumulate flammable materials on or adjacent to the Right of Way.

201.4 METHOD OF MEASUREMENT—Vacant

201.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
<td>Clearing and Grubbing</td>
<td>Lump Sum</td>
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</table>
201.5.1 Work Included in Payment

When clearing and grubbing is not established as a pay item the work will be considered incidental to the completion of the project and no separate payment will be made. The cost involved in obtaining disposal locations and in making the disposal will be considered incidental to the completion of the work and no measurement or direct payment will be made therefore.
SECTION 203: EXCAVATION, BORROW, AND EMBANKMENT

203.1 DESCRIPTION
This Work consists of performing excavation, providing borrow, constructing Embankment, hauling, disposing, placing, and compacting materials.

203.2 MATERIALS
The Department will provide geotechnical investigation results in the Contract documents or will make them available at the project office. Use the results for information only. The results are not a representation or warranty of the continuity of the conditions that exist beyond the subsurface investigation’s test holes or test pits. The Contractor is solely responsible for interpretations and conclusions drawn from this geotechnical information.

203.2.1 Material Classifications
203.2.1.1 Rock Excavation
Rock excavation is material that meets one of the following field test criteria:
1. **Ripping Test.** Material that can not be broken down by one pass with a single tooth ripper mounted on a crawler-type tractor in low gear with a minimum net flywheel power rating of 255 hp;
2. **Seismic Test.** Material that has a seismic velocity greater than 6,000 ft/s. Submit the qualifications of the person performing and interpreting the seismic testing for Project Manager Approval at least 14 Days before testing. Perform the Ripping Test to resolve differences in material classification if seismic velocities fall below 6,000 ft/s;
3. **Handling Test.** Rock with a volume greater than 1 yd³ that cannot be readily broken down with excavation Equipment.

203.2.1.2 Unclassified Excavation
Unclassified excavation is material other than rock excavation or standard excavation.

203.2.1.3 Borrow
Material from Contractor-provided sources required for Embankment, subexcavation replacement or other Work approved by the Department.

203.2.1.4 Subexcavation
Subexcavation is existing material that is unsuitable or unstable. Unsuitable material is that with an R-value less than the Contract R-value. Unstable material is that which is saturated and pumping.

203.3 CONSTRUCTION REQUIREMENTS
203.3.1 General
Finish excavation and Embankment for the Roadway, intersections, and entrances to reasonably smooth and uniform surfaces. Do not remove materials from the project limits without the approval of the Project Manager. Ensure the top 2 ft of the finished Subgrade contains material with the design R-value. Preserve the materials below and beyond the lines and grades while conducting excavation operations. Before beginning excavation, grading, and Embankment operations, perform the necessary clearing and grubbing in accordance with Section 201, “Clearing and Grubbing.” Notify the Project Manager before opening excavation or borrow areas. Take cross section elevations of the ground surface before opening excavation or borrow areas.

Terminate operations in the immediate area of environmental or Cultural Resources not listed in the Contract, until the Department reviews and completes appropriate mitigation actions in accordance with Section 107.12, “Environmental and Cultural Resource Discoveries.”

Place excess or unsuitable excavated material (including rock and boulders unsuitable for Embankments) in the toe of any fills, or use to flatten slopes of nearby fills. Place at least 2 ft of cover soil over the rocks and boulders. Dispose of excess or unsuitable material in accordance with environmental requirements and as approved by the Project Manager.
203.3.2 Excavation

Within cut sections, remove excavated material from the limits of the cut section to the Subgrade elevation for the width of the Roadbed. Finish Roadbed cut sections to a smooth and uniform surface. Remove unsuitable or unstable material below finished Subgrade. Take cross-sectional measurements after the removal of unsuitable and unstable material.

203.3.3 Rock Cuts

Perform proper drilling and blasting operations in accordance with the specified practices. When required, perform controlled blasting of rock excavation to produce a clean face on the excavated cut. Ensure subsequent blasting and excavation operations do not affect previously excavated faces. Do not excavate more than 6 in below the specified Subgrade elevation for Roadbed cuts in rock, unless directed otherwise. Do not leave undrained pockets on the Roadbed surface. Place and compact Base Course on the rock cut foundation in accordance with Section 304, “Base Course.”

203.3.3.1 Blasting Requirements

Use controlled blasting to establish a specified backslope with minimal blast damage, and production blasting to facilitate excavation. Before the start of blasting, notify adjacent property owners and occupants.

203.3.3.1.1 Definitions

**Blasting Operations.** Activities related to blasting including, but not limited to the following:

1. Collaring and drilling blast holes;
2. Preparing, fixing, loading, and firing explosive charges;
3. Assessing the blast after detonation; and
4. Handling misfires.

**Buffer Row.** The first row of production blast holes immediately adjacent and drilled in a plane parallel to the controlled blast line. The explosive load in the buffer row should be reduced from standard production loads to minimize damage to the backslope of the final excavation.

**Controlled Blasting.** The controlled use of explosives and blasting accessories in carefully spaced and aligned blast holes to provide a free surface or shear plane in the rock along the specified backslope, and to limit fly rock, permanent ground displacement, air concussion, and overbreak. Controlled blasting methods include pre-splitting and cushion blasting.

**Cushion Blasting (Trim Blasting).** The simultaneous detonation of one line of blast holes along a specified excavation backslope after the main excavation is complete. This method is performed to trim the excavation to the final backslope.

**Final Line (Controlled Blast Line).** Refers to the row of controlled blast holes drilled in the plane of a specified excavation backslope. The controlled blast holes drilled in this plane constitute the basis for payment under the Controlled Blasting pay item. The Department considers the blast holes drilled in front of the final line blast holes to be production blast holes, which are incidental to the Rock Excavation pay item.

**Pre-Splitting.** The simultaneous detonation of one line of blast holes drilled along a specified excavation backslope before production blast holes are fired.

**Production Blasting.** Fragmentation blasting in the main excavation area.

203.3.3.1.2 Submittals

203.3.3.1.2.1 Blaster in Charge

Do not begin drilling or blasting work until the Project Manager approves of the Blaster in Charge. Submit the name and qualifications of the proposed Blaster in Charge to the Project Manager for approval at least 30 Days before the delivery of explosive material to the project. Provide the following information:

1. Proof of a license by the applicable State and/or local regulatory agencies to possess, transport, and use explosives;
2. A list of, and references, for at least three blasting projects, of similar complexity, successfully completed within the previous five years. The Blaster in Charge must be on site during blasting operations.

203.3.1.2.2 Blasting Plans
Submit a General Blasting Plan to the Project Manager for each cut that requires blasting, at least two weeks before the start of drilling and blasting operations on a specified cut. Provide the following information in the General Blasting Plan:
1. Description of the proposed blasting operation;
2. Preliminary design criteria for production and controlled blasting, including blast hole depths and patterns; and
3. Details regarding the proposed explosives and blasting accessories;
Submit a Detailed Blasting Plan at least 48 h before an individual blast. Provide the following information in the Detailed Blasting Plan:
4. Station limits of the proposed location of the blast, including the bench elevation, if applicable;
5. Date and time the blasting will occur;
6. Required removal of overburden, if applicable;
7. Plan and cross section diagrams of proposed drill pattern for controlled and production blast holes, including buffer rows, free face, burden, blast hole spacing, blast hole diameters, blast hole angles, lift height, and subdrill depth. Draw these plans and cross sections to scale;
8. Loading diagram showing the type and amount of explosives, primers, and initiators; and the location, depth, and type of stemming;
9. Initiation sequence of controlled and production blast holes, including delay times and the delay system;
10. Manufacturer’s data sheets for the explosives, primers, and initiators to be used.
Submit the blasting plans to the Project Manager for review and approval. The Project Manager will review and provide comments to the Contractor. Submit revisions to the blasting plans for final review and approval. Do not proceed with drilling and blasting operations related to a General Blasting Plan or loading of blast holes associated with a Detailed Blasting Plan without written approval.
Cease blasting operations and submit revised blasting plans if the Department determines that the blasting operations under the employed methods are causing property damage in and beyond the Right of Way.

203.3.3.1.2.3 Blasting Records
Prepare and submit to the Department a Blasting Record for each blast, on the day of the blast. Provide the following information in a Blasting Record:
1. Actual dimensions of the shot, including blast hole diameters and depths, burden, spacing, subdrill depths, stemming, powder loads, powder factors, and timing;
2. A drawing or sketch showing the direction of the face and the physical shot layout;
3. The location of the blast in relation to project stationing and elevation;
4. The date and time of loading and detonation;
5. The name and signature of the person responsible for loading and firing;
6. Comments by Blaster in Charge regarding misfires fly rock occurrences, unusual results or effects; and damage to existing facilities, adjacent property, or completed Work;
7. Vibration and blast monitoring results; and
8. Any complaints received due to the blasting.

203.3.3.1.3 Explosives
Transport, store, handle, and use explosives in accordance with applicable federal, State, and local laws and regulations. Purchase explosives and accessory devices from industry recognized Suppliers and manufactures. Use explosives and accessory devices in accordance with manufacturer instructions. Do not use expired products.
The CFR specifies responsibility for the following federal agencies regarding the administration of regulations involving explosive materials:
1. Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF). Storage and accountability of record keeping and security in accordance with 27 CFR part 555;
2. OSHA. Transportation, worker safety, and health in accordance with title 29 CFR;
203.3.3.1.4 Safety
Follow safe practices, including the following:
1. Federal, State, and local regulations pertaining to the transportation, storage, and use of explosives must be strictly followed;
2. When required, the Blaster in Charge must obtain a blasting permit from the local regulatory agency before blasting;
3. Only persons authorized and qualified based on training and experience will handle and use explosives;
4. No person will smoke; carry matches or other flame producing devices; or carry firearms or loaded cartridges while in or near a motor vehicle that is transporting explosives;
5. Keep track of explosives at all times. Explosives must be stored and locked in an approved magazine facility in accordance with the applicable provisions of the Department, ATF, and OSHA until used in blasting;
6. Post appropriate signs in the required areas and vehicles in accordance with federal regulations;
7. Safely station the necessary guards or flag persons on Highways during blasting to control Highway traffic;
8. Before starting work in the cut, observe the entire blast area for at least five minutes after each blast. Remove potentially dangerous rocks or other material located beyond the excavation limits. Cease blasting operations if the required slopes are not stable, or if the safety and convenience of the public are being jeopardized.

203.3.3.1.5 Vibration Risk Survey
For each cut that requires blasting, perform a vibration risk survey of nearby buildings, Structures, utilities, water supplies, or environmentally sensitive areas that may be at risk of blasting or construction damage. Perform the vibration risk survey in accordance with Section 617, “Vibration Monitoring.” Obtain written approval for the vibration risk survey from the Project Manager before drilling blast holes.

203.3.3.1.6 Blasting Test Sections
Demonstrate the adequacy of proposed Blasting Plan with a blasting test section(s) for material of different geologic characteristics. For projects involving multiple cuts in similar geologic materials, the Project Manager may reduce the requirement for a blasting test section in each cut. Blasting test sections include drilling, blasting, and excavating cut sections approximately 100 ft long to determine the optimal combination of method, blast hole spacing, and charge. When field conditions warrant, the Project Manager may direct the Contractor to use test section lengths less than 100 ft long.

Blasting test section requirements include the following:
1. Perform the blasting test section in accordance with Section 203.3.3.1, “Blasting Requirements.” Prepare and submit a Detailed Blasting Plan for the test section to the Project Manager at least 48 h before the planned time of the blast. Do not start blasting the test section until the Project Manager approves the Detailed Blasting Plan;
2. Unless the Contractor’s Detailed Blasting Plan indicates otherwise, begin the tests with the controlled blast holes spaced at 30 in;
3. After blasting, remove a sufficient amount of material from the test section to determine if the blast hole diameter, blast hole spacing, and amount of explosives are adequate to provide the required backslope. Do not continue drilling of the test section area until the test section is excavated and the Department evaluates the results.

If, at any time during the progress of the main blasting operation, the methods of drilling and blasting do not produce the desired results, revise and retest the blasting techniques until a technique produces the required results. The Department will consider the results to be...
unsatisfactory if:
1. There is an excessive amount of breakage beyond the indicated lines and grade;
2. There is excessive flyrock;
3. The final backslope within the specified tolerances is not uniform;
4. Ground vibration and air blast levels exceed limits as stated in Section 617, “Vibration Monitoring;”
5. There are violations of other requirements of the specifications;
6. The slopes are unstable;
7. The safety of the public is jeopardized;
8. Property or natural features are endangered.

203.3.3.1.7 Blasting Execution
203.3.3.1.7.1 Notification and Schedule
The following requirements will apply to the notification and scheduling of blasting procedures:
1. Coordinate blasting operations with the Project Manager and notify the Project Manager a minimum of 1.5 hours before the blast. Provide a one-hour timeframe for the blast. For example, if the Contactor notifies the Project Manager by 9:00 a.m. the blast may occur between 10:30 a.m. and 11:30 a.m;
2. Provide notice to the required federal, state, and local agencies before each blast, as required by the blasting permits;
3. Notify occupants of buildings and owners of structures and utilities of the blast time and location at least 48 hours before the start of drilling or blasting;
4. Detonate blasts at the planned time, unless approved otherwise by the Project Manager.

203.3.3.1.7.2 General Requirements
Cover the blast area with blasting mats, soil, or another equally serviceable material, before firing blasts in areas where flying rock may result in personal injury or damage to property or the Work.

203.3.3.1.7.3 Controlled Blasting Requirements
Perform controlled blasting in accordance with the Detailed Blasting Plans that produced acceptable results in blasting test sections. Perform control blasting using either pre-splitting or cushion blasting in accordance with the following requirements:
1. If the overburden does not support the drill holes, completely remove the overburden soil and loose rock along the top of the cut to expose the rock surface before drilling the controlled blast holes;
2. Mechanically monitor the blast hole angles;
3. Drill and space blast holes with a nominal diameter from 2 in to 3 in, in accordance with the blasting test sections or the results achieved in similar geologic materials. Do not exceed 3 ft;
4. Use proper Equipment and technique to ensure that no blast holes deviate from the plane of the backslope shown in the Plans by more than 8 in, parallel or normal to the slope. The Department will not pay for blast holes exceeding these limits unless the Project Manager approves the obtained slopes;
5. Drill the controlled blast holes at the required slope inclination, to the full depth of the cut, or to a pre-determined stage elevation. The maximum drill depth is 30 ft. Use shallower holes if the directional control is inadequate. If more than 5% of the controlled blast holes are misaligned in any one lift, reduce the height of the lifts until the 8 in tolerance is met. The length of controlled blast holes may be incrementally increased once satisfactory directional control and blast results are demonstrated;
6. Drill unloaded and un-stemmed guide holes to the same diameter, in the same plane, and to the same tolerance as the controlled blast holes;
7. The Department will allow a maximum offset of 24 in from the bottom of each lift to allow for drill Equipment clearances, when the cut requires more than one lift. Begin drilling the control blast hole at a point that allows the necessary offsets, and adjust at the start of lower lifts as necessary to compensate for drift in the upper lifts;
8. Do not use horizontal blast holes for controlled blasting;
9. Use explosive charges, detonating cord, and other items necessary for the blasting operation in accordance with the manufacturer’s recommendations and instructions;
10. Before placing charges, ensure the hole is free of obstructions. Use casing if necessary to prevent the walls of the hole from collapsing.
11. Use only standard explosives manufactured especially for the type of controlled blasting (cushion or pre-splitting). Do not load ammonium nitrate and fuel oil in the controlled blast holes. Use explosives and blasting accessories appropriate for the conditions of the blast hole (including water in the holes) and necessary to achieve satisfactory results;
12. Assemble and affix continuous column cartridge-type explosives to the detonating cord in accordance with the explosive manufacturer’s instructions.
13. The bottom charge in a blast hole may be larger than the charges above, but not large enough to cause overbreak. Place the top charge far enough below the collar and sufficiently reduced in size to avoid overbreaking or heaving;
14. Use a dry, angular, and granular material that passes a 3/8 in sieve to stem the controlled blast holes, from the top charge to the hole collar.

203.3.1.7.4 Pre-Split Blasting
Perform pre-split blasting in accordance with Section 203.3.1.7.3, “Controlled Blasting Requirements,” and the following requirements:
1. Detonate the pre-split blast holes before drilling for production blasting; or fire the pre-split blast holes at least 75 ms before the production holes if detonated in the same blast;
2. Fire pre-split blast holes simultaneously, unless ground vibrations, noise, or air blast are excessive. Fire pre-split holes in delayed sections and reduce the charge weight per delay to mitigate excessive effects;
3. The line of pre-split blast holes will extend beyond the limits of the production blast holes to be detonated. The minimum length of this extension will be 30 ft or to the end of the cut, but will not be greater than one-half of the distance of the expected blast advance;
4. Do not perform pre-split blasting if the distance between the controlled blast line and free face is less than 20 ft or less than 3 times the blast hole depth, whichever is greater.

203.3.1.7.5 Cushion Blasting
Perform cushion blasting in accordance with item No. 3 of Section 203.3.1.7.3, Controlled Blasting Requirements,” and the following requirements:
1. Perform cushion blasting as part of the final shot after other blasting is finished;
2. If the final shot includes production blast holes, detonate the cushion blast no more than 75 ms or less than 25 ms after the production blast;
3. Fire cushion blast holes simultaneously, unless ground vibrations, noise, or air blast are excessive. Fire cushion blast holes in delayed sections and reduce the charge weight per delay to mitigate excessive effects.

203.3.1.7.6 Production Blasting
Perform production blasting in accordance with the Blasting Plan that produced acceptable results in blasting test sections and the following requirements:
1. Minimize blast damage to the final excavation backslope;
2. Drill buffer rows of production blast holes on a plane approximately parallel to the controlled blast line;
3. Place the buffer row of production blast holes no closer than 6 ft to the controlled blast line unless the Contractor can prove the final excavation backslope will not be damaged by the production blast;
4. Where necessary to minimize damage to the excavation backslope, load blast holes in the buffer row lighter than other production holes;
5. Ensure the bottoms of production blast holes are not lower than the bottom of controlled blast holes, except in the lowest lift;
6. Ensure the diameter of production blast holes does not exceed 6 in, unless approved by the Project Manager;
7. Before placing charges, ensure the hole is free of obstructions. Use casing, if necessary, to prevent the walls of the hole from collapsing;
8. Use a dry, angular, and granular material that passes a 3/8 in sieve to stem the holes, from the top charge to the hole collar;
9. Detonate production blast holes in a controlled delay sequence toward a free face;
10. Do not use horizontal holes for production blasting, except for Equipment access;
11. Use explosives and blasting accessories appropriate for wet or dry blast hole conditions and necessary to achieve satisfactory results.

203.3.3.1.7.7 Scaling and Stabilization of Slopes Established by Controlled Blasting
Perform scaling and stabilization of slopes established by controlled blasting in accordance with the following requirements:
1. Observe the entire blast area following a blast before starting work in the cut. If any rocks are loose, hanging, or potentially dangerous within a blast area, the Contractor shall remove them. Scale slopes by hand using a standard steel mine scaling rod. Use other methods to supplement or in lieu of hand scaling, such as, machine scaling, hydraulic splitters, or light blasting, if approved by the Project Manager;
2. Slopes shall be scaled and stabilized before further construction activities take place. Scale slopes throughout the span of the Contract and as often as necessary to keep the slopes free of hazardous loose rock or overhangs;
3. Cease blasting operations if the following conditions exist:
   3.1. There is an excessive amount of breakage beyond the specified lines and grade;
   3.2. There is excessive flyrock;
   3.3. The final backslope within the specified tolerances is not uniform;
   3.4. Ground vibration and air blast levels exceed limits specified in Section 617, “Vibration Monitoring;”
   3.5. There are violations of other requirements of the specifications;
   3.6. The slopes are unstable;
   3.7. The safety of the public is jeopardized;
   3.8. Property or natural features are endangered.

203.3.4 Borrow
Obtain the borrow source, unless otherwise specified. Use Roadbed excavated Material for Embankment before using borrow Material, unless approved by the Project Manager. If the Contractor places more than the specified amount of borrow and causes a waste of excavation, the Department will deduct the wasted amount from the borrow volume, as measured in the borrow area. After excavation is complete, blade the borrow areas and leave in a condition to allow accurate payment measurements by cross sectioning. Restore Right of Way fencing removed for borrow operations to its original condition or better. Prevent livestock from entering Right of Way.

203.3.5 Embankments
Do not place Embankment Material on frozen earth, or incorporate frozen soils in Embankments. Suspend Embankment construction if Embankment Materials become frozen. Do not resume until the Materials are thawed and suitable for compaction. Before beginning Embankment construction, perform scalping in accordance with Section 201, “Clearing and Grubbing.” Bench new Embankments into the following:
1. Natural slopes including rock;
2. Existing Embankments; or
3. Phased Embankment construction.
Ensure benches are wide enough to allow operation and placement of compacting Equipment. Re-compact new Embankment Material and Material that is cut out at no additional cost to the Department. Do not place rock, broken concrete, or other solid materials in Embankment areas where driven pilings, drilled caissons, utility lines, or other Structures are specified in the Plans.

203.3.5.1 Roadbed Embankments
Break up the original ground surface to at least 6 in by plowing, scarifying, or stepping up. Compact this area to 95% of maximum density in accordance with Section 203.3.7, “Moisture and Density Control.” Place Material for Roadbed Embankment in horizontal layers not exceeding 8 in thick and compact in accordance with Section 203.3.7, “Moisture and Density Control.”
The Department will allow rocks no larger than 3 ft (in any dimension) as long as the
Contractor distributes and fills the interstices to form a dense mass. If the interstices between the rock fragments cannot be completely filled and compacted, use bridging geotextile over the top of the rock fragments to prevent the overlying Embankment Material from filling the interstices. Do not use rock fragments that may degrade with time or may be water sensitive (such as shale or gypsum) as rock fill in Roadbed Embankments. The Department considers this material to be unsuitable.

Place large rocks in the toe of the slope in accordance with the following requirements:

1. No rock is larger than one-half the Embankment height or 10 ft;
2. No rock is placed in fill height less than 8 ft, measured at the edge of the Roadway Shoulder;
3. Place rocks inside a line 6 in from the slope stake, space a minimum of 3 ft from edge to edge, and cover with approved Embankment Material.

Construct rock Embankments to a maximum of 6 in below Subgrade elevation. Consolidate rock fills by using the appropriate Equipment and methods approved by the Project Manager.

203.3.5.2 Non-Roadbed Embankment

Construct non-roadbed embankments in accordance with Section 203.3.5.1, "Roadbed Embankments," except, if the Embankment Material consists of rock, place the rock in layers of sufficient depth to contain the largest rock in the Material, and carefully distribute and fill the interstices to form a dense mass.

203.3.6 Subexcavation

Remove unsuitable and unstable materials from the Subgrade unless an alternative treatment is specified in the Contract or agreed upon by the Project Manager.

203.3.7 Moisture and Density Control

Construct Roadbed, Roadbed Embankment, non-roadbed embankment, and Roadway median excavation or Embankment, with moisture and density control. Compact each layer of Embankment to at least 95% of maximum density. Ensure the moisture content of the soil, at the time of compaction, is not greater than or 5% less than the optimum level in accordance with AASHTO T 224 and AASHTO T 99, Method C (TTCP Modified). For soils with a plasticity index of 15 or greater, ensure the moisture content of the soil at the time of compaction is from optimum moisture to 4 percentage points greater than the optimum level. If the moisture content at the time of compaction is not within the specified range, moisten or dry the Material, then thoroughly mix the Material to the full lift depth before re-compacting. Roadbed Embankments that contain mostly rock or coarse-grained Material (65% or greater retained on the No. 4 sieve) does not require moisture and density control, except the top 6 in of the Embankment; construct in accordance with Section 207.3, "Construction Requirements." Non-roadbed embankments of rock Material will not require moisture and density control unless otherwise specified.

Ensure that maximum densities are in accordance with AASHTO T 224 and AASHTO T 99, Method C (TTCP Modified), and field densities are in accordance with AASHTO T 310 or other approved methods. Measure densities at each lift before the next subsequent lift is placed.

203.4 METHOD OF MEASUREMENT

203.4.1 Rock Excavation

The Department will measure Rock Excavation based on the estimated percentages if shown in the Contract, unless otherwise requested by the Contractor. If the Contractor requests, the Department will measure Rock Excavation in its original position for material classified as Rock Excavation in accordance with Section 203.2.1.1, “Rock Excavation.” Before excavation, the Contractor and Project Manager must agree on the limits of material classified as rock excavation. Calculate volumes in accordance with Section 203.4.3, “Unclassified Excavation, Borrow, and Subexcavation.” Include in measurements the overbreakage in rock excavation a maximum of 10 in. beyond the backslope specified in the Plans or directed by the Project Manager. The Department will use the blaster’s drill-hole log cards to determine the quantities of rock excavation covered by soil or overburden. Provide these log cards as part of the surveying records.
203.4.2 Controlled Blasting
The Department will measure Controlled Blasting by the blast holes drilled along the final line, whether loaded or not; and will measure the lengths from the top of the rock surface to the elevation of the Roadway ditch or to a bench elevation set by the Project Manager. The Department based the quantities for Controlled Blasting shown in the Plans on assumed blast hole spacing; the actual quantities depend on field conditions and the results from test sections.

203.4.3 Unclassified Excavation, Borrow, and Subexcavation
Measure unclassified excavation, borrow, and subexcavation in its original position. The measurements for subexcavation will include approved excavation of rock, shale, muck, or other unsuitable material, and its placement in the required Embankment or disposal as directed by the Project Manager. Measure suitable backfill for subexcavation separately as borrow.

Within cut sections, excavated material removed from the limits of the cut section to the Subgrade elevation for the width of the Roadbed shall be paid as Unclassified Excavation.
Submit the original ground surface and final surface data for each phase of construction using an electronic XML-compatible format approved by the Project Manager. Submit volume summary reports to the Project Manager based on this electronic data for each phase of construction including a report that summarizes the basis for the final volumes. Use a licensed New Mexico professional engineer or professional surveyor to certify these volumes.

203.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock Excavation</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Unclassified Excavation</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Borrow</td>
<td>Cubic Yard or Ton</td>
</tr>
<tr>
<td>Subexcavation</td>
<td>Cubic Yard or Ton</td>
</tr>
<tr>
<td>Controlled Blasting</td>
<td>Linear Foot</td>
</tr>
</tbody>
</table>

203.5.1 Extra Work
The Department will pay for stabilization necessitated by existing geological conditions and for Base Course (and geotextile if necessary) as required to backfill rock Subgrade conditions.

The Department will pay for excavated materials that require more than one handling as identified within the Contract before final placement, including fertile topsoil required to be stockpiled and reserved for later use in the Work:
1. At the Bid Item Unit Price for unclassified excavation, for each handling approved by the Project Manager; or
2. As another item of Work for the second handling if specified in the Contract.

However, if the Contractor handles excavated and borrow Materials more than once, at the Contractor’s request or at the convenience of the Contractor, there will be no additional cost to the Department.

203.5.2 Work Included in Payment for Excavation, Backfill, and Embankments
The Department will consider as included in the payment for the pay item(s) listed in this section and will not measure or pay separately for the following Work:
1. Controlled blasting drill holes through overburden;
2. Production blasting;
3. Scaling within the limits of a final backslope established by controlled blasting;
4. Mobilization of any Equipment and testing of rock in accordance with Section 203.2.1.1, “Rock Excavation;”
5. Time delays to perform testing of rock in accordance with Section 203.2.1.1, “Rock Excavation;”
6. Material required to fill the voids and irregularities in the Subgrade below the tolerance limit from the specified elevation, except where the Project Manager requires removal of unsuitable materials designated as subexcavation;
7. Surveying, for the purpose of payment, is considered incidental to the excavation Work and is the Contractor’s responsibility;
8. Hauling related to Rock Excavation, Unclassified Excavation, Borrow, and Subexcavation;}
9. Fence removal and replacement;
10. Damage resulting from blasting.

203.5.3 Work Included in Payment

The following work will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: Controlled blasting drill holes through overburden for the contractor’s convenience. Production Blasting. Scaling within the limits of a final backslope established by controlled blasting. Mobilization of any equipment and testing of rock as covered in subsection 203.2.1.1 Rock Excavation. Time delays to perform testing of rock as covered in subsection 203.2.1.1, Rock Excavation. Material required to fill the voids and irregularities in the subgrade below the tolerance limit from contract established elevation, except where the Project Manager requires removal of unsuitable materials designated as subexcavation. Surveying, for the purpose of payment, is considered incidental to the excavation work and shall be the responsibility of the Contractor. All hauling related to Rock Excavation, Unclassified Excavation, Borrow and Subexcavation. Fence removal and replacement.
SECTION 206: EXCAVATION AND BACKFILL FOR CULVERTS AND MINOR STRUCTURES

206.1 DESCRIPTION
This Work consists of excavating, placing and compacting select backfill, and disposing of material related to construction of box and pipe Culverts, storm drains, cattle guards, and other drainage Structures. Excavation includes dewatering, pumping, bailing, draining, sheeting, bracing, and incidentals required for proper execution of the Work. Ditches required at Culvert inlets and outlets, and other locations indicated in the Plans are included under the item for Unclassified Excavation.

206.2 MATERIALS
206.2.1 Select Backfill
Select backfill Material is composed of stone, crushed stone, crushed or screened gravel, caliche, sand, or a combination of these Materials; and must be free of organic matter, silt, clay balls, lumps or stones (2-inch diameter or greater), and other Deleterious Materials. Provide Materials that are in accordance with AASHTO soil classifications A-1, A-2-4, or A-3 as determined by AASHTO M 145, unless otherwise specified in the Contract.

206.2.2 Flowable Fill
The Contractor may substitute flowable fill for select backfill in accordance with Section 516, “Flowable Fill,” at no additional cost to the Department. Secure Culverts and minor Structures to prevent flotation.

206.2.3 Bedding
Bedding Material is composed of loose sand or sandy soil meeting the gradation requirements of Table 206.2.3.1, “Sand Bedding.” The Material shall be non-plastic.

<table>
<thead>
<tr>
<th>Standard Sieve</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 in</td>
<td>100%</td>
</tr>
<tr>
<td>No. 4</td>
<td>95% - 100%</td>
</tr>
<tr>
<td>No. 16</td>
<td>50% – 85%</td>
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<td>No. 30</td>
<td>25% – 60%</td>
</tr>
<tr>
<td>No. 50</td>
<td>5% - 30%</td>
</tr>
<tr>
<td>No.100</td>
<td>0% - 10%</td>
</tr>
</tbody>
</table>

206.3 CONSTRUCTION REQUIREMENTS
206.3.1 General
Remove unsuitable foundation material below the specified bottom-of-structure elevation and replace with approved Material, as directed by the Project Manager. Use backfill Material to backfill Culverts in accordance with Section 206.2.1, “Select Backfill,” or Section 206.2.2, “Flowable Fill,” unless otherwise shown on the Plans. Compact the top 6 in. of existing ground to at least 95% of maximum density at a moisture content of from optimum to 5% below optimum in accordance with AASHTO T 99, Method C (TTCP Modified). Maintain the density, approved surface elevation, and shape of the foundation immediately before placing Structures and forms. Distribute backfill Material in uniform layers, each no more than 8 in deep (loose measurement), and compact to 100% of maximum density at optimum +/- 3 percentage points moisture content in accordance with AASHTO T 99 Method C (TTCP Modified). Correct for coarse particle content in accordance with AASHTO T 224. Test for field density and moisture content using nuclear methods in accordance with ASTM D 2922. Before placing backfill Material against new masonry or concrete Structures, wait 14 Days or until concrete has developed a compressive strength of 2,500 psi as determined in Section 510.3.5.1, “Concrete Strength.” Maintain Structure alignment and integrity during backfill compaction. Do not place backfill on frozen earth or with frozen Materials. Suspend operations until Material is thawed and dried so that the moisture content meets requirements above. Remove sheeting and bracing before placing backfill.

The Project Manager may reduce the density requirement to 95% if the deflections for flexible pipe (with 72 in. or greater diameter) exceed the manufacturer’s tolerances.
206.3.2 Pipe Culverts, Storm Drains, and Structural Plate Pipe

Remove rock and other unyielding foundation material to at least 12 in. below the bottom of the Structure. Backfill this added depth with an approved Material as identified in the Contract. Excavate trenches wide enough to allow for pipe joining and compaction of the bedding and backfill Material under and around the pipe in accordance with Section 206.3.1, “Construction Requirements, General.” Uniformly compact the trench for its full length and width. If specified in the Plans, provide the longitudinal camber of the specified magnitude for cross drains.

206.3.3 Box Culverts and Other Drainage Structures

The Department shows the approximate elevation of footing bottoms in the Plans. Excavate material to the elevations established by the Project Manager, to ensure satisfactory foundations. Remove, by hand, the last 6 in of material above the footing bottom final grade before placing the footing Material. Do not remove material, except unsuitable material, below the final grade, if placing footings on excavated surfaces other than rock. Cut rock or other unyielding foundation material to a firm surface—level, stepped, or serrated—to meet the neat lines of the footings. Clean rock seams and cavities, and fill with concrete or grout. Use concrete (of the same class as the footing) to backfill areas outside the neat lines or below the final grade of the footing bottom, at no additional cost to the Department. Notify the Project Manager after each footing excavation. Do not place footings until the Project Manager approves the excavation depth and the foundation material. Maintain the density and the approved surface elevation and shape of the foundation before installing reinforcing steel.

206.4 METHOD OF MEASUREMENT

The Project Manager will measure the in-place quantity of Unsuitable Material Excavation below the bottom-of-structure elevation.

206.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsuitable Material Excavation</td>
<td>Cubic Yard</td>
</tr>
</tbody>
</table>

The Department will pay for rock excavation in accordance with Section 203, “Excavation, Borrow, and Embankment.”

206.5.1 Work Included in Payment

Excavation, disposal of unsuitable material, backfill and select backfill material, placement and compaction of select backfill for culverts, storm drains, other drainage structures, box culverts, and minor structures shall be included in the contract unit price per linear foot of culvert. Excavation shall include all dewatering, pumping, bailing, draining, sheeting, bracing, and incidentals required for proper execution of the work. Select backfill shall include the use of Section 516, “Flowable Fill.” Backfilling with concrete of the same class as the footings where the Contractor excavates below the established final elevation for bottom of footings or beyond the neat lines of the footings in rock or other hard foundation material shall be included in the contract unit price per linear foot of culvert. Unrippable rock or unyielding material will be defined and paid for as covered in Section 203, “Excavation, Borrow, and Embankment.”
207.1 DESCRIPTION
This Work consists of compacting and finishing the Subgrade.

207.2 MATERIALS—Vacant

207.3 CONSTRUCTION REQUIREMENTS
Compact the top 6 in of the Roadbed to 100% of maximum density. Compact soils with a PI of 15 or greater to at least 95% of maximum density.
Ensure the soil moisture content (at the time of compaction) is from optimum to optimum minus 5%, in accordance with AASHTO T 99 Method C (TTCP Modified) and AASHTO T 224. For soils with a PI of 15 or greater, ensure the moisture content of the soil at the time of compaction is from optimum moisture to 4 percentage points greater than the optimum level.
Determine densities in accordance with AASHTO T 99 Method C (TTCP Modified) and conduct field density tests at locations according to minimum testing requirements, in accordance with AASHTO T 310, or by other Department-approved methods.

207.3.1 Tolerances
Ensure the top surface elevation of the finished Subgrade does not vary more than 0.10 ft above or below the specified elevation and 0.05 ft above or below the typical section. The Department will measure tolerances on the finished surface at right angles to the centerline.

207.4 METHOD OF MEASUREMENT—Vacant

207.5 BASIS OF PAYMENT
Pay Item Pay Unit
Subgrade Preparation Square Yard

207.5.1 Work Included in Payment
No payment will be made for rehandling or reworking material to meet moisture and density requirements.
208.1 Description
This Work consists of constructing, or restoring and shaping Roadbeds and side ditches to the specified grade and typical section.

208.2 MATERIALS—Vacant

208.3 CONSTRUCTION REQUIREMENTS
208.3.1 General
Use a motor grader to move existing material in the Roadway Prism to bring the existing Roadbed surfaces to grade and section. Material haul of more than 200 ft is not required. Use Material that is free of Deleterious Material and frozen lumps for constructing or reshaping the Roadbed. Treat unsuitable Material in accordance with Section 104.3, “Differing Site Conditions.”

208.3.2 Compaction
Compact the top 6 in of the Roadbed in accordance with Section 207, “Subgrade Preparation.”

208.3.3 Tolerance
The horizontal distance, for a typical section, from the Roadbed centerline to the completed edge of the Shoulder shall not differ by more than 6 in, from the dimension shown on the Plans.

208.4 METHOD OF MEASUREMENT
The Project Manager will measure Linear Grading along the Roadbed centerline.

208.5 BASIS OF PAYMENT
Pay Item Pay Unit
Linear Grading Mile
209.1 DESCRIPTION
This Work consists of restoring existing Roadbed to the specified grade and typical section.

209.2 MATERIALS—Vacant

209.3 CONSTRUCTION REQUIREMENTS
Bring the surface of the existing Roadbed to the specified grade with approved Materials. Reshape Shoulders to the specified width.

209.3.1 Compaction
Perform the following to the top 6 in of the Roadbed, after restoring the grade and typical section:
1. Scarify the surface;
2. Water, when required;
3. Compact in accordance with Section 207, “Subgrade Preparation;”
4. Smooth and finish the Roadbed to a uniform grade and typical section.

209.4 METHOD OF MEASUREMENT
The Department will measure Blading and Reshaping along the Roadbed centerline.

209.5 BASIS OF PAYMENT
Pay Item                  Pay Unit       
Blading and Reshaping     Mile
SECTION 210: EXCAVATION AND BACKFILL FOR MAJOR STRUCTURES

210.1 DESCRIPTION
This Work consists of excavating, backfilling, and disposing of materials related to the construction of Bridges, cast in place retaining walls, and CBCs 20 feet or greater measured along the centerline of the Roadway. All excavation for major Structures below the designed slope or Subgrade lines, as shown on the Plans, is included under this Contract Item. Excavation for major Structures includes pumping, bailing, draining, sheeting, bracing, and incidentals required for proper execution of the Work.

210.2 MATERIALS

210.2.1 Select Backfill
Use select backfill Material composed of stone, crushed stone, crushed or screened gravel, caliche, sand, or a combination thereof. Use Material that is free of Deleterious Materials and that does not contain lumps or stones with diameters larger than 2 in. Provide select backfill Materials in accordance with AASHTO Soil Classifications A-1, A-2-4, or A-3 as determined by AASHTO M 145, unless otherwise shown in the Contract.

210.2.2 Approach Slab
Use AASHTO Soil Classifications A-1-a Material or Base Course under the approach slab and extending 10 ft beyond the end of the approach for the full width of the abutment and to the depth indicated in the Plans and in accordance with Section 210.3.2, "Compaction."

210.3 CONSTRUCTION REQUIREMENTS

210.3.1 General
The Department shows the approximate elevation of footing bottoms in the Plans. Excavate material to the elevation established by the Project Manager, to ensure satisfactory foundations. Remove, by hand, the last 6 in of material above the final grade of footing bottoms for Bridge abutments and piers before placing the footing Material. Do not remove material, except unsuitable material, below the final grade, if placing footings on excavated surfaces other than rock. Cut rock or other unyielding foundation material to a firm surface — level, stepped, or serrated — to meet the neat lines of the footings. Clean rock seams and cavities, and fill with concrete or grout. Use concrete (of the same class as the footing) to backfill areas outside the neat lines or below the final grade of the footing bottom, at no additional cost to the Department. The Contractor may use excavated surpluses of suitable Material in the construction of Embankments, but must dispose of unsuitable material. Notify the Project Manager after each footing excavation. Do not place footings until the Project Manager approves the excavation depth and the foundation material.

Dewater wet pits for inspection and for construction of footings. When necessary, install well-braced cofferdams, built as watertight as practical. Do not use timber or bracing inside cofferdams that cannot be removed without damage to the concrete. Make temporary Structures large enough to provide ample room for pile driving, form construction, inspection, and sump pumps. Straighten or move cofferdams that threaten to damage the Structure. As specified, submit to the Project Manager Working Drawings showing proposed methods of constructing cofferdams, cribs, shoring, or similar temporary Structures. The submittal of Working Drawings does not relieve the Contractor of any responsibility.

Backfill excavated areas not occupied by piers, abutments, or other permanent Structures to the adjoining finished surface elevation. Do not use rock in backfill that is within 2 ft of the Structure. Place backfill Material in approximately level layers for the length and width of the backfilled area. When necessary to prevent wedge action, bench the slopes bounding the area being backfilled in accordance with Section 203.3.6, "Embankments." Dispose of unsuitable excavated material outside of the Roadway Prism as directed by the Project Manager. Before placing backfill Material against new masonry or concrete Structures, wait 14 Days or until concrete has developed a compressive strength of 2,500 psi. Prevent unbalanced loading while placing backfill Material.

210.3.2 Compaction
Make layers of uncompacted backfill no more than 8 in. thick. Before placing the next layer, compact to 100% of the maximum density near optimum moisture content for AASHTO Soil Classifications A-1-a Material and Roadway Embankment as determined by AASHTO T 99, Method C (TTCP Modified). Use nuclear methods to determine field densities.
in accordance with AASHTO T 310.

For Bridge abutments, backfill the excavated volume and compact to 100% of the maximum density as follows:
1. Under the approach slab and extending 10 ft beyond the end of the approach for the full width of the abutment and to a depth specified in the Plans; use AASHTO Soil Classification A-1-a Material with a maximum coarse fraction size of 1.5 in. The Department will pay for A-1-a Material as Excavation and Backfill for Major Structures;
2. The remaining volume extending 50 ft behind the abutment at the proper moisture content for Roadway Embankment.

The Contractor may use any type of Equipment necessary to obtain the required backfill densities; do not damage the Structure. Repair damage resulting from this Work.

210.4 METHOD OF MEASUREMENT

The Department will measure Excavation and Backfill for Major Structures in its original position from the ground surface after excavation of any overburden material to final Plan grade, to the bottom of the Structure or Structure footings. For this measurement, ground surface is defined as the bottoms of channel excavations, the template sections of the Roadway cuts, or the undisturbed natural ground surface. This method applies whether or not the Contractor elects to excavate for the Roadway or channel before making the excavation for the Structure. The Department will measure Excavation and Backfill for Major Structures for all grade separation Structures in its original position between the template section of the lower Roadway and the bottom of the footings.

210.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation and Backfill for Major Structures</td>
<td>Cubic Yard</td>
</tr>
</tbody>
</table>

The Department will not pay for material excavated outside the area:
1. Bounded by vertical planes 18 in from, and parallel to, the footings;
2. The neat lines for footings in rock; or
3. For material excavated below the established final elevation.

210.5.1 Work Included in Payment

Excavation and Backfill for Major Structures includes the following:
1. Compaction to 100% of maximum density for 50 ft approach to Bridge abutments;
2. Any temporary shoring of excavations required for construction phasing;
3. Dewatering of excavations for Structure backfill; and
4. Select backfill A-1-a or Base Course.
213.1 DESCRIPTION
This Work consists of obliterating old road.

213.2 MATERIALS—Vacant

213.3 CONSTRUCTION REQUIREMENTS
After the old road is no longer needed for traffic, remove and stockpile existing surfacing materials in an environmentally acceptable manner.

Fill ditches, rough grade the road (to blend with the surrounding terrain) and form natural rounded slopes (approved by the Project Manager). Next, scarify or plow (to thoroughly mix the remaining surfacing material with earth), harrow, and smooth the Roadbed.

213.4 METHOD OF MEASUREMENT
Measure Obliterating Old Road along the centerline of the road.

213.5 BASIS OF PAYMENT
<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obliterating Old Road</td>
<td>Mile</td>
</tr>
</tbody>
</table>
Division 300 – BASES

Division Contents
302: Processing, Placing, and Compacting Existing Pavement .... 87
303: Base Course (QLA).............................................................. 88
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306: Portland Cement Or Lime Treated Subgrade.................... 94
302.1 DESCRIPTION
This Work consists of processing, placing, and compacting existing pavements.

302.2 MATERIALS
The following gradation requirements apply:

<table>
<thead>
<tr>
<th>Sieve size (in)</th>
<th>% passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>95–100</td>
</tr>
<tr>
<td>1 1/2</td>
<td>90–100</td>
</tr>
</tbody>
</table>

302.3 CONSTRUCTION REQUIREMENTS
Process the existing pavement in place to a homogeneous mixture and a depth in accordance with the Plans. Mix the existing pavement and underlying aggregate to a homogeneous mixture and a depth in accordance with the Plans. Place and compact the mixed Materials on the existing Subgrade. Perform compaction and provide a final surface in accordance with Section 303, "Base Course (QLA)."

302.4 METHOD OF MEASUREMENT—Vacant

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing, Placing, and Compacting Existing Pavement</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>
303.1 DESCRIPTION
This Work consists of providing, hauling, and placing Base Course.

303.1.1 Stockpiling
This Work consists of providing, hauling, and stockpiling Base Course at specified locations.

303.1.2 Removing, Processing, and Placing Base Course
This Work consists of removing, hauling, processing, placing existing Base Course Material.

303.2 MATERIALS
303.2.1 General
Base Course consists of one or more of the following:
1. Crushed stone;
2. Crushed or screened gravel;
3. Caliche;
4. Sand;
5. HMA RAP or recycled concrete pavement (RC) not to exceed 50%;
6. Processed glass aggregate.
Base Course does not contain organic matter or other Deleterious Materials, including silt and clay balls.
The Department will allow a maximum of 10% (by weight) processed glass aggregate, uniformly distributed, in composite Base Course. Processed glass aggregate shall meet physical properties and deleterious substance requirements in accordance with AASHTO M 318.

303.2.2 Aggregate Acceptance
The Department will accept Base Course based on periodic random samples taken by the Contractor from the Roadway in accordance with Section 901, “Quality Control/Quality Assurance (QC/QA).” Unless the Contract specifies otherwise, combine the aggregate Materials, including processed glass aggregate, in proportions that produce a homogeneous composite blend in accordance with Table 303.2.1:1, “Base Course Gradation Target.”

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>% passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 in</td>
<td>100</td>
</tr>
<tr>
<td>3/4 in</td>
<td>90</td>
</tr>
<tr>
<td>No. 4</td>
<td>45</td>
</tr>
<tr>
<td>No. 10</td>
<td>32</td>
</tr>
<tr>
<td>No. 200</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Ensure that at least 50% of the Materials retained on or above the No. 4 sieve have at least two Fractured Faces when evaluated by NMDOT Method FF-1, Fractured Face Determination for Coarse Aggregate. Provide Base Course with a maximum AI of 35 when calculated in accordance with Section 910, “Aggregate Index,” a maximum LL of 25, and a maximum PI of 6. Determine the AI for the untreated natural aggregate source only when using RAP or RC with or without processed glass in combination with an untreated aggregate.

303.3 CONSTRUCTION REQUIREMENTS
303.3.1 Preparation of Subgrade
Clean the Subgrade of loose and Deleterious Material. Ensure that the top 6 in of the Roadbed meets the density requirements of Section 207, “Subgrade Preparation.” Proof-roll the Subgrade with a 27 ton roller or alternate Equipment as approved by the Project Manager to expose and correct soft areas.

303.3.2 Mixing and Placing
Mix the Base Course Material to a homogenous mixture. Place maximum 6 in
Section 303.3 Surface Tolerance

The Department will allow a surface tolerance of 1/2 in within 10 ft. If the depth is deficient, the Project Manager can accept the Work and reduce the Contractor's payment, or reject the Work with subsequent replacement by the Contractor.

Section 303.4 Plan Base Course and Subbase Depths

Monitor and record Base Course depth during the placement in accordance with the Department’s Minimum Testing and Acceptance Requirements. If the placed thickness deviates from the requirements by more than minus 1/2 in, the Project Manager may:

1. Accept and approve the payment for the measured quantity only; or
2. Accept the in-place layer of Base Course Material along with another layer of Base Course Material up to the specified thickness.

Section 303.5 Stockpiled Base Course

Stockpile Material at locations shown on the Plans. Prevent segregation of Materials at each stockpile. Maintain each stockpile in accordance with Section 423.2.2.3, “Stockpiling.”

Section 303.6 Removing and Processing Base Course

Minimize contamination of Base Course Material when removing it from the Roadway.

Section 303.7 Sampling and Testing

Section 303.7.1 Contractor Quality Control

Develop and administer a quality control plan that ensures the product meets the requirements of Section 901.2, “Contractor Quality Control.” Ensure that the quality control plan addresses the following elements:

1. Contractor management and process control personnel;
2. Testing Equipment and lab facilities;
3. Aggregate production;
4. Quality of components;
5. Stockpile management;
6. Proportioning;
7. Mixing and processing;
8. Transporting;
9. Placing and spreading;
10. Compaction;
11. Line and grade control; and
12. Criteria for the correction or rejection of unsatisfactory Materials.

Include names and duties of personnel responsible for sampling and testing the Base Course. Use test results, inspections, and other quality control practices to assure the quality of each Material source and to control processes for crushing, mixing, proportioning, processing, transporting, placing, spreading, and compacting quality.

Section 303.8 Acceptance and Pay Factor Determination

Take random samples of the Base Course and test in accordance with Table 901.7.6, “Minimum Acceptance Guidelines.” The Department will evaluate and accept the Materials in accordance with Section 901.5, “Quality Level Analysis.” The Department will determine Base Course pay factors for each lot in accordance with the equation in Section 901.5, “Quality Level Analysis,” and Table 901.7.2, “Pay Factors.” Limits for the evaluation of Materials and the “f” factor in the equation in Section 901.5, “Quality Control/Quality Assurance (QC/QA)” are shown in Table 303.3.8.1, “Limits.”
### Table 303.3.8:1  
**Limits**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification limit*</th>
<th>&quot;f&quot; factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 in</td>
<td>- 10% + 10%</td>
<td>6</td>
</tr>
<tr>
<td>No. 4</td>
<td>- 15% + 15%</td>
<td>10</td>
</tr>
<tr>
<td>No. 10</td>
<td>- 12% + 12%</td>
<td>6</td>
</tr>
<tr>
<td>No. 200</td>
<td>- 4.0% + 4.0%</td>
<td>20</td>
</tr>
</tbody>
</table>

*Percent difference from TV

If the Composite Pay Factor is less than 80%, reprocess the Base Course Material to obtain an acceptable quality level. If the Composite Pay Factor is equal to or greater than 80% but less than 100%, the Contractor may accept reduced payment or reprocess the Material one time to improve the quality and retest. The Department will determine the final pay factor by the results of the retest.

If the pay factor falls below 80% upon reprocessing, continue to reprocess the Base Course Material to obtain a quality level of 80% or higher. If a pay factor of 80% cannot be achieved, remove and replace the Base Course. If the Contract requires the stockpiling of Material for later use by the Department, perform acceptance testing as the Material is placed in the stockpile. The Department will accept Material that obtains a composite pay factor of at least 80%, and will allow no further attempts to improve the pay factor. The Department will reject Material obtaining a composite pay factor less than 80%.

### 303.4  METHOD OF MEASUREMENT

When calculating the square yardage, the Department will use the average Base Course width and the station-to-station length along the centerline. The dimensions will show on the typical section of the Plans.

When calculating the weight of the Material, the Department will deduct the weight of moisture that exceeds the optimum moisture content plus 2%. No additional payment shall be made for the stockpile pad.

### 303.5  BASIS OF PAYMENT

The Department will pay for the accepted quantities of Base Course modified by the appropriate pay factor as determined in Section 303.3.8, “Acceptance and Pay Factor Determination.” The Department will pay for Material per lot by multiplying the Bid Item Unit Price by the composite pay factor of each lot.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Course</td>
<td>Cubic Yard or Ton</td>
</tr>
<tr>
<td>Base Course _____ in Depth</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Remove, Process and Place Base Course</td>
<td>Square Yard or Ton</td>
</tr>
<tr>
<td>Stockpiled Base Course</td>
<td>Cubic Yard or Ton</td>
</tr>
</tbody>
</table>
304.1 DESCRIPTION
   See Section 303.1, “Description.”

304.2 MATERIALS

304.2.1 General
   Base Course consists of the following:
   1. Crushed stone;
   2. Crushed or screened gravel;
   3. Caliche;
   4. Sand;
   5. RAP;
   6. Processed glass aggregate; or
   7. A combination of these Materials.

   Base Course does not contain organic matter or other Deleterious Materials, including silt
   and clay balls.

   The Department will allow a maximum of 10% (by weight) processed glass aggregate,
   uniformly distributed, in composite Base Course. Processed glass aggregate shall meet
   physical properties and deleterious substance requirements in accordance with
   AASHTO M 318.

   The following gradation requirements apply to aggregate Materials:

   Table 304.2.1:1
   Base Course Gradation
   \begin{tabular}{l|c}
   \hline
   Sieve size & \% passing \\
   \hline
   1 in & 100 \\
   3/4 in & 80–100 \\
   No. 4 & 30–60 \\
   No. 10 & 20–45 \\
   No. 200 & 3.0–10.0 \\
   \hline
   \end{tabular}

   Use the gradation, as shown in Table 304.2.1:1, “Base Course Gradation,” unless
   otherwise specified.

   Ensure that at least 50% of the Materials retained on the No. 4 sieve have at least two
   Fractured Faces (FF) when evaluated by NMDOT Method FF-1, Fractured Face Determination
   for Coarse Aggregate. Provide Base Course with a maximum AI of 35 (calculated in
   accordance with Section 910, “Aggregate Index,” a maximum LL of 25, and a maximum PI of
   6. Determine the AI per source at the untreated natural aggregate source only when using
   RAP with or without processed glass in combination with an untreated aggregate.

304.2.2 Aggregate Acceptance
   See Section 303.2.2, “Aggregate Acceptance.”

304.3 CONSTRUCTION REQUIREMENTS

304.3.1 Preparation of Subgrade
   See Section 303.3.1, “Preparation of Subgrade.”

304.3.2 Mixing and Placing
   See Section 303.3.2, “Mixing and Placing.”

304.3.3 Surface Tolerance
   See Section 303.3.3, “Surface Tolerance.”

304.3.4 Plan Base Course and Subbase Depths
   See Section 303.3.4, “Plan Base Course and Subbase Depths.”

304.3.5 Stockpiled Base Course
   See Section 303.3.5, “Stockpiled Base Course.”
304.3.6 Removing and Processing Base Course
See Section 303.3.6, “Removing and Processing Base Course.”

304.3.7 Sampling and Testing

304.3.7.1 Contractor Quality Control

Develop and administer a quality control plan that ensures that the product meets the following requirements:

1. Sample the stockpiled Base Course at a point approved by the Project Manager and conduct gradation testing, FF, LL, and PI testing in accordance with applicable AASHTO test procedures in accordance with Section 901, "Quality Control/Quality Assurance (QC/QA)."
2. Ensure that qualified sampling and testing personnel (in accordance with Section 901, “Quality Control/Quality Assurance (QC/QA)”) perform sampling and testing in accordance with Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA),” using Contractor-provided Equipment;
3. Establish a Laboratory to do the testing;
4. Comply with the requirements of Section 423.3.6.1, “Contractor Quality Control;”
5. Perform gradation and Fractured Face tests at the rate of one test per 500 ton of Material produced. Perform LL and PI tests at the rate of one test per 1,000 ton of Material produced. If the quantity of Base Course is less than 500 ton, conduct at least one gradation test, one FF determination, one LL test, and one PI determination;
6. Establish a plan for line and grade control;
7. Perform compacted thickness tests at a rate of at least one test per 1,000 ton of placed Material, in accordance with Table 901.7.3, “Minimum Process Control Guidelines for Aggregates and Base Course.”

304.3.8 Acceptance

The Department will accept Base Course Material based on samples taken after placement but before compaction. The Contractor shall meet the following tolerances:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation (Refer to Table 304.2.1:1)</td>
<td>Refer to Table 304.2.1:1</td>
</tr>
<tr>
<td>Density</td>
<td>96%</td>
</tr>
<tr>
<td>Transverse Surface Tolerance</td>
<td>TV - 0.5 in</td>
</tr>
</tbody>
</table>

The Department will accept stockpiled Base Course for gradation requirements based on samples taken as the aggregate Material is stockpiled. The Department or a designated representative will conduct this acceptance testing as shown in the Department’s Minimum Acceptance and Testing Requirements in accordance with Section 901, “Quality Control/Quality Assurance.” The Department will submit acceptance test results to the Contractor’s quality control representative or designee within two Working Days after the samples are taken. If the Base Course Material that the Contractor has placed does not meet the specifications, the Contractor will either remove it or take corrective action.

304.4 METHOD OF MEASUREMENT

The Department will deduct the weight of moisture that exceeds the optimum moisture content plus 2%.

304.4.1 Stockpiling

See Section 303.1.1, “Stockpiling.”

304.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Course</td>
<td>Cubic Yard or Ton</td>
</tr>
<tr>
<td>Base Course in Depth</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

Section 304: Base Course
304.5.1  **Base Course Testing by the Contractor**

The Department will make partial payments according to the percentage of sampling and testing completed, as determined by the Project Manager. Before sampling and testing begins, the Project Manager will make a schedule that shows the percentages of sampling and testing, and will provide it to the Contractor.
SECTION 306: PORTLAND CEMENT OR LIME TREATED SUBGRADE

306.1 DESCRIPTION
This Work consists of the following:
1. Preparing the Roadbed;
2. Providing, applying, mixing, and processing portland cement or lime; and
3. Compacting the mixture.

306.2 MATERIALS
306.2.1 Portland Cement Treated Subgrade
Provide portland cement in accordance with Section 510, “Portland Cement Concrete.”

306.2.2 Lime Treated Subgrade
306.2.2.1 Hydrated Lime
Provide hydrated lime in accordance with AASHTO M 216. When dry sieved in a mechanical shaker for 10 min ± 30 s, a 0.5 lb test sample of hydrated lime shall conform to the gradation requirement in Table 306.2.2.1:1, “Hydrated Lime Gradation Requirements.”

<table>
<thead>
<tr>
<th>Table 306.2.2.1:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrated Lime Gradation Requirements</td>
</tr>
<tr>
<td>Sieve size</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

306.2.2.2 Quicklime
Provide quicklime in accordance with AASHTO M 216. When dry sieved in a mechanical shaker for 10 min ± 30 s, ensure a 0.5 lb test sample of quicklime is in accordance with Table 306.2.2.2:1, “Quicklime Gradation Requirements.”

<table>
<thead>
<tr>
<th>Table 306.2.2.2:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quicklime Gradation Requirements</td>
</tr>
<tr>
<td>Sieve size</td>
</tr>
<tr>
<td>3/4 in</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
</tbody>
</table>

306.2.2.3 Commercial Lime-Slurry
Provide commercial lime-slurry as a suspension of solids in water that can be pumped. The water or liquid portion of the slurry is free of dissolved material. The hydrated lime solids in the mixture shall meet the following requirements:
1. Chemical Composition. Lime-slurry with a “solids content” of at least 90% (by weight) calcium and magnesium oxides;
2. Residue. Lime-slurry mixture with a retained “solids content” residue in accordance with Table 306.2.2.3:1, “Lime Slurry ‘Solids Content’ Gradation Requirements;”

<table>
<thead>
<tr>
<th>Table 306.2.2.3:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime-Slurry “Solids Content” Gradation Requirements</td>
</tr>
<tr>
<td>Sieve size</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
</tbody>
</table>

3. Grade. Commercial lime-slurry with an approved minimum “dry solids content,” generally from 25 to 40%.

306.3 CONSTRUCTION REQUIREMENTS
306.3.1 Subgrade Preparation
Treat the Subgrade in accordance with the State Materials Bureau’s mix design. Identify and correct soft areas, then shape the Subgrade to the grades shown in the Plans before adding portland cement or hydrated lime, quicklime, or lime-slurry. Ensure that the scarified depth of the treated Subgrade (shown in the Plans) is free of Deleterious Material...
and stones retained on a 3.0 in sieve.

Do not perform Work during wet or inclement weather. Mix and place portland cementor lime-treated Subgrade only if when the air temperature is at least 40 °F and rising in theshade. Do not mix or place cement- or lime-treated Subgrade on frozen Subgrade. When theair temperature is forecast to fall below 32 °F within a 48-hour period, cease work or ensure theSubgrade temperature will not fall below 40 °F.

Proof-roll with a 30 ton roller or alternate Equipment as approved by the Project Manager toexpose and correct soft areas.

Where unstable Subgrade is encountered in cuts or existing grades, due to no fault orneglect of the Contractor, subexcavation and borrow will be paid for and measured as perSection 203, “Excavation, Borrow, and Embankment.” Engineered designs will be measuredand paid for on an item by item basis or as specified in the Contract. Conduct operations in such away that the Project Manager can take the necessary cross-sectional measurements before the backfill is placed.

306.3.2 Portland Cement Treated Subgrade

Prior to the addition of portland cement, pulverize the Subgrade to the specified depth sothat at least 80% (by weight) passes through a No. 4 sieve.

Apply portland cement at the specified application rate and to the depth shown on thePlans. When processing the portland cement-treated Subgrade, ensure that cement dust isnot a hazard to the public or workers. Perform mixing, placing, compacting, and finishing onthesame day as the cement placement.

306.3.2.1 Mixing

Mix the portland cement, soil, and water with a self-propelled rotary-type mixing machine(approved by the Project Manager) to provide a uniform mixture. Overlap at least 6 in betweenthe passes.

The Department will consider streaks and pockets of portland cement as evidence of unacceptable mixing.

Ensure the Material moisture content ranges between optimum to 5% over optimum within the entire treated depth.

306.3.2.2 Finishing Operations

Compact to 100% maximum density in accordance with AASHTO T 99, Method C (TTCPModified), immediately after mixing is complete. Finish to ± 0.1 ft along centerline and± 0.05 ft at right angles to the centerline. Correct deviations from these tolerances. Final rollthesurface to finish the completed Work and prevent hairline cracking. Finish within 4 h ofadding the portland cement.

Allow the cement-treated Subgrade to cure for at least 7 Days. Maintain a moist, notsaturated, condition during the entire curing period, to prevent drying. If permitted by localjurisdiction, the Contractor may use an alternate curing procedure by applying a CSS-1 orSS-1 emulsified asphalt to the surface so that the surface is fully covered and sealed, asapproved by the Project Manager.

306.3.3 Lime Treated Subgrade

Use a distributor that will apply a uniform application and automatically adjust the spreadrate for variable travel speeds. Apply hydrated lime or quicklime dry, within ±10 of thespecified percentage, onto the prepared scarified Subgrade. Do not use a tailgate spreader. When used, apply quicklime at the equivalent percentage to hydrated lime (1.0 ton quicklimeis equivalent to 1.3 tons hydrated lime).

Apply lime-slurry, at the specified percentage of dry solids content onto the preparedscarified Subgrade, with a distributor having a pump and a spray bar. Continuously circulatetheslurry in transit and during application. Apply the lime-slurry within 24 h of its production.After 24 h, the slurry is considered expired. Dispose of the expired slurry in an environmentally-acceptable manner, and do not use it on the project. Replace lime-slurry thatis left exposed on the ground to the open air for more than ten hours and shows excessivemoisture loss.

306.3.3.1 Initial Mixing

Process the hydrated lime, quicklime, or lime-slurry so as not to present a hazard to thepublic or workers.
Mix immediately after applying the lime treatment using a self-propelled rotary-type mixing machine. Provide a loose uniform mixture, with clods and lumps no larger than 2 in, that, when compacted, will meet the required depth and width shown in the Plans. Overlap at least 6 in between passes.

The Department will consider visible streaks and pockets as evidence of unacceptable mixing.

Immediately following mixing, ensure the entire treated Subgrade depth’s moisture content is 3% to 5% above optimum in accordance with AASHTO T 99, Method C (TTCP Modified). Lightly compact the surface to minimize water loss or gain and lime carbonation.

306.3.3.2 Curing
Allow the treated lightly compacted Subgrade to cure for at least 24 h. Apply a seal during the cure period using either:
1. A water curing seal that maintains moisture content at not less than 3%, or more than 5% above optimum as determined by AASHTO T 99, Method C (TTCP Modified); or
2. An SS or CSS emulsified asphalt seal using a rate between 0.10 to 0.20 gal per square yard as determined by the Project Manager.

Treated Subgrade temperature must remain above 40 °F during the entire curing period.

306.3.3.3 Final Mixing
Ensure, by additional pulverization, the stabilized lime-soil mixture meets with the requirements of Table 306.3.3.3.1, “Lime-Treated Subgrade Gradation Requirements” before final compaction.

<table>
<thead>
<tr>
<th>Table 306.3.3.3:1</th>
<th>Lime-Treated Subgrade Gradation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve size</td>
<td>% passing</td>
</tr>
<tr>
<td>1 in</td>
<td>100.0</td>
</tr>
<tr>
<td>No. 4</td>
<td>60.0 – 100.0</td>
</tr>
</tbody>
</table>

306.3.3.4 Finishing Operations
Compact immediately after final mixing is complete to 100% of the maximum density in accordance with AASHTO T 99, Method C (TTCP Modified). The Project Manager will verify the compacted depth of lime-treated Subgrade with a Contractor-provided phenolphthalein indicator chemical or beet juice.

Finish to ± 0.1 ft along the centerline and ± 0.05 ft at right angles from centerline. Lightly roll the completed section to prevent hairline cracking.

306.3.4 Protection of Treated Subgrade
Allow only sprinkling or spraying Equipment, on the treated Subgrade during the curing period, unless otherwise approved by the Project Manager.

Install a base, Subbase, or wearing surface before opening the Roadway to the public, unless otherwise approved by the Project Manager.

306.4 METHOD OF MEASUREMENT
The Department will pay for lime as Hydrated Lime using the following conversion: 1 ton of quicklime equals 1.3 ton of hydrated lime.

306.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement-Treated Subgrade</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Portland Cement</td>
<td>Ton</td>
</tr>
<tr>
<td>Lime Treated Subgrade</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Hydrated Lime, per Section 402</td>
<td>Ton</td>
</tr>
</tbody>
</table>
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SECTION 401: PAVEMENT SMOOTHNESS MEASUREMENT

401.1 DESCRIPTION
This Work consists of providing and using profile-testing Equipment that incorporates the IRI measurement.
This specification applies to new and reconstruction projects. For overlay, rehabilitation, and pavement preservation projects, this specification applies only if the Department provides the Contractor with two or more opportunities to achieve smoothness. Examples of these types of opportunities are pavement surface milling followed by a HMA overlay and projects including two or more layers of HMA.

401.2 MATERIALS—Vacant

401.3 CONSTRUCTION REQUIREMENTS

401.3.1 Profile Measurements
Submit all unprocessed raw data profile measurements to the accompanying Department representative within 1 hour after all the data has been collected in the University of Michigan Transportation Research Institute’s Engineering Research Division (ERD) format, on either a CD or Universal Serial Bus (USB) memory storage device. If the Contractor does not submit the profile measurements within this time period, the Department will not pay incentives greater than 100% of the criteria presented in Table 401.5.1.1.1, “IRI Based Profile Pay Adjustment Schedule For HMA Pavements,” Table 401.5.1.2.1, “IRI Based Profile Pay Adjustment Schedule for PCC Pavements, Ramps, Tapers, and Holding Lanes,” or Table 401.5.1.3.1, “IRI Based Profile Pay Adjustment Schedule for HMA Ramps, Tapers, and Holding Lanes,” for the section.

401.3.1.1 Profile Measurement Device
Provide, operate, and maintain a profile measurement device that is in accordance with AASHTO MP 11 and that uses computer programs in accordance with AASHTO PP 37, or an equal approved by the State Materials Bureau.

401.3.1.2 Profile Measurement Device Calibration and Certification
Certify the profile measurement device in accordance with the Department’s Standard Practice “Certification of Inertial Profilers.” It must also have a current TTCP annual calibration sticker or manufacturer’s calibration and certification certificate. The manufacturer’s certificate is valid only until the date of the next TTCP-sponsored profile measuring device certification test.
Verify calibration of the profile measurement device. Verify both horizontal and vertical calibration before each use. Perform verifications in accordance with the manufacturer’s approved procedures and maintain copies of the verification documentation and manufacturer’s procedures with the machine. The Project Manager may require additional calibrations or verifications.
Remove the profile measurement device from the project if it does not meet manufacturer’s calibration requirements. The Project Manager will report the TTCP profile measurement device certification number to the TTCP Administrator in order to provide notification that the Contractor cannot use the machine on other projects until the Contractor obtains re-certification. Once the manufacturer re-certifies the profile measurement device, provide a copy of the certificate to the Department’s TTCP Administrator.

401.3.1.3 Technician Certification
The Department’s TTCP will certify individuals performing profile measurement. The Department will base certification on demonstrated ability and a written test. The TTCP will establish the term and expiration date of certification and requirements for renewal. If concern arises as to the competence of a certified individual, submit concerns in writing to the Department State Materials Engineer and the District Construction Engineer. The Department State Materials Engineer, through the TTCP, will investigate the concern and implement corrective action if necessary in accordance with the TTCP Board of Directors established procedures.
401.3.1.4 Profile Measurement Operations

Sweep the Roadway surface and get the Project Manager’s approval before beginning profile operations.

Measure the longitudinal smoothness of the final surface of HMA, OGFC, and PCCP using a profile measurement device. Operate the profile measurement device in accordance with AASHTO PP 50 and manufacturer’s recommendations using a cutoff wavelength of 300 ft. Using dual-sensors, measure the profile traces for each wheel path. Locate outside trace 3 ft from and parallel to the approximate location of the pavement edge line. Ensure the centerline distance between sensors is 70.0 in + 1.0 in. At transverse joints, commence profile traces 15 ft into the previous placement. Operate the device on the driving surface of the Roadway and be sure it can maintain the manufacturer’s recommended speed without interfering with traffic or its own operation.

On HMA projects, perform profile measurements and corrective actions on the final surface of HMA. On PCCP projects, perform profile measurements and corrective actions on the finished surface of PCCP before longitudinal diamond grooving operations.

The Department will use the latest version of the FHWA’s “ProVal” software to determine the IRI for each lane, reported to the nearest 0.1 in per mile using the average of each wheel path IRI.

Maintain the profile data files. Take additional profiles to retest paved surfaces that have received corrective work. The Project Manager may require additional profiles to check previously submitted data or to identify the limits of surface irregularities. Include the following information for each data file:

1. Project number;
2. Date;
3. Lane profiled;
4. Beginning and ending stations;
5. Horizontal equation stations;
6. Location of Bridge abutments;
7. Net total linear feet of each lane; and
8. Operator’s signature.

The Department will consider profile testing as part of the paving operation. Include the proposed frequency for profile testing with the paving plan submittal at the pre-paving conference.

401.3.2 Straightedge Measurements

Test the final surface of HMA, OGFC, or PCCP not subject to profile measurement with an approved 10-foot straightedge at both right angles and parallel to the centerline. Correct surface deviations greater than 1/8 in within 10 ft, as directed by the Project Manager. Exclude the following from profile measurement and evaluate using a straightedge:

1. Shoulders, turnouts, median lanes, and other areas less than 0.5 mi as designated by the Project Manager during the pre-paving conference;
2. Concrete pavement slab removal and replacement, and intersections not paved integrally with the main line;
3. A single lift of HMA over Cold In-Situ recycle; and
4. Other projects as determined by the Department.

401.3.3 Evaluation for Corrective Work

Evaluate the pavement in 0.1-mile sections for determining needed corrective work and price adjustments.

Develop an appropriate corrective action plan if the measured smoothness value falls within the “Corrective Work Required” value of Table 401.5.1.1.1, “IRI Based Profile Price Adjustment Schedule for HMA Pavements;” Table 401.5.1.2.1, “IRI Based Profile Price Adjustment Schedule for PCC Pavements, Ramps, Tapers, and Holding Lanes;” or Table 401.5.1.3.1, “IRI Based Profile Price Adjustment Schedule for HMA Ramps, Tapers, and Holding Lanes.” Submit the plan to the Project Manager for review and approval. If approved, complete elected corrective action, including necessary traffic control, at no additional cost to the Department. After completion of the approved corrective action, re-profile the corrected area to verify compliance with specification requirements.

Identify areas of localized roughness with a 25 ft moving average filter. Determine the difference between the 25 ft moving average and the reported relative elevation for every profile point using the latest version of the FHWA’s “ProVal” software. Evaluate reported
deviations greater than 0.15 in to develop an appropriate corrective action plan. The Department will refer to positive deviations as "bumps" and negative deviations as "dips."

401.3.4 Corrective Work
Limit corrective work to diamond grinding, overlaying, or removing and replacing rejected 0.1-mile sections. Submit a written corrective action plan to the Project Manager including methods and procedures. Do not begin corrective work until the Project Manager approves the methods and procedures in writing. The Project Manager’s approval does not relieve the Contractor of the responsibility to comply with the specifications.

Perform corrective work in accordance with the following:

1. Diamond Grinding. Use a Roadway planning device to perform diamond grinding to bring the reported average measured smoothness value to an acceptable level in accordance with Table 401.5.1.3:1, "IRI Based Profile Price Adjustment Schedule for HMA Pavements," Table 401.5.1.3:3, "IRI Based Profile Price Adjustment Schedule for PCC Pavements, Ramps, Tapers, and Holding Lanes," or Table 401.5.1.4:1, "IRI Based Profile Price Adjustment Schedule for HMA Ramps, Ramps, and Holding Lanes." Do not reduce planned pavement thickness by more than 0.3 in without approval of the Project Manager. Grind the edges of localized roughness areas to produce a smooth transition to the surrounding pavement. For HMA, if the Contract does not require an OGFC, apply a fog seal to the ground areas as approved by the Project Manager. For PCCP, perform additional diamond grinding as necessary in the following situations:
   1.1. The transverse direction, so the lateral grinding limits are at a constant offset from and parallel to the nearest lane line or pavement edge; and
   1.2. The longitudinal direction, so the grinding begins and ends at lines perpendicular to the pavement centerline. Maintain diamond ground locations as neat rectangular areas of uniform appearance. Ensure a skid resistance comparable to adjacent sections that do not require grinding. Immediately repair curing membrane damage resulting from diamond grinding if the concrete is less than 28 Days old;
2. Overlaying. If the Contractor uses an additional lift of HMA to correct rough pavement, it shall meet the requirements of the appropriate specification. Extend the overlay lift the full width of the underlying pavement surface to a finished compacted thickness sufficient to correct the existing pavement roughness. The Department will not allow a second overlay if the first overlay does not meet the longitudinal smoothness requirement. Correct a corrective overlay that does not meet the smoothness requirement by diamond grinding or removing and replacing;
3. Removing and Replacing. Remove pavement the full width of the lane and the full thickness of the course. The removal area shall begin and end with a transverse saw cut perpendicular to centerline. Use HMA or PCCP as replacement Material. Re-profile the 0.1 mile section of travel lane after performing corrective work and use the re-profile’s reported measured smoothness data to represent the particular section for price adjustment purposes.

401.3.5 OGFC Placement and Profile Measurement
Ensure all HMA profile measurements and corrective actions have been completed before placing OGFC. If the measured average IRI of the OGFC is greater than the measured average IRI of the HMA on the same 0.1 mile section, the Department will base the pay factor for the HMA section on the OGFC’s measured average IRI and not the HMA’s measured average IRI.

401.4 METHOD OF MEASUREMENT—Vacant

401.5 BASIS OF PAYMENT
Surface smoothness testing and corrective work to bring the final surface within specification smoothness is included in the Bid Item Unit Price for HMA or PCCP; the Department will make no separate payment.

401.5.1 Price Adjustments
The Department will calculate a price adjustment for each 0.1 mile section of travel lane. The price adjustment will apply to the total accepted quantity of the total thickness or area of each section of HMA or PCCP constructed for the actual measured lane width and Roadway
The Department will not include Shoulder and turnout areas for payment purposes. Determine the price adjustment by applying the appropriate percentage to the Bid Item Unit Price for HMA or PCCP.

If the pay factor for a 0.1 mile section is equal to or greater than 100%, the Project Manager will not allow additional Work to reduce the reported measured smoothness value.

If the pay factor for a 0.1 mile section is equal to or greater than 90% but less than 100%, the Contractor may accept the designated pay factor. Otherwise, get the Project Manager’s approval to develop a corrective action plan to further reduce the measured smoothness value (to increase the designated pay factor).

### 401.5.1.1 Price Adjustment for HMA Projects

The Department will base price adjustments on the final average IRI in accordance with Table 401.5.1.1:1, “IRI Based Profile Price Adjustment Schedule for HMA Pavements,” after the Contractor performs and measures corrective work.

| IRI\(^a\) | Interstate Routes | National Highway Routes | US (non-NH) and NM Routes | Pay Factor (%)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 54.7</td>
<td>&lt; 52.7</td>
<td>&lt; 43.9</td>
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<td>43.9 to 45.5</td>
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<td>45.6 to 47.0</td>
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<td>90</td>
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</tr>
</tbody>
</table>

Corrective work required

*Based on an Initial Serviceability Index of 4.3

\(^a\)inch per 0.1 mi

### 401.5.1.2 Price Adjustment for PCCP Pavement, Ramps, Tapers, and Holding Lanes

The Department will base price adjustments on the final average IRI in accordance with Table 401.5.1.2:1, “IRI Based Profile Pay Adjustment Schedule for PCC Pavements, Ramps, Tapers, and Holding Lanes,” after the Contractor performs and measures corrective work.
### Table 401.5.1.2:1
IRI Based Profile Price Adjustment Schedule for PCC Pavements, Ramps, Tapers, and Holding Lanes*  

<table>
<thead>
<tr>
<th>IRI(^b)</th>
<th>Pay factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate and National Highway Routes</td>
<td>US (non-NH) and NM Routes</td>
</tr>
<tr>
<td>&lt; 52.2</td>
<td>&lt; 49.6</td>
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<tr>
<td>52.2 to 53.2</td>
<td>49.6 to 50.9</td>
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<tr>
<td>53.3 to 54.2</td>
<td>51.0 to 52.1</td>
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<tr>
<td>71.8 to 72.8</td>
<td>74.7 to 76.0</td>
</tr>
</tbody>
</table>

| Corrective work required | \(>72.8\) | \(>76.0\) |

*Based on an Initial Serviceability Index of 4.3
\(^b\)inch per 0.1 mi

#### 401.5.1.3 Price Adjustment for Miscellaneous HMA

The Department will base unit price adjustments for miscellaneous HMA pavement (including ramps, tapers, and holding lanes greater than 0.5 mi long) in accordance with Table 401.5.1.3:1, “IRI Based Profile Price Adjustment Schedule for HMA Ramps, Tapers, and Holding Lanes.” Measure ramps, tapers, and holding lanes less than 0.5 mi long in accordance with Section 401.3.2, “Straightedge Measurements.”
<table>
<thead>
<tr>
<th>IRI (m/mi)</th>
<th>Pay Factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50.8</td>
<td>110</td>
</tr>
<tr>
<td>50.8 to 51.7</td>
<td>109</td>
</tr>
<tr>
<td>51.8 to 52.5</td>
<td>108</td>
</tr>
<tr>
<td>52.6 to 53.3</td>
<td>107</td>
</tr>
<tr>
<td>53.4 to 54.1</td>
<td>106</td>
</tr>
<tr>
<td>54.2 to 55.0</td>
<td>105</td>
</tr>
<tr>
<td>55.1 to 55.8</td>
<td>104</td>
</tr>
<tr>
<td>55.9 to 56.7</td>
<td>103</td>
</tr>
<tr>
<td>56.8 to 57.5</td>
<td>102</td>
</tr>
<tr>
<td>57.6 to 58.3</td>
<td>101</td>
</tr>
<tr>
<td>58.4 to 59.2</td>
<td>100</td>
</tr>
<tr>
<td>59.3 to 60.0</td>
<td>99</td>
</tr>
<tr>
<td>60.1 to 60.9</td>
<td>98</td>
</tr>
<tr>
<td>61.0 to 61.7</td>
<td>97</td>
</tr>
<tr>
<td>61.8 to 62.5</td>
<td>96</td>
</tr>
<tr>
<td>62.6 to 63.4</td>
<td>95</td>
</tr>
<tr>
<td>63.5 to 64.2</td>
<td>94</td>
</tr>
<tr>
<td>64.3 to 65.1</td>
<td>93</td>
</tr>
<tr>
<td>65.2 to 65.9</td>
<td>92</td>
</tr>
<tr>
<td>66.0 to 66.8</td>
<td>91</td>
</tr>
<tr>
<td>66.9 to 67.6</td>
<td>90</td>
</tr>
<tr>
<td>&gt; 67.6</td>
<td>Corrective work required</td>
</tr>
</tbody>
</table>

*a* Based on an Initial Serviceability Index of 4.3

*b* inch per 0.1 mi
402.1 DESCRIPTION
This Work consists of providing, mixing, and applying asphalt Materials, hydrated lime, or liquid anti-stripping agents.

402.2 MATERIALS
402.2.1 Sampling and Testing
The Department will sample and test the Materials, unless otherwise shown in the Contract. The sampling, testing, and inspecting of Materials will conform to the requirements of Section 105, "Control of Work," and Section 106, "Control of Materials." The Department may waive its testing responsibilities and require the Contractor to provide CTRs. Sample and test performance-graded asphalt binders in accordance with the Department’s Standard Practice for Certifying Suppliers of Performance-Graded Asphalt Binders. The Department will assume no obligation to accept the test certificates, and may additionally test the certified Materials. The Department may test asphalt Materials at the manufacture or shipping location.

402.2.2 Acceptance
The Department will accept asphalt cement in accordance with the Department’s Standard Practice for Certifying Suppliers of Performance-Graded Binders.

402.2.3 Shipping
Ship asphalt Material in sealed, insulated tank vehicles with convenient access to the Material so that it may be sampled. Keep the shipping tanks free of foreign matter. The Department will reject contaminated asphalt Material. The Project Manager may conditionally accept each delivery of asphalt Material upon receiving the Loading Certificate Test, which is subject to the provisions of Section 402.2.1, “Sampling and Testing.” Ship the performance-graded binder as shown in the requirements of the Department’s Standard Practice for Certifying Suppliers of Performance-Graded Asphalt Binders.

402.2.4 Asphalt Cement
Asphalt cement binders are uncracked petroleum asphalts. Prepare asphalt cement binders by refining petroleum at a maximum temperature of 700 °F. Do not use Materials that are prone to cracking. The asphalt cement will be:
1. Free of thermal decomposition products;
2. Free of residue from non-asphalt sources;
3. Homogeneous and free from water;
4. Non-foaming when heated to 350 °F; and
5. Conforming to the requirements of performance-graded asphalt binder.

402.2.5 Performance-Graded Asphalt Binder
Provide performance-graded asphalt binder in accordance with AASHTO M 320. The Contractor may substitute a performance-graded asphalt binder with a high-end or low-end temperature grade in excess of that shown in the Plans, at no additional cost to the Department.

402.2.6 Polymer-Modified Asphalt Binder
Provide a polymer-modified asphalt binder that meets the requirements for a PG 70-28 per AASHTO M 320 in addition to the requirements in Table 402.2.6.1, “OGFC Polymer-Modified Asphalt Binders.”
Table 402.2.6.1
OGFC Polymer-Modified Asphalt Binders

<table>
<thead>
<tr>
<th>Properties</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal-Blended Tire Rubber Content, % minimum</td>
<td>— 5.0</td>
</tr>
<tr>
<td>Styrene-Butadiene-Styrene (SBS)</td>
<td>— 2.0</td>
</tr>
<tr>
<td>Polymer Content by Weight of Total Formulation, % minimum</td>
<td>97.5 97.5</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, % minimum (Note 1), ASTM D 2042</td>
<td>65 65</td>
</tr>
<tr>
<td>Elastic Recovery @ 77°F, % minimum, AASHTO T 301</td>
<td>— —</td>
</tr>
</tbody>
</table>

Note 1: If the solubility of the binder is less than 97.5 percent, test the base asphalt binder. The solubility of the base asphalt binder shall be greater than 99 percent.

402.2.7 Emulsified Asphalt

Emulsified asphalt consists of uncracked petroleum asphalt uniformly emulsified with water and an emulsifying or stabilizing agent. Ensure that emulsified asphalt is homogenous after mixing. Provide anionic emulsified asphalt in accordance with AASHTO M 140 and cationic emulsified asphalt in accordance with AASHTO M 208.

402.2.7.1 High-Float Emulsions

Provide high-float emulsions (HFE-60, HFE-90, HFE-150, and HFE-300) in accordance with Table 402.2.7.1:1, “High-Float Emulsions Requirements.”

Table 402.2.7.1:1
High-Float Emulsions Requirements

<table>
<thead>
<tr>
<th>Test</th>
<th>HFE-60</th>
<th>HFE-90</th>
<th>HFE-150</th>
<th>HFE-300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 122 °F, Seconds</td>
<td>50+</td>
<td>50+</td>
<td>50+</td>
<td>50+</td>
</tr>
<tr>
<td>Sieve Test, Retained on No. 20 Sieve, %</td>
<td>0.10-</td>
<td>0.10-</td>
<td>0.10-</td>
<td>0.10-</td>
</tr>
<tr>
<td>Settlement, 5 Days, %</td>
<td>5-</td>
<td>5-</td>
<td>5-</td>
<td>5-</td>
</tr>
<tr>
<td>Storage Stability Test, 1 Day, %</td>
<td>1-</td>
<td>1-</td>
<td>1-</td>
<td>1-</td>
</tr>
<tr>
<td>Demulsibility, 1.2 fl oz 0.10 N, CaCl, %</td>
<td>30+</td>
<td>30+</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Residue from Distillation Test to 500 °F</td>
<td>65+</td>
<td>65+</td>
<td>65+</td>
<td>65+</td>
</tr>
<tr>
<td>Oil Distillate by Volume of Emulsion, %</td>
<td>1-</td>
<td>3-</td>
<td>7-</td>
<td>7-</td>
</tr>
<tr>
<td>Coating Test, 3 minutes Grades, stones coated thoroughly</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Tests on Residue from Distillation Test Penetration at 77 °F, 3.5 oz, 5 sec, 0.1 mm</td>
<td>90-</td>
<td>150-</td>
<td>300</td>
<td>300+</td>
</tr>
<tr>
<td>Float Test at 140 °F, Seconds</td>
<td>1,200+</td>
<td>1,200+</td>
<td>1,200+</td>
<td>1,200+</td>
</tr>
</tbody>
</table>
402.2.7.2 Polymer-Modified High-Float Emulsions

This Material is a high-float emulsion containing polymer-modified asphalt and water in accordance with the requirements of Table 402.2.7.2.1, “Polymer-Modified High-Float Emulsions Requirements.”

Table 402.2.7.2:1
Polymer-Modified High-Float Emulsions Requirements

<table>
<thead>
<tr>
<th>Test</th>
<th>HFE-60P</th>
<th>HFE-100P</th>
<th>HFE-150P</th>
<th>HFE-300P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 122 °F, Seconds</td>
<td>50+</td>
<td>50+</td>
<td>50+</td>
<td>50+</td>
</tr>
<tr>
<td>Sieve Test, Retained on No. 20 Sieve, %</td>
<td>0.10-</td>
<td>0.10-</td>
<td>0.10-</td>
<td>0.10-</td>
</tr>
<tr>
<td>Storage Stability Test, 1 Day, %</td>
<td>1-</td>
<td>1-</td>
<td>1-</td>
<td>1-</td>
</tr>
<tr>
<td>Demulsibility, 1.2 fl oz 0.10 N, CaCl, %</td>
<td>30+</td>
<td>30+</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Residue from Distillation Test to 400 °F</td>
<td>65+</td>
<td>65+</td>
<td>65+</td>
<td>65+</td>
</tr>
<tr>
<td>Oil Distillate by Volume of Emulsion, %</td>
<td>1-</td>
<td>3-</td>
<td>7-</td>
<td>7-</td>
</tr>
<tr>
<td>Tests on Residue from Distillation Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration at 77 °F, 3.5 oz, 5 s, 0.1 mm</td>
<td>60–90</td>
<td>150</td>
<td>300</td>
<td>300+</td>
</tr>
<tr>
<td>Ductility 77 °F, 2 in/min, %</td>
<td>40+</td>
<td>40+</td>
<td>40+</td>
<td>—</td>
</tr>
<tr>
<td>Elastic Recovery, % a</td>
<td>55+</td>
<td>58+</td>
<td>25+</td>
<td>25+</td>
</tr>
<tr>
<td>Float Test @ 140 °F, Seconds</td>
<td>1,200+</td>
<td>1,200+</td>
<td>1,200+</td>
<td>1,200+</td>
</tr>
</tbody>
</table>

*Test in accordance with AASHTO T 301 at a test temperature of 50 °F.

402.2.7.3 Polymer-Modified High-Float Emulsion, Rapid Set

Provide a high-float rapid-set, polymerized emulsion (HFRS-2P) that contains polymer-modified asphalt, water, and an emulsifier. Provide high-float rapid-set, polymerized emulsion (HFRS-2P) in accordance with Table 402.2.7.3:1, "Rapid-Set Polymer-Modified High-Float Emulsion Requirements.”

Table 402.2.7.3:1
Rapid-Set Polymer-Modified High-Float Emulsion Requirements

<table>
<thead>
<tr>
<th>Test</th>
<th>HFRS-2P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 122 °F, Seconds</td>
<td>100–400</td>
</tr>
<tr>
<td>Sieve Test, Retained on No. 20 Sieve, %</td>
<td>0.10</td>
</tr>
<tr>
<td>Demulsibility, 1.2 fl oz 0.02 N, CaCl, %</td>
<td>40+</td>
</tr>
<tr>
<td>Residue from Distillation Test to 450 °F</td>
<td>65+</td>
</tr>
<tr>
<td>Oil Distillate by Volume of Emulsion, %</td>
<td>3.0-</td>
</tr>
<tr>
<td>Tests on Residue from Distillation Test</td>
<td></td>
</tr>
<tr>
<td>Penetration at 77 °F, 3.5 oz, 5 s, 0.1 mm</td>
<td>90–150</td>
</tr>
<tr>
<td>Ductility 39.2 °F, 2 in/min, %</td>
<td>20+</td>
</tr>
<tr>
<td>Elastic Recovery, % a</td>
<td>58+</td>
</tr>
<tr>
<td>Float Test at 140 °F, Seconds</td>
<td>1,200+</td>
</tr>
</tbody>
</table>

*Test in accordance with AASHTO T 301 at a test temperature of 50 °F.

402.2.7.4 Asphalt-Emulsified Prime (AE-P)

Provide AE-P designated asphalt-emulsified prime in accordance with Table 402.2.7.4:1, “Asphalt Emulsified Prime.”
### Table 402.2.7.4:1
Asphalt Emulsified Prime

<table>
<thead>
<tr>
<th>Test</th>
<th>AE-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity Saybolt Furol at 122 °F, Seconds</td>
<td>15–150</td>
</tr>
<tr>
<td>Settlement 24 h, %</td>
<td>1-</td>
</tr>
<tr>
<td>Residue from Distillation Test, %</td>
<td>65+</td>
</tr>
<tr>
<td>Oil Distillate by volume of Emulsion, %</td>
<td>25-</td>
</tr>
<tr>
<td>Tests on Residue from Distillation</td>
<td></td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>97.5+</td>
</tr>
</tbody>
</table>

### 402.2.7.5 Penetrating Emulsified Prime
Provide PE-P designated penetrating emulsified prime in accordance with Table 402.2.7.5:1, “Penetrating Emulsified Prime.”

<table>
<thead>
<tr>
<th>Test</th>
<th>PE-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 122 °F, Seconds</td>
<td>75-</td>
</tr>
<tr>
<td>Sieve Test, Retained on 0.35 in Sieve, %</td>
<td>0.1-</td>
</tr>
<tr>
<td>Residue from Distillation Test, %</td>
<td>38+</td>
</tr>
<tr>
<td>Oil Distillate by volume of Emulsion, %</td>
<td>0–4</td>
</tr>
</tbody>
</table>

### 402.2.8 Cutback Asphalts (Medium-Curing Type)
Provide cutback asphalt in accordance with AASHTO M 82. Do not use MC-30.

### 402.2.9 Hydrated Lime
Provide hydrated lime in accordance with ASTM C 1097, with the following exception:
1. Delete ASTM C 1097, Section 4.1; and
2. Substitute the following: “Hydrated lime, dry or slurry, will have a maximum of 3% retained on a No. 30 sieve and a maximum of 25% retained on a No. 200 sieve.”
Determine the fineness of hydrated lime in accordance with AASHTO T 219. Use a 1/4-pound sample to perform tests in accordance with AASHTO T 219, sections 6.1 and 6.1.1.

### 402.2.10 Anhydrite Based Material
Provide anhydrite based material in accordance with Tables 402.2.10:1 “Anhydrite Based Material Chemical Composition” and Table 402.2.10:2 “Anhydrite Based Material Physical Properties.” Use ASTM C 114 for the chemical analysis.

#### Table 402.2.10:1
Anhydrite Based Material Chemical Composition

<table>
<thead>
<tr>
<th>Chemical Compound</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>6.7 to 10.7</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>1.0 to 3.0</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>1.0 to 1.4</td>
</tr>
<tr>
<td>MgO</td>
<td>0.2 to 1.2</td>
</tr>
<tr>
<td>CaO</td>
<td>44.5 to 54.5</td>
</tr>
<tr>
<td>SO₃</td>
<td>32.3 to 42.3</td>
</tr>
</tbody>
</table>

#### Table 402.2.10:2
Anhydrite Based Material Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOI, %</td>
<td>0.37 to 1.37</td>
</tr>
<tr>
<td>Passing #200 Sieve, %</td>
<td>98.8 to 100.0</td>
</tr>
<tr>
<td>Passing #325 Sieve, %</td>
<td>98.0 to 100.0</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.970 to 3.030</td>
</tr>
</tbody>
</table>

### 402.3 CONSTRUCTION REQUIREMENTS
Submit the Material Supplier’s name and address to the Project Manager. If required by the Project Manager, submit representative samples of each grade or classification of asphalt...
Materials for testing. Mix and apply asphalt Materials within the approved temperature range. Do not make changes in the crude stock source, manufacture method, or the Supplier without written approval from the Project Manager.

402.4 METHOD OF MEASUREMENT

If asphalt Materials are not stored in tanks for exclusive use on the project, the Department will determine the acceptable quantity of Asphalt Material, per lot, based on the following equation:

\[ Q = T \times X \]  \hspace{1cm} (1)

where

- \( Q \) is the quantity of Asphalt Material (in tons)
- \( T \) is the quantity of placed and accepted asphalt pavement (in tons)
- \( X \) is the average percent asphalt content in the asphalt pavement (per lot)

402.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Material</td>
<td>Ton</td>
</tr>
<tr>
<td>Hydrated Lime</td>
<td>Ton</td>
</tr>
<tr>
<td>Anhydrite Based Material</td>
<td>Ton</td>
</tr>
</tbody>
</table>
403.1 DESCRIPTION
This Work consists of constructing an open-graded friction course (OGFC) on a prepared surface.

403.2 MATERIALS
403.2.1 General
Provide OGFC composed of aggregate, asphalt binder, and hydrated lime or anhydrite based material.

403.2.2 Aggregate
The aggregate is crushed stone or crushed gravel, composed of hard durable pebbles or fragments. Ensure the aggregate meets the grading requirements in Table 403.2.2:1, “OGFC Gradation Requirements,” when tested in accordance with AASHTO T 11 and AASHTO T 27. The Department will determine aggregate acceptance by testing samples of the combined aggregates and lime taken before adding asphalt Materials.

<table>
<thead>
<tr>
<th>Table 403.2.2:1 OGFC Gradation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve size</td>
</tr>
<tr>
<td>1/2 in</td>
</tr>
<tr>
<td>3/8 in</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 10</td>
</tr>
<tr>
<td>No. 40</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

Accepted aggregate Material must also meet the following requirements:
1. At least 75% of the Material retained in the No. 4 sieve will be composed of particles that have at least two Fractured Faces. Fractured Faces will be determined in accordance with NMDOT Method FF-1, Fractured Face Determination for Coarse Aggregate;
2. The aggregate is free of organic matter, lumps of clay, or other material that prevents thorough coating with asphalt Material;
3. The aggregate is obtained from a source with an Al of 20 or less when calculated in accordance with Section 910, “Aggregate Index;”
4. The Department will allow the combination of Materials from two or more sources to produce coarse aggregate only when each source independently meets the requirements of item 3, above.

403.2.3 Asphalt Material
Use either a PG 70-28+ or PG 70-28R+ as specified in the Contract, in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.”

403.2.4 Hydrated Lime or Anhydrite Based Material
Provide hydrated lime or Anhydrite based Material in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.”

403.2.5 Mix Design
The District Laboratory will develop the OGFC mix design. The JMF gradation will be within the master range for the specified type of OGFC. The mix design will establish a single percentage of aggregate passing each required sieve size and a single percentage of asphalt Material to be added to the aggregate. The mix design will specify whether to add hydrated lime or anhydrite based material and how much to use. If hydrated lime or anhydrite based material is added, include it in the gradation for establishing the mix design. If liquid anti-strip is required, compensation will be by Change Order.

403.3 CONSTRUCTION REQUIREMENTS
403.3.1 General
Use the “strap method” to determine the quantity of asphalt Material, and maintain the
percentage of asphalt Material specified in the mix design, within ±0.3%.

403.3.2 Preparation of Roadbed
Before placing OGFC, clean Deleterious Materials from the existing surface.

403.3.3 Temperature and Weather Limitations
Do not place OGFC on wet surfaces or when the Project Manager determines that the weather conditions prevent proper handling and finishing. Place OGFC when the Chill Factor is at least 60 °F. If the air temperature is 90 °F or warmer, do not consider the Chill Factor.

403.3.4 Mixing Requirements
Ensure that:
1. Hot mix plants conform to the requirements of Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA),” and are of a size that is proportional to the scale of the Work;
2. The mineral aggregate is free of oily or carbonaceous coatings;
3. The moisture content of the mixed Material does not exceed 1% (by weight) of the dry aggregate;
4. The aggregate is mixed with asphalt Material until the aggregate particles are thoroughly and uniformly coated;
5. The mixture temperature does not vary by more than 20 °F from the placement temperature established by the Project Manager;
6. The placement temperature for the mixture does not exceed the asphalt binder Supplier’s recommendation, or fall below 220 °F;
7. If the Contract requires hydrated lime or anhydrite based material, add it to the aggregate in accordance with Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA)” within the production tolerances specified.

403.3.5 Placement and Finishing
Place the OGFC with a paving machine in accordance with Section 423.3.4.3, “Pavers.” The Project Manager may require an external reference of at least 40 ft to improve the rideability. Immediately following the OGFC placement, roll the surface with a steel-wheeled, self-propelled roller that weighs enough to achieve adequate consolidation of the aggregate without excessive breakage. The finished surface shall be smooth and in accordance with Section 401.3.1.4, “Profile Measurement Operations.” Use a 10-foot straightedge to ensure the surface is free of irregularities larger than 1/8 in. Immediately remove low and defective areas, replace them with new, hot OGFC, and compact the corrected work to conform to the surrounding area.

403.3.5.1 Plan Surfacing Depths
Monitor and record plan depths throughout the surfacing operations at intervals specified by the Project Manager. The Department will not pay for any excess course depth. Courses will be rejected, if less than 1/2 in.

403.3.6 Sampling and Testing
403.3.6.1 Contractor Quality Control
Sample the stockpiled aggregate at a point agreed to by the Project Manager and shall conduct testing on those samples in accordance with applicable test procedures. This sampling and testing will be accomplished by qualified testing personnel using equipment furnished by the Contractor that meets all applicable ASTM and AASHTO requirements. The applicable test procedures, performed as described in the NMDOT Technician Training and Certification Manual, are as follows:

AASHTO T 2  Sampling Aggregates
AASHTO T 11  Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing
AASHTO T 27  Sieve Analysis of Fine and Coarse Aggregates
AASHTO T 248 Reducing Field Samples of Aggregate to Testing Size
NMDOT FF-1  Fractured Face Determination for Coarse Aggregate

Sample test at the rate of at least one test per 250 tons of material produced for the first
2000 tons of production, and test at least 500 tons of material produced thereafter.

403.3.6.1 Suspension of Operations

If one or more properties listed in Subsection 403.6.3, Department Quality Assurance Testing, fail to meet the specification requirements for a period of one day or a maximum production of 1000 tons; the production will be halted by the Project Manager. Use the gradation information to determine causes or factors that may be a contribution to the problem and prepare a plan to solve the problem. Approval of the plan must be obtained from the Project Manager before resumption of paving operations. Upon approval of the proposed plan, the Contractor may resume operations to determine if the actions taken have corrected the problem. Limit production to 1000 tons that will be tested in 500 ton increments. If that testing indicates that the problem has been corrected, the Contractor may resume full operations. If the problem has not been corrected, further trial runs and testing as described herein will be required. Take corrective action to remedy any property of the mix that is out of specification. Contractors who elect to produce material that is not within the specification limits do so at their own risk. Price reductions due to out of specification material being placed will be deducted from the unit price of the item in accordance with the Department’s current Acceptance and Price Reduction Procedures. All material that is rejected shall be removed and replaced with specification material at the Contractor’s expense. Material that is improperly graded or segregated or fails to meet the requirements herein provided shall be corrected or removed and disposed of immediately as directed by the Project Manager at the Contractor’s expense.

403.3.6.2 Department Quality Assurance

403.3.6.2.1 Acceptance

After the mix design has been issued and approved, control the mixture production on the project such that the tolerances of Table 403.3.7:1 are met. The Department will conduct quality assurance sampling, testing, and monitoring to ensure that the Contractor provides a mix that meets the tolerances. Acceptance for gradation will be based on testing of samples obtained from combined aggregates and lime, if used, before addition of asphaltic materials. Acceptance for asphalt content will be based on strap method. Acceptance for lime content will be based on daily strap totals. The testing will be conducted in accordance with the Department’s minimum Acceptance Testing Requirements. Acceptance test results will be provided to the Contractor’s Quality Control Representative or designee by the end of the workday after the samples are taken.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Content</td>
<td>± 0.3%&quot;</td>
</tr>
<tr>
<td>Hydrated Lime or Anhydrite based Material Content (If Required by the Mix Design)</td>
<td>± 0.2%&quot;</td>
</tr>
<tr>
<td>1/2 in Gradation Band</td>
<td></td>
</tr>
<tr>
<td>3/8 in Gradation Band</td>
<td></td>
</tr>
<tr>
<td>No. 4 Gradation Band</td>
<td></td>
</tr>
<tr>
<td>No. 10 Gradation Band</td>
<td></td>
</tr>
<tr>
<td>No. 40 Gradation Band</td>
<td></td>
</tr>
<tr>
<td>No. 200 Gradation Band</td>
<td></td>
</tr>
</tbody>
</table>

*Percent difference from TV of approved JMF.

403.4 METHOD OF MEASUREMENT

403.4.1 OGFC

OGFC will be measured by the square yard or ton. The average width of the OGFC in place will be used in computing the quantities. The length used in computing the area shall be station to station along the centerline of the roadway. All dimensions shall be as shown on the typical section of the plans.

403.5 BASIS OF PAYMENT

403.5.1

The accepted quantities of the OGFC will be paid for at the contract unit price per square yard.
yard or ton. The accepted quantities complete in place will be considered full compensation for furnishing all materials, labor, tools, equipment, testing, and any appurtenances necessary to complete the work as directed by the Project Manager. Materials shall be considered to include all aggregate, bituminous material, and hydrated lime. The checking of the depth of the course(s) for process control and cutting of the test cores that include the refilling and compacting with acceptable materials shall be done by and at the expense of the Contractor under the direct supervision of the Project Manager.

Payments will be made under:

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-Graded Friction Course</td>
<td>Square Yard or Ton</td>
</tr>
</tbody>
</table>

403.5.2 Price Adjustments

A price reduction in accordance with the Department’s Price Reduction Guidelines will be applied if the OGFC, bituminous material, or hydrated lime are not produced, mixed, or placed in accordance with the contract requirements.
SECTION 405: DETOUR PAVEMENTS

405.1 DESCRIPTION
This Work consists of the following:
1. Providing and placing surfacing Materials, including Subgrade preparation, Base Course, prime coat, asphalt Material, tack coat, and OGFC, if required;
2. Maintaining, removing, hauling, and disposing of Detour pavements in an environmentally-acceptable manner;
3. Hauling and stockpiling salvageable Detour pavements as directed by the Project Manager.

Unless otherwise noted in the Contract, Detour pavements do not include Detour Embankments, drainage, and major Structures. Embankment, drainage, and major Structures will conform to their applicable sections.

405.2 MATERIALS
405.2.1 General
Obtain surfacing Material for the Detour construction from a suitable source in accordance with Section 106, “Control of Materials.”

405.2.2 Approval of Pavement Section
The Department based the Detour pavement section in the Contract on the Subgrade design R-value for the project. If the Contractor or Department finds that the Subgrade R-value of the existing material is different from the Subgrade design R-value shown in the Contract, the Contractor shall use Material with a suitable Subgrade R-value. The Department will use the Contractor-proposed Subgrade R-value to determine the appropriate new structural number using the structural coefficients shown in Table 405.2.3:1, “Acceptance Testing Tolerances,” and adjust the thickness of the Detour section accordingly. (The structural number of a pavement layer is the thickness multiplied by the structural coefficient.) Detour section Material within 2 ft of the finished Subgrade will meet or exceed the Subgrade design R-value specified by the State Materials Bureau.

405.2.3 Alternate Pavement Section
Two weeks before constructing the Detour, submit the pavement section proposal to the Project Manager for approval. The proposal shall include the surfacing thickness and the types of Materials.

The approved alternate Detour pavement section must have at least the same structural number specified in the Contract.

Determine the structural number in accordance with the structural coefficients in Table 405.2.3:1, “Acceptance Testing Tolerances.”

<table>
<thead>
<tr>
<th>Description</th>
<th>Structural coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Course</td>
<td>0.11</td>
</tr>
<tr>
<td>Hot-mix asphalt (HMA)</td>
<td>0.44</td>
</tr>
<tr>
<td>Cold-mixed asphalt pavement*</td>
<td>0.15</td>
</tr>
</tbody>
</table>

*The Contractor may use cold-mixed asphalt pavement in low-traffic areas, with the District Construction Engineer’s written approval.

405.3 CONSTRUCTION REQUIREMENTS
405.3.1 General
Construct the Detour pavement in accordance with the following applicable specifications:
1. Section 207, “Subgrade Preparation;”
2. Section 304, “Base Course;”
3. Section 403, “Open Graded Friction Course;”
4. Section 407, “Tack Coat;” and
5. Section 408, “Prime Coat.”

Detours shall include a final surface of OGFC, if specified in the Contract.
405.3.2 Contractor Testing/Design Requirements

Provide Subgrade R-values for the top 2 ft of the Detour Subgrade. Use the Department’s procedures to determine the Subgrade R-values from sieve analysis and Atterberg limits. Obtain referenced documents and manuals from the Department’s State Materials Bureau web site.

405.3.3 Maintenance of Detour Section

Ensure that the maintenance and repair of the detours do not impact the public. Maintain safe traffic flow during construction.

If the Project Manager determines that the Detour surfacing is damaged, correct the problem immediately. If the Project Manager determines that the corrective actions failed, overlay the Detour with additional HMA at no additional cost to the Department.

If the Contractor does not immediately fix the Detour surfacing as directed by the Project Manager, the Department will assess liquidated damages in accordance with Section 108.3, “Prosecution and Progress,” for each day that the Detour remains unacceptable to the Project Manager.

405.3.4 Removal of Detours

When removing the Detour, dispose of the surfacing material in an environmentally acceptable manner, or salvage the material as shown in the Contract.

The salvage of the Detour pavement Material includes hauling and stockpiling.

405.4 METHOD OF MEASUREMENT

The Department will measure the Detour Pavement Construction actually placed and maintained on the top width and length of the detour if paid by the unit of the Contract Item. If no Contract Item exists for Detour Pavement Construction, payment will be incidental to Section 618, “Traffic Control Management.”

405.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detour Pavement Construction</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

405.5.1 Work Included in Payment

The following work or items will be considered as included in the payment for Detour Pavement Construction and will not be measured or paid for separately: Submittals; Maintenance of detours; Furnishing and placement of OGFC on detours, if designated in the contract; Base course; Removal of detour materials including surfacing, earthwork, and drainage structures; Furnishing and placement of prime and tack coat; Subgrade preparation; Testing; Hauling and stockpiling of salvageable materials.
407.1 DESCRIPTION
This Work consists of providing and applying asphalt Material to an existing hot-mix asphalt or portland cement concrete pavement surface.

407.2 MATERIALS
Use one of the following asphalt Materials types for the tack coat:
1. CSS-1, CSS-1H, or SS-1, or SS-1H emulsified asphalt;
2. Performance-graded asphalt binder; or
3. Project Manager approved selection from the Department’s Approved Products List. Provide the asphalt Materials in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.”

407.3 CONSTRUCTION REQUIREMENTS
The Project Manager will determine the tack coat application rate.

407.3.1 Temperature and Weather Limitations
Do not apply tack coat on a wet surface. Do not apply emulsified asphalt when the air temperature is below the manufacturer’s recommended application temperature.

407.3.2 Equipment
The Equipment shall include an asphalt distributor and Equipment for heating asphalt Material. Provide Equipment that is in accordance with Section 408, “Prime Coat.”

407.3.3 Preparation of Surface
The surfaces and edges to be tack coated shall be dry, patched, cleaned, and free of dirt, surface moisture, vegetation and other Deleterious Materials or irregularities.

407.3.4 Application of Asphalt Material
Uniformly apply asphalt Material with a pressure distributor at a rate determined by the Project Manager (to provide a “residual” asphalt cement content of from 0.04 gal per square yard to 0.08 gal per square yard). Ensure that the nozzles on the pressure distributor are fully open and at the same angle from the spray bar, approximately 30°. Keep the spray bar at a height above the pavement surface to provide for a double or triple lap of the applied asphalt Material. Keep traffic off of the tack coat, unless otherwise approved by the Project Manager. If the Roadway being paved is closed to traffic, the Contractor may place tack coat a maximum of 24 h ahead of the laydown operation. If the Roadway being paved is open to traffic, place the tack coat only over the area that can be paved during that day’s laydown operation. If the Contractor uses an emulsified asphalt tack coat, the Contractor may begin paving operations after the emulsified asphalt is cured. Reapplication of tack coat damaged by traffic or construction Equipment will be at no cost to the Department.

407.4 METHOD OF MEASUREMENT
The Department will consider any water added to further dilute emulsified asphalts incidental to Asphalt Material for Tack Coat and no separate payment will be made.

407.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Material for Tack Coat</td>
<td>Ton</td>
</tr>
</tbody>
</table>
408.1 DESCRIPTION
This Work consists of providing and applying asphalt Material and blotter material (if required) to an existing surface.

408.2 MATERIALS
Provide one of the following types of prime coat asphalt Material:
1. Asphalt emulsified prime (AE-P);
2. Penetrating emulsified prime (PE-P);
3. MC-70; or
4. Other Material approved by the Project Manager.
Provide prime coat asphalt Material in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.”

408.2.1 Certification
Provide a manufacturer’s written certification that the prime Material is chemically identical to those identified on the Department’s Approved Products List.

408.2.2 Blotter Material
Provide fine aggregate (sand) blotter material in accordance with Table 408.2.2:1, “Blotter Material,” unless otherwise approved by the Project Manager.

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>% passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 in</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>80 – 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>45 – 80</td>
</tr>
<tr>
<td>No. 50</td>
<td>10 – 30</td>
</tr>
<tr>
<td>No. 100</td>
<td>2 – 10</td>
</tr>
</tbody>
</table>

408.3 CONSTRUCTION REQUIREMENTS

408.3.1 Temperature and Weather Limitations
Do not apply the prime Material in the following conditions:
1. If the surface has standing water;
2. If the air temperature is less than manufacturer’s recommendation; or
3. If weather conditions prevent the proper placement of the prime coat.
The Project Manager may waive these temperature and weather limitations due to wet weather conditions or to protect Work in progress during Department approved suspensions.

408.3.2 Equipment
Provide a distributor and Equipment for heating bituminous Material.
Ensure the distributor is capable of maintaining the prime Material at an even temperature and can uniformly distribute the Material on variable widths with uniform pressure.
Ensure that the distributor can apply the Material as required.
Ensure that the distributor circulates the prime Material within the tank, the spray bar, and other accessories when not spraying.
Ensure that the distributor has a hand spray gun with a precise-control single or double nozzle and a positive shut-off valve.
Ensure that the distributor has the following Equipment:
1. A tachometer;
2. Pressure gauges;
3. Accurate volume-measuring devices or a calibrated tank;
4. A thermometer that measures the temperature of tank contents;
5. A power unit for the pump; and
6. Laterally and vertically adjustable spray bars.

408.3.3 Preparation of Surface
Shape the surface to be primed in accordance with the Plans, and ensure that it is free of ruts, corrugations, segregated Materials, or other irregularities. Uniformly compact the surface.
in accordance with Section 304, “Base Course.” Ensure that the surface is slightly moist but not saturated when applying the prime.

408.3.4 Application of Prime Material

Do not apply the prime coat until the Project Manager has approved the quantities, application rates, Material temperature, and locations.

Apply the prime Material in a uniform and continuous layer using a pressure distributor. Ensure the nozzles on the pressure distributor are fully open and at the same angle from the spray bar, approximately 30°. Keep the spray bar at a height above the pavement surface to provide a double or triple lap of the prime Material. If using a hand-held wand, ensure the application is uniform.

If distribution irregularities occur, cease operations and take corrective action.

If the Department allows traffic on the surface, maintain one-way traffic on the untreated section of the Roadbed until the treated surface has absorbed the prime Material, then transfer traffic to the treated portion and prime the untreated section.

Perform Work and procedures in accordance with manufacturer’s recommendations.

408.3.5 Application of Blotter Material

If the prime Material fails to penetrate the surface within 24 h after its application, spread blotter material to absorb the excess Material. The Project Manager may approve the use of blotter material on Roadway sections that must be opened to traffic before the 24 hr waiting period.

408.4 METHOD OF MEASUREMENT

The Department will consider any water added to further dilute emulsified asphalts incidental to Asphalt Material for Prime Coat and no separate payment will be made.

408.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Coat Material</td>
<td>Ton</td>
</tr>
</tbody>
</table>
411.1 DESCRIPTION
This Work consists of preparing and cleaning cracks and joints in the existing Roadway surface and sealing these cracks with hot-poured sealant.

411.2 MATERIALS
For crack and joint seals, use hot-poured sealant in accordance with the general and physical requirements of ASTM D 6690, as specified in the Contract.

The Contractor shall have the Supplier sample and test the sealant in accordance with ASTM D 6690 and provide certified test results for each lot or batch of sealant supplied.

Provide sealant packaged in containers and labeled in accordance with ASTM D 6690.

Bulk shipments of sealant must be accompanied by documents that state the following:
1. Manufacturer’s name;
2. Trade name of the sealant;
3. Batch or lot number;
4. Pouring temperature; and
5. Safe heating temperature.

Do not mix more than one lot or batch within a bulk shipment of sealant.

411.3 CONSTRUCTION REQUIREMENTS

411.3.1 Temperature and Weather Limitations
Apply the sealant in the following conditions:
1. When the air temperature is at least 40 °F and rising; and
2. When the temperature of the existing pavement surface is above 32 °F during application.

Do not place the sealant during inclement weather, on wet surfaces, or when the wind conditions prevent satisfactory sealing.

411.3.2 Equipment
Provide router bits of at least 1/2-inch diameter that cut to 1 in deep.

Use air compressors that provide uncontaminated air at a pressure capable of cleaning approved cracks. Equip air compressors with traps to prevent oil and moisture from entering the air stream.

The Equipment for heating and preparing the sealant mixture shall provide a continuous supply of the prepared mixture and maintain a continuous, uniform and homogeneous mixture during the sealing operation. Provide continuous mechanical agitation as necessary to maintain homogeneity.

Use application devices that provide uniform application of the sealant Materials without clogging, or causing other irregularities in distribution. Application devices and Equipment shall meet the requirements of the sealant manufacturer.

411.3.3 Preparation of Cracks
Route and clean cracks to the satisfaction of the Project Manager.

Route cracks with an average clear opening less than 1/2 in to provide a minimum sealant reservoir of 1/2 in wide and to a depth of from 3/4 in to 1 in, unless otherwise directed by the Project Manager. Center routers over the cracks during routing operations.

Clean cracks with an average clear opening 1/2 in or greater with high-velocity compressed air to a depth of from 3/4 in to 1 in, unless otherwise directed by the Project Manager.

Immediately before placing the sealant, clean loose particles, dust, and other Deleterious Materials from the sealant reservoirs with high-velocity compressed air.

411.3.4 Application of Sealant
Control the application to confine sealant within the reservoirs. Apply sealant to the clean, dry-surfaced reservoirs to a depth of from 3/8 in to 1/4 in below the existing surface of the Roadway. If the Project Manager determines that the method of filling results in an excessive amount of sealant on the pavement surface, stop filling and change the method.

Clean excess sealant Material from the pavement surface.

If application devices clog or irregularities in the application occur, halt operations until corrective action is taken.
411.3.5 Resumption of Traffic
Cure sealant in accordance with the manufacturer’s requirements, before placing traffic on the pavement surface.

411.4 METHOD OF MEASUREMENT—Vacant

411.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot-Poured Crack Sealing</td>
<td>Pound</td>
</tr>
</tbody>
</table>
SECTION 412: HOT IN-PLACE RECYCLING OF ASPHALT PAVEMENT (REMIXING METHOD)

412.1 DESCRIPTION
This Work consists of recycling the existing in-place asphalt surface in a multi-step process of cleaning, heating, milling, rejuvenating (if required), spreading, and leveling. This Work also consists of placing and compacting the new HMA over the recycled surface. The Contract may require the Contractor to blend recycled Material with an asphalt-rejuvenating agent.

412.2 MATERIALS
412.2.1 Rejuvenating Agent
Provide an agent that will rejuvenate the existing HMA’s binder properties. The existing HMA’s asphalt Material shall be extracted, recovered, and combined with a virgin asphalt binder per AASHTO M 323, Appendix A such that the combination of the rejuvenating agent with the existing HMA asphalt binder will meet the full AASHTO M 320 requirements for the required PG asphalt grade in the approved mix design.

412.2.2 HMA
Provide the HMA Material and mix design in accordance with Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA).”

412.3 CONSTRUCTION REQUIREMENTS
412.3.1 Equipment
412.3.1.1 General
At the pre-construction conference, notify the Project Manager of the necessary types of Equipment. Deliver the Equipment to the project in time for the Project Manager’s evaluation. Demonstrate the rate, depth, and recycling operations on a Roadway test section before beginning production operations. If Equipment or recycling operations do not meet requirements, correct or replace the deficiency.

412.3.1.2 Heating Units
Ensure the heating units can heat the existing asphalt pavement high enough to mill the Material to the minimum specified depth without the following results:
1. Breaking aggregate particles;
2. Charring the existing asphalt; or
3. Producing undesirable pollutants.

Apply the heat under an enclosed or shielded hood. Do not heat the pavement surface with a direct flame.

412.3.1.3 Milling Units
Use milling units that can mill to the specified depth. Equip the units with automatic height controls to clear utility manholes and other obstructions in the pavement surface. Use units with enough power to mill through high spots and create a leveled surface.

412.3.1.4 Rejuvenating Agent Storage Unit
Use a thermostatically-controlled storage unit to maintain the rejuvenating agent at a constant, Supplier-specified temperature.

412.3.1.5 Metering Unit
Use a unit that can uniformly apply the rejuvenating agent to the milled Material. The unit shall incorporate a meter for continuous quantity verification. Vary the applied amount in direct proportion to the recycling system’s operating speed and synchronize with the amount of Material milled. Do not vary the rejuvenating agent’s application tolerance by more than 0.5% of the specified application rate.

412.3.1.6 Blending Unit
Use a twin-shaft pugmill unit that can uniformly mix the milled Material, rejuvenating agent, and virgin HMA.
412.3.1.7 Spreading and Leveling Unit
Use a unit with automatic grade controls capable of spreading and leveling the Material uniformly over the specified surfaces.

412.3.1.8 Compaction Equipment
Use compaction Equipment in accordance with Section 423.3.4.4, “Compaction Equipment.”

412.3.2 Construction Details
412.3.2.1 Cleaning of Existing Pavement Surface
Before beginning hot in-place recycling, clean the existing pavement surface of non-asphalt Materials by blading and brooming or use methods approved by the Project Manager.

412.3.2.2 Heating, Milling, and Processing
Heat, mill, and process the in-place asphalt surface in a uniform manner to the widths and depths in accordance with the Plans. Control the heat to assure a uniform heat penetration without the following results:
1. Differential softening of the pavement;
2. Breaking of the aggregate particles;
3. Charring of the asphalt; or
4. Producing undesirable pollutants.
If required, uniformly apply the rejuvenating agent to the milled Material before the addition of new HMA. Determine the actual amount of rejuvenating agent needed to address field conditions and to optimize the properties of the in-place pavement. Uniformly mix the milled Material, rejuvenating agent, and HMA to produce a homogeneous mixture.

412.3.2.3 Placing and Compacting
Uniformly spread and level the recycled mixture to the width, grade, and slope specified in the Plans. Immediately after leveling the recycled Material, compact the Material in accordance with Section 423.3.5, “Placement Operations.”

412.3.2.4 Temperature Requirements
Ensure the temperature of the asphalt Materials immediately behind the laydown machine is between 225 °F and 300 °F.

412.3.2.5 Joints
The heating unit shall heat a minimum of 4 in beyond the width of recycling. Construct joints in accordance with Section 423.3.5.4, “Joints.”

412.3.2.6 Debris and Waste Material Disposal
Dispose of debris and waste material in an environmentally safe manner at locations approved by the Project Manager.

412.3.2.7 Weather Limitations
Do not perform hot in-place recycling of asphalt pavement when the Roadway surface is wet or when weather conditions prevent the proper handling, finishing, and compacting of the asphalt mixture.

412.3.2.8 Surface Tolerance
Provide a compacted surface in accordance with Section 423.3.5.5, “Surface Tolerances.”

412.3.2.9 Plan Surfacing Depths
Monitor and record the depth of the compacted recycled pavement Material (including new HMA Material, if specified) during the placement operations. Perform this task in accordance with the Department’s Minimum Testing and Acceptance Requirements and as approved by the Project Manager. The Project Manager will address deficiencies of more than 0.5 in by:
1. Accepting the in-place compacted thickness at an adjusted price; or
2. Rejecting the in-place mixed Material and requiring the Contractor to remove and replace.
412.3.3 Contractor Quality Control

412.3.3.1 Contractor Quality Control for Materials
Provide new HMA Materials in accordance with Section 423.3.6.1, “Contractor Quality Control,” except take random test samples from the HMA windrow before the Material goes through the paver.

412.3.3.2 Contractor Quality Control for Compaction
See Section 423.3.6.1.2, “Contractor Quality Control for Compaction.”

412.3.3.3 Suspension of Operations
See Section 423.3.6.2.1, “Acceptance.”

412.3.4 Project Verification Testing
Place new HMA Materials in accordance with Section 423.3.6.3, “Independent Assurance Testing.”

412.4 Department Quality Assurance

412.4.1 Department Quality Assurance Testing for HMA Mix
New HMA Materials shall meet the requirements of Section 423.3.6, “Sampling and Testing,” with the exception that the Department will base acceptance on random test samples taken from the HMA windrow before the Material goes through the paver.

412.4.2 Department Quality Assurance Testing for HMA Compaction
The Department will test in accordance with Section 423.3.6, “Sampling and Testing.” The target density is a mean density of at least 93% of the theoretical maximum density. The Project Manager will grant an exception to the target if the Contractor can demonstrate that the target density is not reasonably obtainable because of the conditions of the existing Pavement Structure or Subgrade Materials.

If the Department grants this exception, construct a roadway test strip and develop a HMA compaction process to obtain the highest possible target density based on an approved roller’s density gain per pass, in accordance with Section 423.3.4.4, “Compaction Equipment.” Do not begin paving operations (except for the roadway test strip) until the Project Manager approves the process. The in-place density shall not exceed 98% of the theoretical maximum density or be more than 3% below the target density. If a lot’s mean density does not meet this density requirement, the Project Manager may do the following:
1. Require the Contractor to remove and replace the defective lot of HMA at no additional cost to the Department; or
2. Accept the HMA Material and pay the Contractor 50% of the Bid Item Unit Price.
If the Project Manager determines that the mean measured densities are consistently higher, not exceeding 93% of the theoretical maximum density, or lower than the current lot’s target density, the Project Manager may establish a new acceptance lot on the Project.

412.4.3 Department Quality Assurance Testing for HMA Smoothness
If the Contract requires two or more layers of new HMA Material, meet the requirements of Section 401, “Pavement Smoothness Measurement.”

412.4 METHOD OF MEASUREMENT
The Department will measure HMA in accordance with Section 423.4, “Method of Measurement.”

412.5 BASIS OF PAYMENT
The Department will pay for new HMA Material in accordance with Section 423.5, “Basis of Payment.”

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot In-place Recycling of Asphalt Pavement</td>
<td>Square Yard</td>
</tr>
<tr>
<td>HMA Sampling and Testing by the Contractor</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>Rejuvenating Agent</td>
<td>Gallon</td>
</tr>
</tbody>
</table>
SECTION 413: SINGLE-MACHINE HOT IN-PLACE SURFACE REPAVING

413.1 DESCRIPTION
This Work consists of recycling the existing asphalt surface in a simultaneous multi-step process of cleaning, heating, milling, scarifying, rejuvenating (if required), spreading, and leveling. This Work also consists of placing and compacting new HMA Material over the recycled surface. The Contract may require the Contractor to blend the recycled Material with an asphalt-rejuvenating agent.

413.2 MATERIALS
413.2.1 Rejuvenating Agent
Provide an agent that will rejuvenate the existing HMA's binder properties. Extract, recover, and combine the existing HMA's asphalt Material with a virgin asphalt binder per AASHTO M 323, Appendix A. such that the combination of the rejuvenating agent with the existing HMA asphalt binder will meet the AASHTO M 320 requirements for the required PG asphalt grade in the approved mix design.

413.2.2 HMA
Provide HMA Material in accordance with Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA).”
Provide a HMA mix design in accordance with subsection 423.2, “Materials.” The State Materials Bureau must approve the HMA mix design before the beginning of the Work.

413.3 CONSTRUCTION REQUIREMENTS
413.3.1 Equipment
413.3.1.1 General
At the pre-construction conference, notify the Project Manager of the type of Equipment that will be used. Deliver the Equipment to the project in time for the Project Manager’s evaluation. Provide a machine with a single, self-propelled mobile unit capable of heating, scarifying, rejuvenating, mixing, leveling the existing surface Material, and immediately laying new hot-mix Material over the recycled surface. Demonstrate the rate, depth, and recycling capabilities on the Roadway before beginning operations. If Equipment or recycling operations do not meet requirements, correct or replace the deficiency.

413.3.1.2 Heating Unit
Use a height-adjustable heating unit that is specifically designed to heat the upper layer of asphalt pavement. The unit shall heat the asphalt pavement in a manner that:
1. Will not burn, char, coke, or scrub the recycled mix;
2. Will meet state and local air quality requirements;
3. Will not pose health risks or damage to property;
4. Will not break aggregate particles; and
5. Will produce enough heat to soften the pavement to at least a depth of 1 in.
Apply the heat under an enclosed or shielded hood so that blasting or scrubbing of the existing pavement is eliminated. Use Equipment that can apply heat uniformly under controlled atmospheric conditions to eliminate free oxygen under the heating chamber.

413.3.1.3 Milling/Scarifying Unit
Use a unit that can remove pavement to a minimum depth of 1 in. The unit shall loosen the in-place asphalt pavement to a minimum depth of 1 in without excessively breaking the aggregate. Use a unit equipped with automatic height, grade, and cross slope controls with enough power to push the scarifiers through the high spots and create a leveled surface.

413.3.1.4 Rejuvenating Agent Storage Unit
Use a thermostatically-controlled storage unit to maintain the rejuvenating agent at a constant, Supplier-specified temperature.

413.3.1.5 Metering Unit
Use a unit that can uniformly apply the rejuvenating agent to the milled and scarified material. The unit shall incorporate a meter for continuous quantity verification. Vary the applied amount in direct proportion to the recycling system's operating speed and synchronize with the amount of material milled or scarified. Do not vary the rejuvenating agent’s
application rate by more than \( \pm 0.5\% \) of the rate defined in the mix design.

413.3.1.6 Blending Unit
Use a unit that can mix the scarified Material with the rejuvenating agent to produce a uniform, consistent final product.

413.3.1.7 Spreading and Leveling Unit
Use a unit equipped with automatic grade controls, capable of uniformly spreading and leveling the blended recycled Material. Use a unit equipped with a leveling blade and auger capable of moving recycled Material in a transverse direction to the center of the windrow. Equip the unit with a recycling screed to partially compact the recycled mix before placing the top layer of new HMA.

413.3.1.8 Compaction Equipment
Use Equipment in accordance with Section 423.3.4, “Equipment.”

413.3.2 Construction Details
413.3.2.1 Cleaning of Existing Pavement Surface
Before beginning hot in-place recycling, clean the existing pavement surface of non-asphalt materials by blading and brooming or other methods approved by the Project Manager.

413.3.2.2 Heating, Milling/Scarifying, and Processing
Evenly heat, mill, scarify, and rework the in-place asphalt surface to a minimum depth of 1 in, in accordance with the Plans. Heat the existing pavement surface with continuously moving heaters to scarify the pavement to at least a 1 in average depth in a single pass. Keep the surface temperature of the remaining in-place pavement below 475 °F and produce reclaimed mix at a temperature of at least 225 °F. Extend the heating operation at least 4 in beyond the width of scarification on both sides. Immediately scarify the heated pavement with scarifying shanks spaced so that they cover the surface without leaving ridges. Mount the shanks to allow control from the operator’s platform. Scarification shall cut through the pavement at a level that comes within 1/4 in of the finished pavement’s grade and cross slope. If required, uniformly apply the rejuvenating agent to the material immediately after milling and scarifying.

413.3.2.3 Placing and Compacting
Uniformly spread and level the recycled mixture to the width, finished grade, and cross slope, shown in the Contract. After partially compacting the recycled mixture with the recycling screed, place a new layer of HMA on top of the recycled paving material using a four-section vibratory screed. Perform this in one continuous operation while the temperature of the recycled mix is at least 225 °F. Compact the Material in accordance with Section 423.3.5, “Placement Operations.”

413.3.2.4 Temperature Requirements
Maintain the temperature of the asphalt Material between 225 °F and 300 °F when measured immediately behind the laydown machine.

413.3.2.5 Joints
The heating unit shall heat a minimum of 4 in beyond the width of recycling. Construct joints in accordance with Section 423.3.5.4, “Joints.”

413.3.2.6 Debris and Waste Material Disposal
Dispose of debris and waste material in an environmentally safe manner at locations approved by the Project Manager.

413.3.2.7 Weather Limitations
Do not perform hot in-place recycling of asphalt pavement when the Roadway surface is wet or when weather conditions prevent the proper handling, finishing, and compacting of the
Section 413: Single-Machine Hot In-Place Surface Repaving

413.3.2.8 Surface Tolerance
Place the compacted surface of recycled pavement material or new HMA Material in accordance with Section 423.3.5.5, “Surface Tolerances.”

413.3.2.9 Plan Surfacing Depths
Monitor and record the material depth of the compacted recycled pavement material or new HMA Material throughout the placement operations. Perform this task in accordance with the Department’s Minimum Testing and Acceptance Requirements and as approved by the Project Manager. The Project Manager will address a deficiency of more than 0.5 in-place compacted thickness as follows:
1. Accept the in-place compacted thickness at a reduced payment; or
2. Reject the in-place mixed Material.

413.3.3 Contractor Quality Control
413.3.3.1 Contractor Quality Control for Materials
Place new HMA Materials in accordance with Section 423.3.6.1, “Contractor Quality Control,” except take random test samples from the HMA windrow before the Material goes through the paver.

413.3.3.2 Contractor Quality Control for Compaction
See Section 423.3.6.1.2, Contractor Quality Control for Compaction.

413.3.3.3 Suspension of Operations
See Section 920.3.1, “Evaluation of Quality Control Properties.”

413.3.3.4 Project Verification Testing
Place new HMA Material in accordance with Section 423.3.6.3, “Independent Assurance Testing.”

413.3.4 Department Quality Assurance
413.3.4.1 Department Quality Assurance for HMA
New HMA Materials shall meet the requirements of Section 423.3.6.2.1, “Acceptance,” with the exception that the Department will base acceptance on random test samples taken from the HMA windrow before the Material goes through the paver.

413.3.4.2 Department Quality Assurance Testing for HMA Compaction
Meet the requirements of Section 423.3.6.2.1, “Acceptance.” The Project Manager will grant an exception to the mean density requirement of at least 93% of the theoretical maximum density if the Contractor can demonstrate that a minimum of 93% cannot be reasonably obtained because of the conditions of the existing Pavement Structure or Subgrade materials. If the Project Manager grants this exemption, construct a roadway test strip and develop a HMA compaction process to get the highest possible density based on an approved roller’s density gain per pass, in accordance with Section 423.3.4.4, “Compaction Equipment.” The Project Manager will approve the process (except for the roadway test strip) before paving operations begin. In no case shall the percentage of theoretical maximum density exceed 98% nor fall more than 3 percentage points lower than the target density. If a lot does not meet either of these density requirements, the Project Manager will do the following:
1. Accept and pay for the lot of HMA Material at 50% of the Bid Item Unit Price; or
2. Reject the in-place material and require the Contractor to remove and replace.
   If the Project Manager determines that the mean measured densities are consistently higher, but not to exceed 93%, or lower than the current lot’s target density, the Project Manager may establish a new acceptance lot on the project.

413.3.4.3 Department Quality Assurance Testing for HMA Smoothness
If the Contract requires two or more lifts of new HMA Material, place in accordance with Section 401, “Pavement Smoothness Measurement.”
413.4 METHOD OF MEASUREMENT
If the Contract requires HMA, the Department will measure it in accordance with Section 423.4, “Method of Measurement.”

413.5 BASIS OF PAYMENT
The Department will pay for new HMA Material in accordance with Section 423.5, “Basis of Payment.”

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Machine Hot In-Place Surface Repaving</td>
<td>Square Yard</td>
</tr>
<tr>
<td>HMA Sampling and Testing by the Contractor</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>Rejuvenating Agent</td>
<td>Gallon</td>
</tr>
</tbody>
</table>
SECTION 414: COLD MILLING

414.1 DESCRIPTION
This Work consists of cold milling pavement surfaces and removing, hauling, and disposing of cold-milled materials.

414.2 MATERIALS—Vacant

414.3 CONSTRUCTION REQUIREMENTS

414.3.1 Equipment
Use a pavement profiler that has cross slope elevation controls and can accurately control Profile Grades and cross slopes within a 1/4 in tolerance, unless otherwise shown in the Contract. The Equipment must control Profile Grades by using an independent grade control or a 40 ft minimum external reference.

Use Equipment that provides an enclosed cutting area and dust control.

The milling Equipment must produce a uniform milled surface. Maintain the Equipment’s teeth and spacing to produce the desired texture. Immediately replace broken, damaged, or excessively worn teeth.

414.3.2 Operations
Cold mill the existing pavement surface in accordance with the Contract.

Adjust the specified depth in maximum increments of 1/4 in, as directed by the Project Manager.

Minimize gouges, grooves, and ridges to create a uniform surface without deviations greater than 1/2 in when measured with a 10 ft straightedge. Keep the milled surface free of loose material.

Perform milling operations in accordance with the Department’s Pavement Drop-Off Guideline. Immediately remove any standing water.

Do not expose the milled surface to traffic for more than 14 Days before beginning further surface operations.

Correct unacceptable Work and damage to adjacent Structures caused by the operations. Obtain Project Manager’s approval of corrected Work.

Perform additional milling or patching to repair damage to the milled surface, as directed by the Project Manager. If the Project Manager determines that damage is due to conditions beyond the Contractor’s control, the Department will pay for the required milling or patching for milled surfaces, at the Bid Item Unit Price.

Remove the cold milled pavement material, and dispose of the surfacing material in an environmentally acceptable manner or stockpile in accordance with the Contract.

The Contractor may also use cold milled pavement Material as RAP or recycled concrete (RC) in accordance with the Contract.

414.4 METHOD OF MEASUREMENT
The Department will measure Cold Milling to the nearest 1/4 in, if by the square yard-inch.

414.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Milling (Asphalt)</td>
<td>Square Yard-Inch or Square Yard</td>
</tr>
<tr>
<td>Cold Milling (Concrete)</td>
<td>Square Yard-Inch or Square Yard</td>
</tr>
<tr>
<td>Patching of Milled Surface</td>
<td>Ton</td>
</tr>
</tbody>
</table>
415.1 DESCRIPTION
415.1.1 General
This specification covers the requirements for:
1. **Option A**: In-Situ Cold Recycling of Existing Surfacing; and
2. **Option B**: Cold Milling with Hot-Mix Asphalt (HMA) Inlay.
Choose either option. The Contractor may change options once during the project at no additional cost to the Department.

415.1.2 Option A: In-Situ Cold Recycling of Existing Surfacing
This Work consists of the following:
1. Pulverizing the existing surfacing;
2. Mixing an emulsified binder agent with the pulverized surfacing;
3. Mixing hot hydrated lime slurry with the pulverized surfacing;
4. Spreading and compacting the mixture; and
5. Sealing the compacted surface.

415.1.3 Option B: Cold Mill with HMA Inlay
This Work consists of the following:
1. Cold milling;
2. Applying a tack coat; and
3. Placing an inlay of HMA.

415.2 MATERIALS
415.2.1 Option A: In-Situ Cold Recycling of Existing Surfacing
Use an emulsified binder agent that is polymerized high-float emulsion HFE-150P, unless otherwise specified. Changing one grade up or down will change the Bid Item Unit Price based on the difference in invoice prices between the grades of emulsion. Change the grade only with the approval of the Project Manager and District Laboratory supervisor. Use polymerized high-float emulsion in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.” Use cold recycled Material that meets the following gradation requirements:

<table>
<thead>
<tr>
<th>Table 415.2.1:1 Cold Recycled Pavement Gradation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve size</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>1 1/4 in*</td>
</tr>
<tr>
<td>1 in</td>
</tr>
</tbody>
</table>

*Allow 1 1/2 in if pavement with fabric is recycled.

Use sealing emulsion that is diluted high-float emulsion, CSS-1, or another approved equal. Use hot hydrated lime slurry meeting the following requirements:
1. High-calcium pebble quicklime meeting the requirements of ASTM C 977;
2. Clean water in accordance with Section 509.2.6, “Water;” and
3. Slurry with a minimum dry solids content of 35% by weight and consisting of a uniform, pumpable suspension of solids in water.

415.2.1.1 Option A Mix Design
Provide a laboratory mix design developed and tested in accordance with the Department’s procedures. The mix design will establish the initial target addition rate for the emulsified binder agent and for the hot hydrated lime slurry. Provide copies of the laboratory mix design, along with supporting documentation, to the Project Manager, the District Laboratory supervisor, and the State Materials Bureau. Do not use the mix design without State Materials Bureau approval. The Department will consider the laboratory mix design a starting point only. The Contractor may adjust the target addition rates for emulsified binder agent and hot hydrated lime slurry as necessary, with the Project Manager’s approval.

415.2.2 Option B: Cold Mill with HMA Inlay
Cold millings removed during the surface restoration process will become the property of the Department, unless used on the project or otherwise specified. The Contractor may use
cold milling Material from this project as RAP in the HMA inlay. Provide HMA in accordance with a Department-recognized HMA mixture type, with a nominal size of at least 3/4 in or greater, and Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA).” Use a tack coat in accordance with Section 407, “Tack Coat.” Use HMA mixture containing performance-graded asphalt Material in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.”

415.2.2.1 Option B Mix Design

Provide a mix design developed and approved in accordance with Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA).”

415.2.3 Equipment

415.2.3.1 Option A: In-Situ Cold Recycling of Existing Surfacing

415.2.3.1.1 Cold In-Situ Machinery

Use a self-propelled machine capable of pulverizing in-situ asphalt Materials to the specified depth in one pass. Ensure that the machine provides a minimum rotor cutting width of 12 ft with automatic grade and slope control. Use a machine with screening and crushing capabilities to reduce or remove oversized particles before mixing with emulsion. The Department will allow the removal of a maximum of 2% oversize material before adding emulsion, with the Project Manager’s approval. Use a mixing machine capable of mixing the pulverized Material and the emulsified binder agent in a homogeneous mixture and placing in a windrow while preventing segregation. Use a positive displacement pump capable of accurately metering the required quantity of emulsified binder agent into the pulverized Material. Equip the pump with a positive interlock system that will permit addition of the emulsified binder agent only when the pulverized Material is present in the mixing chamber, and that will automatically shut off when the Material is not in the mixing chamber. Equip each mixing machine with a meter capable of registering the rate of flow and total delivery of the emulsified binder agent introduced into the mixture. Calibrate the meter in the presence of the Project Manager before beginning recycling operations and check or calibrate the meter as directed by the Project Manager.

415.2.3.1.2 Lime Slurry Equipment

Produce lime slurry at the job site using a batch type process. Ensure the Equipment accurately proportions the quicklime and water, mixes the two to obtain proper slaking, and maintains homogeneous slurry. Provide horizontal mixing shafts in the transports used to convey the slurry to maintain a homogenous mixture. Add the lime slurry to the pulverized surfacing with a spray bar located at the cutting head on the milling machine. Use a metering device that accurately measures the amount of slurry delivered to within ± 10% by weight.

415.2.3.1.3 Pavers

Place the recycled asphalt Base Course with a self-propelled asphalt paver in accordance with Section 423.3.4.3, “Pavers,” except do not heat the screed. Use Equipment capable of spreading the recycled asphalt base in one continuous pass, without segregation, to the section shown on the Plans. When using a pick-up machine to feed the windrow into the paver’s hopper, ensure that it is capable of picking up the entire windrow, down to the underlying Materials.

415.2.3.1.4 Rollers

Provide rollers in accordance with Section 423.3.4.4, “Compaction Equipment.” Ensure that the number, weight, and types of rollers are sufficient to obtain the required compaction while the mixture is in a workable condition. Use one pneumatic roller that weighs at least 30 ton. Equip rollers with pads and water systems that prevent the recycled mixture from sticking to the roller wheels.

415.2.3.1.5 Brooms

Maintain a working rotary power broom on site capable of removing aggregate that dislodges from the recycled surface.

415.2.3.2 Option B: Cold Mill with HMA Inlay

415.3 CONSTRUCTION REQUIREMENTS

Before beginning the pre-paving conference, submit a paving schedule to the Project Manager for pavement surface restoration operations (Option A or Option B). Begin paving operations only after the Project Manager has given written approval. Monitor and record plan depths throughout the pavement surface restoration operations and at intervals directed by the Project Manager. The Department will not pay for any depth in excess of the Contract-specified depth.

415.3.1 Option A: In-Situ Cold Recycling of Existing Surfacing

Ensure that Option A Work has a minimum depth of 4 in and the specified width, or as directed by the Project Manager. Begin placing the HMA overlay of the in-situ cold recycled layer within four weeks of completing the in-situ cold recycled layer.

Remove Deleterious Materials within the width of the pavement to be recycled before beginning recycling operations or other relevant Work. Dispose of the debris as directed by the Project Manager. Control water to the pulverized Material to facilitate uniform mixing with the emulsified binder agent. The Contractor may add water before or with the emulsified binder agent. Provide a means to accurately meter and register the rate of flow of water into the pulverized Material. If the typical section to be recycled is on a super elevated or sloped section, begin the initial pass of the milling Equipment at the lowest portion of the section and proceed in succession towards the higher side of the slope. Remove fillets of fine, pulverized Material that form adjacent to a vertical face before spreading the recycled mix. The Contractor shall not remove fillets adjacent to existing pavement if the Contractor is to remove the fillets by overlapping during subsequent milling operation. If segregation occurs either in the windrow or behind the paver, the Project Manager may require the Contractor to make changes to the Equipment or operations.

If a section of recycled pavement contains a paving fabric, as identified in the Plans, waste oversized material as directed by the Project Manager. This may require changes in Equipment and procedures to obtain an acceptable end product.

Make these changes at no additional cost to the Department.

When a section of recycled pavement contains a paving fabric not identified in the Plans, or if the vertical location of the fabric varies by more than 1 in from that specified, submit a written proposal to the Project Manager describing in detail the recommendations for addressing the fabric. Address the size of shredded fabric pieces, the removal of oversize fabric pieces, the removal of oversize RAP, and any anticipated changes to the emulsion addition rate.

Proposals that incorporate a reduction of the existing pavement thickness or a decrease in the depth of cold recycling must include an analysis addressing the structural adequacy of the proposed new pavement section. Submit the proposal to the State Materials Bureau for their review. Do not begin the Work until the Project Manager approves the proposal in writing.

Spread the recycled asphalt base in one continuous pass, without segregation, in accordance with the typical section.

415.3.1.1 Surface Tolerance

Ensure that the final surface of recycled asphalt base does not deviate more than 1/4 in when measured with a 10 ft straightedge.

415.3.1.2 Temperature and Weather Limitations

Do not perform recycling operations in the following conditions:

1. The average daily air temperature is below 55 °F.
2. The Chill Factor is below 35 °F.
3. The weather is foggy or rainy; or
4. The weather conditions are such that proper mixing, spreading, and compaction requirements of the recycled material cannot be accomplished.

415.3.1.3 Binder Application

Apply the emulsified binder agent to the pulverized Material at the target addition rate in accordance with Section 415.2.1.1, “Option A Mix Design.” Maintain an allowable tolerance of ± 0.2% from the target binder content.
415.3.1.4 Lime Slurry Addition
Add water to the quicklime and incorporate it uniformly into the pulverized surfacing Material at a rate that will result in 1.5% hydrated lime by dry weight of pulverized surfacing Material. Control the addition of lime slurry by continuously weighing the pulverized surfacing Material.

415.3.1.5 Density and Rolling Requirements
Establish a rolling pattern to obtain a minimum of 96% of the maximum theoretical density of a Laboratory briquette, prepared in accordance with Department molding and testing procedures. The Project Manager may require a re-demonstration of rolling capabilities for the following reasons:
1. The Project Manager observes a change in the recycled Materials;
2. The Contractor changes the rolling Equipment; or
3. The Contractor does not obtain proper densities.
Perform initial rolling with a pneumatic roller until the mixture has no visible displacement. Perform the final rolling, to eliminate pneumatic tire marks and achieve density, with steel wheel rollers, either in static or vibratory mode. Perform rolling in accordance with Section 423.3.5, “Placement Operations.” Suspend rolling operations that result in cracking, movement, or other types of pavement damage, and correct the problem. The Project Manager will make suspension and resumption of rolling operations decisions.

415.3.1.6 Finishing Operations
Do not permit vehicles on the completed recycled asphalt base for at least two hours after the recycled Material is spread and compacted. Allow traffic on the recycled Material when approved by the Project Manager. Allow the recycled Material to cure so that the free moisture in the recycled Material reduces to a maximum of 1% above the inherent moisture content of the existing pavement by the total weight of the mix. Determine the inherent moisture content of the existing pavement from samples taken at a maximum of 1-mile intervals, or as approved by the Project Manager. Determine the free moisture content of the recycled pavement from samples taken from the same areas and same intervals sampled for the inherent moisture content. Take the samples and determine the free moisture immediately before sealing or overlaying operations. If the free moisture content of the recycled Material is 1% or less above the inherent moisture of the Material, seal the surface with emulsion at an approximate rate of 0.05 gal per square yard to 0.10 gal per square yard, in order to control surface raveling. Repair unacceptable recycled Material, as directed by the Project Manager, before placing a subsequent surfacing course. Ensure that the surface of the recycled pavement is safe for traffic. Remove loose aggregate that develops on the surface of the recycled pavement with a power-broom.

415.3.2 Option B: Cold Mill with HMA Inlay
Ensure that Option B Work has a minimum depth of 3 in, unless otherwise specified in the Plans, and a width as specified in the Plans, or as directed by the Project Manager. If required, mill the pavement surface to the grades, depths, and widths specified in the Plans. Remove dirt and other objectionable material from the surface of the pavement with blades, brooms, or other methods approved by the Project Manager in accordance with Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA),” Section 407, “Tack Coat,” and Section 414, “Cold Milling.”

415.4 METHOD OF MEASUREMENT—Vacant

415.5 BASIS OF PAYMENT
Pavement Surface Restoration includes Contractor testing.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Surface Restoration</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

415.5.1 Option A: In-Situ Cold Recycling of Existing Surfacing
If the actual quantity of polymerized high-float emulsion varies outside the range of 1% to 2%, the Department will pay for or credit the actual amount of variation at the invoice cost for emulsion (per ton).
416.1 DESCRIPTION
This Work consists of constructing one or more courses of HMA pavement on a prepared
base in accordance with the Plans or as directed by the Project Manager.
Examples of minor paving locations may include the following:
1. Bridge approaches;
2. Intersection improvements;
3. Auxiliary lanes; and
4. Turnouts that provide access to commercial establishments or to more than one
residence.

416.2 MATERIALS
Use HMA of the type and gradation shown in the Contract for minor paving. HMA is a
mixture of asphalt binder, aggregate, blending sand, mineral filler, hydrated lime, or anhydrite
based material liquid anti-strip (if required). Use Materials for minor paving in accordance with
Section 423.2, "Materials."

416.3 CONSTRUCTION REQUIREMENTS
Perform minor paving in accordance with Section 423.3.1, "Construction Requirements,
General," Section 423.3.2, "Mix Temperature Requirements," Section 423.3.3, "Addition of
Hydrated Lime or Anhydrite Based Material," Section 423.3.4, "Equipment," and
Section 423.3.5, "Placement Operations."

416.3.1 Sampling and Testing
416.3.1.1 Contractor Quality Control
Provide the Materials, Equipment, and personnel necessary for quality control.
Submit a proposed quality control plan in accordance with Section 423 “Hot Mix Asphalt –
Superpave.”
Provide the Department with quality control test results, quality control charts, and other
documentation of the quality control efforts. Submit changes to the approved quality control
plan to the Project Manager before performing Work affected by the change. Failure to submit
a quality control plan or failure to follow the approved quality control plan constitutes grounds
for suspending the operations.

416.3.1.2 Department Quality Assurance
416.3.1.2.1 Acceptance
The Department will accept the constructed product based on inspection and on
Laboratory testing for conformance with the Contract. The Department will test samples of
HMA taken from the Roadway before compaction, and on cut pavement samples (cores). The
Department will accept the constructed product based on the following criteria:
1. Air voids as determined from Laboratory-compacted specimens in accordance with
   AASHTO T 166 and AASHTO T 209;
2. Asphalt content as determined by the tank strap method;
3. Final thickness of the compacted Material as measured from cores in accordance
   with ASTM D 3549;
4. Density of the compacted roadbed as determined from cores in accordance with
   AASHTO T 310.
Department representatives, certified in the relevant test procedures by the State
Materials Bureau through TTCP, will perform acceptance testing in accordance with AASHTO
or Department methods, using the test methods and modifications in the current TTCP
Manual.

416.3.1.2.1.1 Acceptance Lots and Pay Factor Determination
The Department will accept density based on the average of three cores per lot and will
accept air voids and asphalt content based on one test per lot. Lot sizes will be 1500 yd^2 or
less, as determined by the Project Manager.

The Department will determine pay factors in accordance with Table 416.3.1.2.1:1, "Price
Adjustments for Density," Table 416.3.1.2.1:2, "Price Adjustments for Air Voids,
Table 416.3.1.2.1:3, "Price Adjustments for Asphalt Content," and Table 416.3.1.2.1:4 "Price
Adjustment for Thickness." The Department will obtain the TVs for asphalt content and air
voids from the approved JMF and will determine payment for each acceptance lot by multiplying the Bid Item Unit Price by the average of the pay factors per lot and multiplying the result by the total lot area.

<table>
<thead>
<tr>
<th>Percent density</th>
<th>Pay factor (%)</th>
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<tbody>
<tr>
<td>&gt; 97.99</td>
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<td>90.0 – 90.99</td>
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<tr>
<td>&lt; 90.00</td>
<td>Reject</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent deviation from TV</th>
<th>Pay factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1.31 – 1.69</td>
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</tr>
<tr>
<td>≥ 2.0</td>
<td>Reject</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent deviation from TV</th>
<th>Pay factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.1</td>
<td>102</td>
</tr>
<tr>
<td>0.1 – 0.29</td>
<td>100</td>
</tr>
<tr>
<td>0.30 – 0.49</td>
<td>90</td>
</tr>
<tr>
<td>≥ 0.5</td>
<td>Reject</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deficiency from plan minimum thickness</th>
<th>Pay factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (Plan Minimum or Thicker)</td>
<td>102</td>
</tr>
<tr>
<td>&lt; 1/4 in</td>
<td>100</td>
</tr>
<tr>
<td>1/4 in–1/2 in</td>
<td>90</td>
</tr>
<tr>
<td>1/2 in–3/4 in</td>
<td>75</td>
</tr>
<tr>
<td>3/4 in–1 in</td>
<td>50</td>
</tr>
<tr>
<td>&gt; 1 in</td>
<td>Corrective action</td>
</tr>
</tbody>
</table>

Remove and replace rejected Material identified in Table 416.3.1.2.1:1, “Price Adjustment for Density,” Table 416.3.1.2.1:2, “Price Adjustment for Air Voids,” and Table 416.3.1.2.1:3, “Price Adjustments for Asphalt Content.” Instead of removing and replacing rejected Material, the Project Manager may allow the Material to remain in place at 50% of the Bid Item Unit Price, if in the best interest of the Department.

Take corrective action if specified in Table 416.3.1.2.1:4, “Price Adjustment for Thickness.” Corrective action includes removal and replacement of the unacceptable Material, overlay of the unacceptable Material, or other corrective actions approved by the Project Manager. Thin or feathered edge surface patching is not acceptable. Overlay lift thicknesses must meet the requirement of Table 416.3.1.2.1:5, “HMA Lift Thickness.”
Table 416.3.1.2.1.1:5
HMA Lift Thickness

<table>
<thead>
<tr>
<th>HMA Type</th>
<th>Lift Thickness (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>SP-II</td>
<td>3.0</td>
</tr>
<tr>
<td>SP-III</td>
<td>2.5</td>
</tr>
<tr>
<td>SP-IV</td>
<td>1.5</td>
</tr>
</tbody>
</table>

416.3.1.3 Independent Assurance Testing
The Department will perform independent assurance sampling and testing in accordance with Section 901.1.3, “Acceptance Sampling and Testing.”

416.4 METHOD OF MEASUREMENT—Vacant

416.5 BASIS OF PAYMENT
The Department will adjust payment for minor pavement in accordance with Section 416.3.1.2.1.1, “Acceptance Lots and Pay Factor Determination.”

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor Pavement</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>
SECTION 417: MISCELLANEOUS PAVING

417.1 DESCRIPTION
This Work consists of constructing one or more courses of asphalt paving on a prepared surface.
Examples of miscellaneous paving include ditch paving, median paving, slope paving, guardrail pads, bicycle/pedestrian paths and trails, asphalt curbs, residential turnouts and field entrances.

417.2 MATERIALS
The asphalt paving consists of coarse and fine aggregates, asphalt binder, mineral filler, and hydrated lime or anhydrate based Material, and liquid anti-stripping agent (if required).

417.2.1 Aggregate
Use aggregate that meets the requirements in Table 417.2.1:1, “Aggregate Gradation Requirements.”

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>% passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 in</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>40 – 70</td>
</tr>
<tr>
<td>No. 200</td>
<td>&lt; 10</td>
</tr>
</tbody>
</table>

Coarse aggregate shall have an AI of 30 or less in accordance with Section 910, “Aggregate Index.” The combined aggregate shall have a minimum sand equivalent of 45.

417.2.2 Asphalt Material
Use the type and grade of asphalt Material specified in the Contract. If no grade is specified, use any performance-graded asphalt binder in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.”
Use asphalt mixture with sufficient asphalt binder to produce a design air voids of 4% or less, except for ditch paving, which shall have a design air voids of 3% or less. Use the superpave gyratory compactor at N (design) of 75 gyrations to determine the percentage. Use asphalt Material content that meets requirements for workability and desired surface texture.

417.2.3 Reclaimed Asphalt Pavement (RAP)
The Contractor may use RAP miscellaneous paving in any amount up to 40% of the total weight of the mix, providing the other provisions of this specification are met.

417.2.4 Job Mix Formula
Submit a JMF proposal to the Project Manager for approval at least 14 Days before paving. The JMF shall include the following:
1. Stockpile combination percentages and resulting gradation;
2. Source, grade, and percentage of asphalt binder; and
3. Any other information that will assist the Project Manager in evaluating the appropriateness of the mix design.
Do not begin miscellaneous paving until the Project Manager has approved the JMF.
The Contractor may substitute any approved mix design that complies with the requirements of Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA)” instead of the requirements of this section.
Submit proposed changes to the approved JMF to the Project Manager for approval before placement.

417.3 CONSTRUCTION REQUIREMENTS

417.3.1 Mixing Plants
Prepare HMA for miscellaneous paving in an asphalt plant of typical configuration and in good repair. The Contractor may use drum or batch mixing plants in accordance with Section 423.3.4, “Equipment.”
417.3.2 Haul Equipment
Use haul Equipment in accordance with 423.3.4.2, "Haul Equipment."

417.3.3 Placement Operations
Unless otherwise specified in the Contract, prepare the surface by compacting the top 6 in of soil to 95% of maximum density in accordance with AASHTO T 99 Method C. Place asphalt mixtures in accordance with the Plans, or as directed by the Project Manager. The surface of the placed mix shall be smooth and uniform in texture. Compact with a mechanical roller of suitable type and size to obtain the density and surface texture specified in the Plans. Cross-roll ditch paving with a pneumatic roller or by other approved means to produce a corrugated texture. Roll and consolidate median and slope paving, and guardrail pads to a uniform texture.

417.3.4 Temperature and Weather Limitations
Perform miscellaneous paving in accordance with Section 423.3.5.1, “Temperature and Weather Limitations.”

417.3.5 Acceptance
Correct or remove Material that the Project Manager determines is improperly coated or segregated or that otherwise fails to meet the requirements of this specification.

The Department will base acceptance of miscellaneous paving on visual examination, verification of line and grade, and by density testing (if required). The Department will require density testing on turnouts, and bicycle/pedestrian paths and trails.

Perform test strip and nuclear density testing with a Department representative observing.

Evaluate density with nuclear methods and calibrate with the test strip produced at the beginning of paving. For the test strip, place the HMA at the proper compaction temperature and thickness (as shown on the Plans). Run three passes on the placed hot mixture with a smooth steel-surface roller that has a minimum weight of 250 lb per inch of drum width.

Acceptance lots for density will be a maximum of 500 yd$^2$, or per guardrail pad or turnout. Take three nuclear density readings at random locations within each lot, and average the three tests for acceptance and pay factor determination. The Department will determine the pay factor for each lot in accordance with Table 417.3.5:1, “Price Adjustments for Density”:

<table>
<thead>
<tr>
<th>Density, percent of test strip</th>
<th>Pay factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 98</td>
<td>100</td>
</tr>
<tr>
<td>95.0 – 97.9</td>
<td>95</td>
</tr>
<tr>
<td>92.0 – 94.9</td>
<td>80</td>
</tr>
<tr>
<td>&lt; 92.0</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Remove and replace rejected Material identified in Table 417.3.5:1, “Price Adjustment for Density.” Instead of removing and replacing rejected Material, the Project Manager may allow the Material to remain in place at 50% of the Bid Item Unit Price, if in the best interest of the Department.

417.4 METHOD OF MEASUREMENT—Vacant

417.5 BASIS OF PAYMENT
The Department will adjust payment for miscellaneous paving in accordance with Section 417.3.5, “Acceptance.”

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscellaneous Paving</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Asphalt Curb</td>
<td>Linear foot</td>
</tr>
</tbody>
</table>
423.1 DESCRIPTION
This Work consists of constructing one or more courses of hot-mix asphalt (HMA) on a prepared base.

423.2 MATERIALS
423.2.1 General
HMA is a mixture of asphalt binder, aggregate, blending sand, mineral filler, and hydrated lime or anhydrite based material. The Department will allow RAP in HMA mixtures as long as the resulting mixture conforms to all specification requirements, unless otherwise prohibited in the Contract.

Size, uniformly grade, and combine aggregate fractions in accordance with the Contract. Test Materials in accordance with applicable AASHTO methods, as modified by the Department (if applicable) or other test procedures as directed by the Department. The State Materials Bureau will decide all questions pertaining to the interpretation of test procedures.

423.2.2 Aggregate
The aggregate gradation of the HMA mixture will meet the requirements of Table 423.2.2.1:1, “HMA Aggregate Gradation Control Points.” The Project Manager may require, at no additional cost to the Department, wet preparation, per AASHTO T 146, Method A, if the Project Manager believes there are Deleterious Materials present in the aggregate stockpiles before aggregate gradation testing. The Contract will specify the type of HMA the Contractor is to use. The Department will allow the Contractor to combine Materials from two or more sources to produce aggregate only when each individual aggregate source meets all applicable quality requirements.

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>SP-II</th>
<th>SP-III</th>
<th>SP-IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1 1/2 in</td>
<td>100</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1 in</td>
<td>90</td>
<td>100</td>
<td>--</td>
</tr>
<tr>
<td>3/4 in</td>
<td>--</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>1/2 in</td>
<td>--</td>
<td>--</td>
<td>90</td>
</tr>
<tr>
<td>3/8 in</td>
<td>--</td>
<td>--</td>
<td>90</td>
</tr>
<tr>
<td>No. 8</td>
<td>19</td>
<td>45</td>
<td>23</td>
</tr>
<tr>
<td>No. 200</td>
<td>1.0</td>
<td>7.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

423.2.2.1.1 Aggregate Quality
For each Material source, the HMA coarse aggregate will have an AI of 25 or less when calculated in accordance with Section 910, “Aggregate Index.”

Regulate amount of crushing of aggregate stockpiles so that the minimum Fractured Faces content of the plus No. 4 Material complies with the requirements of Table 423.2.2.1:1, “Fractured Faces, Sand Equivalent, and Fine Aggregate Angularity,” and evaluation by NMDOT Method FF-1, “Fractured Face Determination for Coarse Aggregate.” The plus 3/8 in material will contain a maximum of 20% flat, elongated particles with a dimensional ratio of 3:1 or greater as determined by ASTM D 4791 (TTCP Modified).

Combined material, excluding RAP, passing the No. 40 sieve will be non-plastic. Before the addition of hydrated lime or anhydrite based material, the minimum sand equivalent value and the minimum fine aggregate angularity value of the combined aggregate, excluding RAP, will comply with the requirements of Table 423.2.2.1:1.2, “Fractured Faces, Sand Equivalent, and Fine Aggregate Angularity.” Determine the sand equivalent value in accordance with AASHTO T 176, Alternate Method No.1 and the fine aggregate angularity value in accordance with AASHTO T 304, Method A.

423.2.2.1.2 Fractured Faces
The Department will consider a face to be fractured when at least one-half of the projected particle area exhibits a rough, angular, or broken texture with well defined edges.

### Fractured Faces, Sand Equivalent, and Fine Aggregate Angularity

<table>
<thead>
<tr>
<th>Design Traffic, ESALs$^a$ x 10$^6$</th>
<th>Fractured Faces$^b$</th>
<th>Sand Equivalent (%)</th>
<th>Fine Aggregate Angularity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3.0</td>
<td>75.0 / —</td>
<td>45.0</td>
<td>40.0</td>
</tr>
<tr>
<td>&gt; 3.0 – &lt; 10.0</td>
<td>85.0 / 80.0</td>
<td>45.0</td>
<td>45.0</td>
</tr>
<tr>
<td>&gt; 10.0 – &lt; 30.0</td>
<td>95.0 / 90.0</td>
<td>45.0</td>
<td>45.0</td>
</tr>
<tr>
<td>≥ 30.0</td>
<td>100.0 / 100.0</td>
<td>50.0</td>
<td>45.0</td>
</tr>
</tbody>
</table>

$^a$ESALs are based on a 20-year design life for all scenarios.

$^b$Under “Fractured Faces”, 85.0 / 80.0 denotes that 85.0% of the course aggregate will have at least 1 Fractured Face and 80.0% will have at least two Fractured Faces.

423.2.2.2 Production

When producing aggregates for HMA, remove natural fines by screening and stockpiling separately. Use a No. 4 screen, minimum, or a larger screen if needed to properly control the crushing and screening operation. Crush the aggregate retained on the scalping screen and separate the crushed Material into at least two stockpiles of fine and coarse aggregates. Regulate crushing operations to produce Material within the specified gradation band.

423.2.2.3 Stockpiling

The following requirements apply to stockpiles:

1. Place stockpiles upon prepared sites;
2. Make stockpiles neat and regular to prevent segregation;
3. Provide enough storage space for each size of aggregate;
4. Separate the aggregate stockpiles far enough apart to prevent mixing, or with walls or partitions;
5. Prevent contamination (store stockpiles away from vehicular and Equipment traffic);
6. Keep the storage yard neat and orderly and keep the stockpiles accessible for sampling; and
7. Keep the aggregate sizes separated until delivered to the cold feed system that feeds the drier.

423.2.2.4 Combining

When combining crushed Materials from different stockpiles, including RAP (if in the mixture), ensure the product is in accordance with the gradation requirements. Use controlled feeders from each stockpile to combine crushed Material.

423.2.3 Asphalt Binder

The Contract will specify the type and grade of asphalt binder. Provide asphalt binders in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.” Do not change the asphalt source after approval of the mix design without written approval of the State Materials Bureau.

423.2.4 Hydrated Lime or Anhydrite Based Material

Provide hydrated lime or anhydrite based material in accordance with Section 402, “Asphalt Materials, Hydrated Lime, and Anhydrite Based Material.”

423.2.5 Blending Sand

Blending sand consists of the following:

1. Natural fines from the scalping process;
2. Concrete sand;
3. Sandy Material; or
4. A combination of these, graded to the mix design requirements.

Determine the need for and percentage (a maximum of 20.0%) of blending sand using mix design tests on samples taken from stockpiles during crushing operations and submitted to an approved testing Laboratory.
423.2.6 Mineral Filler
Provide mineral filler in accordance with AASHTO M 17 and approved by the State Materials Bureau. The Department will not allow fly ash as mineral filler for HMA.

423.2.7 Reclaimed Asphalt Pavement
Unless otherwise specified in the Contract, the Contractor may use RAP removed under the Contract consisting of salvaged, milled, pulverized, broken, or crushed asphalt pavement. After the Contractor obtains sufficient quantities of RAP aggregate samples in accordance with AASHTO T 308, the Department will accept RAP for which each fraction of coarse aggregate has a percent wear of 40.0 or less, at 500 revolutions, when tested in accordance with AASHTO T 96. Provide plus No. 4 RAP Material with a minimum Fractured Faces content in accordance with Table 423.2.2.1-2.1, “Fractured Faces, Sand Equivalent, and Fine Aggregate Angularity,” as evaluated by the NMDOT Method FF-1, “Fractured Face Determination for Coarse Aggregate.” Provide plus 3/8-inch RAP aggregate with a maximum of 20% flat, elongated particles and a dimensional ratio of 3:1 or greater in accordance with ASTM D 4791.

The Contractor may use a maximum of 15% RAP (by weight) in the production of HMA mixtures without changing the asphalt binder. For 15% to 25% RAP, lower the asphalt binder’s high and low temperature grades one grade (e.g. lower a PG 76-22 to a PG 70-28). For 25% to 35% RAP, extract, recover, and combine the RAP’s asphalt binder with a virgin asphalt binder per AASHTO M 323, Appendix A. Ensure the resultant binder meets the entire AASHTO M 320 required project PG asphalt binder properties indicated on the approved mix design. The Department will not allow the Contractor to use more than 35% RAP in the production of HMA mixtures.

Process RAP so that 100% passes a 1 1/2-inch sieve. For HMA mixtures containing more than 15% RAP, process and maintain the RAP aggregate stockpiles so they are uniform throughout the stockpile. Account for the weight of the binder in the RAP when batching aggregates. Provide RAP that is free of Deleterious Materials. If the Contractor decides to use RAP in the production of HMA mixtures, the Department will make no additional payment for the RAP.

423.2.8 Mix Design
Provide a mix design developed by a Department-approved testing Laboratory. A list of approved private testing laboratories is available from the State Materials Bureau. Develop the mix design at no additional cost to the Department. The Contractor may develop the mix design at any time. Submit at least five independent aggregate gradation test results from each stockpile to the Project Manager.

Provide the Department with a copy of the request to the testing Laboratory to develop a mix design, along with supporting documents in accordance with AASHTO R 35, to the Project Manager and the State Materials Bureau. Include the proposed aggregate combination and copies of all stockpile test results. Summarize the mix design results from the Department-approved testing Laboratory in a format approved by the State Materials Bureau and submit them to the State Materials Bureau for review and concurrence. Include the results and design worksheets of testing calculations in accordance with AASHTO R 35, for the mix components as well as the mixture itself and in accordance with State Materials Bureau procedures. Department concurrence of a mix design will not relieve the Contractor of full responsibility for producing an acceptable mixture. The mix design may require adjustment in accordance with Section 423.2.8.1, “Mix Design Adjustment.”

Create the JMF gradation in accordance with Table 423.2.2.1.1, “HMA Aggregate Gradation Control Points.” The Department will require at least 1.0% hydrated lime or anhydrite based material in all mix designs. Include the hydrated lime or anhydrite based material in the gradation for developing the mix design. The mix design will establish a single percentage of the aggregate passing each sieve size and a single percentage of asphalt binder the Contractor is to add to the aggregate. Develop the mix design using the Strategic Highway Research Program (SHRP) gyratory compactor in accordance with AASHTO R 35. NMDOT 001 (2006) may be used in lieu of AASHTO T 84. The mix design will be in accordance with Table 423.2.8.1.1, “HMA Superpave Design Requirements for Aggregates with Less Than 3.0% Absorption,” or Table 423.2.8.2, “HMA Superpave Design Requirements for Aggregates with 3.0% or Greater Absorption.”

Test the HMA with at least 1.0% hydrated lime or anhydrite based material in accordance with AASHTO T 283, as modified below:
1. Use 6 in by 3.75 in specimens for all prisms;
2. Compact all test specimens in accordance with AASHTO T 312 to an air content of 7% +/- 0.5%.
3. On a scale of 0-5, with 5 exhibiting the most damage from moisture visually estimate the amount of damage caused by moisture on the interior surfaces of each broken prism.

Use at least 1% hydrated lime or anhydrite based material and ensure the design amount results in a tensile stress ratio of at least 85%, and that no visual rating is greater than 1. Provide a mixture that meets all applicable criteria. If tests indicate the need for additives or modifiers not specified in the Contract or a change in source of binder to satisfy mix design requirements, the Contractor will perform the required changes at no additional cost to the Department.

### Table 423.2.8:1
HMA Superpave Design Requirements for Aggregates with Less Than 3.0% Absorption

<table>
<thead>
<tr>
<th>20-year design ESALs (a)</th>
<th>N initial</th>
<th>N design</th>
<th>N max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in (SP-I)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4 in (SP-II)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2 in (SP-III)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4 in (SP-IV)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent Voids in the Mineral Aggregate (VMA) per nominal maximum aggregate size</th>
<th>Voids Filled with Asphalt (VFA) Range, % (c)</th>
<th>Dust to Binder Ratio Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-year design ESALs (a)</td>
<td>12.0–14.0</td>
<td>68.0–75.0</td>
</tr>
</tbody>
</table>

For 1 in nominal maximum size mixtures, the specified lower limit of the VFA will be 70% for the design traffic level <0.3 million ESALs.

---

*In Millions*

*Design Air Void Content of 4%*
### Table 423.2.8:2
HMA Superpave Design Requirements for Aggregates with 3.0% or Greater Absorption

<table>
<thead>
<tr>
<th>20-year design ESALs (a)</th>
<th>N initial</th>
<th>N design (b)</th>
<th>N max (c)</th>
<th>Percent Voids in the Mineral Aggregate (VMA) per nominal maximum aggregate size</th>
<th>Voids Filled with Asphalt (VFA) Range, % (c)</th>
<th>Dust to Binder Ratio Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.3</td>
<td>&lt;91.5</td>
<td>1 in (SP-II)</td>
<td>3/4 in (SP-III)</td>
<td>1/2 in (SP-IV)</td>
<td>70.0–80.0</td>
<td>0.6</td>
</tr>
<tr>
<td>0.3–&lt;3.0</td>
<td>&lt;90.5</td>
<td>&lt;12.0</td>
<td>&lt;13.0</td>
<td>&lt;14.0</td>
<td>65.0–78.0</td>
<td>–</td>
</tr>
<tr>
<td>≥3.0</td>
<td>&lt;89.0</td>
<td>≥14.0</td>
<td>≥15.0</td>
<td>≥16.0</td>
<td>65.0–75.0</td>
<td>1.4</td>
</tr>
</tbody>
</table>

*In Millions

*Design Air Void Content of 3.5%

*For 1 in nominal maximum size mixtures, the specified lower limit of the VFA will be 70% for the design traffic level <0.3 million ESALs.

The State Materials Bureau may allow the Contractor to use a mix design for one year from the date of approval. The Contractor may use or re-submit the design during that time period provided the Contractor submits acceptable evidence to the State Materials Bureau verifying that the component Materials have not changed significantly. Submit a new mix design if changing the source of Materials. Obtain concurrence from the State Materials Bureau before using the new Materials.

### 423.2.8.1 Mix Design Adjustment
See Section 423.3.6.2.1, “Acceptance,” and Section 901, “Quality Control/Quality Assurance (QC/QA).”

### 423.2.9 Job Mix Formula
The JMF will be in accordance with all aggregate gradation requirements and will result in a mix that meets all specified mix design requirements. During production, increase the percentage of hydrated lime or anhydrite based material by 0.2% to account for the effective loss of hydrated lime or anhydrite based material during actual HMA production. The Department will refer to the result of the laboratory mix design developed in accordance with Section 423.2.8, “Mix Design,” as JMF1.

### 423.2.9.1 Job Mix Formula Adjustment
The Contractor may propose adjustments to the JMF in accordance with Section 920.2.2, “Job Mix Formula Adjustments.”

### 423.3 CONSTRUCTION REQUIREMENTS

#### 423.3.1 General
Provide sufficient storage space for each size of aggregate and RAP. Keep the different sizes separate until delivery to the cold feed system feeding the drier. While storing and moving the coarse and fine aggregate, ensure that segregation, degradation, or combination of Materials of different grades does not occur. Re-screen or waste segregated or degraded Material. Provide separate storage and bin feeder for mineral filler if the Contract requires mineral filler. Stockpile aggregates and RAP that contain gravitational water and allow them to drain before mixing. After introducing the required amounts of aggregate, RAP (if used), and asphalt binder into the mixer, mix them until the aggregate particles are completely and uniformly coated with asphalt binder. If the Project Manager determines that excessive
uncoated aggregate exists, take corrective action. Ensure that the moisture content of the HMA at discharge from the mixer does not exceed 0.5%.

423.3.2 Mix Temperature Requirements
Do not allow the temperature of the HMA discharged from the mixer to exceed the target temperature specified in the mix design by more than 20 °F.

423.3.3 Addition of Hydrated Lime or Anhydrite Based Material
Add the hydrated lime or anhydrite based material to the aggregate in an enclosed pug mill immediately after leaving the cold feed and just before introduction into the drier drum or aggregate drier. Minimize the loss of hydrated lime or anhydrite based material when adding hydrated lime or anhydrite based material to the aggregate. Use an enclosed conveyor belt to prevent blowing or loss of hydrated lime or anhydrite based material.

Equip the out feed of the hydrated lime or anhydrite based material silo with a vane feeder and install a flow sensor on the discharge from the vane feeder. Ensure that the sensor activates audible and visual signals at the control panel upon interruption of hydrated lime or anhydrite based material flow.

Equip the hydrated lime or anhydrite based material silo with an approved means of metering the addition of hydrated lime or anhydrite based material to the mix at typical discharge rates with an accuracy of ± 3.0 %, by weight. Approved means of metering hydrated lime or anhydrite based material include load cell weighing devices placed beneath each leg of the silo, or a weigh belt feeder between the silo discharge and the pug mill. Obtain Project Manager approval of other means of metering the addition of hydrated lime or anhydrite based material before use. Do not use external strain gauges affixed to the legs of the silo. If the Contractor uses load cell weighing devices for hydrated lime or anhydrite based material metering, use a cast-in-place concrete foundation pad to support the silo. Place grout between the foundation and the load cells to ensure contact between the load cell and the foundation. Control the hydrated lime or anhydrite based material content within ± 0.2% of the mix design TV.

When mixing the aggregate and hydrated lime or anhydrite based material, maintain the moisture content of the combined aggregate at the recommended saturated surface dry moisture content, plus an additional 1.5 % ± 0.5 %, by weight. The Project Manager may increase the moisture content of the coarse and fine aggregates to properly coat the aggregates with hydrated lime or anhydrite based material and to eliminate dust pollution. Provide a method to measure the amount of moisture added to the hydrated lime or anhydrite based material-aggregate mix. On a daily basis, the Project Manager will record the average amount of added moisture to verify specification compliance.

423.3.4 Equipment
423.3.4.1 Mixing Plants
423.3.4.1.1 Plant Scales
Ensure that the scales are accurate to 0.5% of the maximum allowable load in accordance with the Federal Motor Carrier Safety Administration (FMCSA) publication. A licensed scale serviceman must certify the scales. Submit a copy of the certification to the Project Manager.

423.3.4.1.2 Equipment for Preparation of Asphalt Materials
Provide storage tanks for asphalt binder capable of heating and holding the asphalt at the required temperatures and measuring the temperature of the asphalt in the tank. Use approved heating methods that do not allow flames in contact with the tank. Design the circulating system for the asphalt binder to assure proper and continuous circulation during the operating period. Allow measuring and sampling of asphalt binder from the delivery truck upon arrival.

423.3.4.1.3 Feeder for Drier
Equip the plant with an accurate feeding mechanism to deliver the aggregate into the drier and maintain uniform production and temperature.

423.3.4.1.4 Drier
Equip the plant with a system to continuously agitate the aggregate during the heating and drying process. Use a drier that can dry and heat the aggregate and prevent fuel oil or
carbon from coating the aggregate. Take corrective action if the aggregate becomes coated.

423.3.4.1.5 **Bins**
Equip the plant with storage bins large enough to supply the mixer when it is operating at full capacity. Arrange the bins to ensure separate and adequate storage of the appropriate fractions of the mineral aggregates. When necessary, use separating boards. Provide separate dry storage for hydrated lime or anhydrite based material. Ensure that the gates on the bins do not leak. Equip the bins with warning devices that notify the control panel when the bins are low.

423.3.4.1.6 **Asphalt Binder Control Unit**
Equip the plant with the following:
1. A scale or meter to obtain the proper amount of asphalt binder in the mix, within the allowable tolerances; and
2. A meter for checking the quantity or rate of flow of asphalt binder put in the mixer.

423.3.4.1.7 **Thermometers**
Equip the asphalt feed line, near the charging valve at the mixer unit, with an approved thermometer with a range of from 100 °F to 400 °F. Equip the discharge chute of the drier with an approved thermometer to automatically register the temperature of the heated aggregates or mix, as necessary. Provide the Project Manager with a record of discharge temperatures at the end of each week's production and when requested by the Project Manager during the course of production.

423.3.4.1.8 **Truck Scales**
Weigh the HMA on approved scales (provided by the Contractor) or public scales in accordance with Section 109.1, “Measurement of Quantity.”

423.3.4.1.9 **Requirements for Batching Plants**
423.3.4.1.9.1 **Weigh Box or Hopper**
Provide a batching plant that can accurately weigh aggregate in a weigh box or hopper suspended on scales. Use a weigh box or hopper that can hold a full batch. Ensure that the gate of the weigh box or hopper does not allow material to leak into the mixer while being weighed. Test the scales in accordance with Section 109.1, “Measurement of Quantity.”

423.3.4.1.9.2 **Asphalt Binder Control**
Measure the asphalt binder with equipment accurate to ± 0.3%.

423.3.4.1.9.3 **Mixer**
Provide a batch mixer with a capacity of at least 2,000 lb, capable of producing a uniform mixture within specified tolerances.

423.3.4.1.9.4 **Control of Mixing Time**
Equip the mixer with an accurate timing device that signals the end of the mixing time.

423.3.4.1.10 **Drum Mix Plants**
Equip the drum mix plant with the following auxiliary equipment and capabilities:
1. Separate cold feed controls for each Material;
2. An automatic interlocking device for cold feed, asphalt, and additive;
3. A means for determining moisture content of aggregate so the dry weight of cold feed can be determined for proper setting of asphalt and additive flow. Determine the moisture content of the aggregate at least twice daily and shall adjust the moisture correction equipment accordingly;
4. A means for sampling individual cold feeds and provisions for sequential sampling of aggregate, RAP, asphalt binder, and additives while under full production;
5. Measure the temperature of the mix at the discharge and the automatic burner controls;
6. A surge storage system having a minimum capacity of 40 ton, designed and equipped to prevent segregation. Equip the surge storage system bins with mechanical or electrical devices that provide an audible or visual warning when the bins are less than 1/4 full;
7. Equip the bin containing fine aggregate and filler, if required, with a device that prevents material hang-up during plant operation;
8. A minimum of one cold feed bin for each aggregate fraction in the mix;
9. Equip the cold feed with mechanical or electrical devices that indicate when the bins are empty or when the cold feed belt is not carrying the proper amount of Material. The device shall automatically lock the cold feed belt and provide an audible or visual warning;
10. A separate cold feed for RAP Material. Introduce RAP so that it does not come into direct contact with the burner flame;
11. Equip the feeding mechanism with an individual belt feeder with a variable speed feeder drive controlled by electronically operated actuators. Couple the asphalt feed control with the total-aggregate-weight measurement device to automatically vary the asphalt feed rate to maintain the required proportion.

423.3.4.2 Haul Equipment
Haul asphalt mixtures with trucks that have tight, clean, smooth metal beds and a thin coat (a minimal amount) of a Department-approved release agent to prevent the mixture from adhering to the bed. Do not use diesel fuel as a release agent.

423.3.4.3 Pavers
Use self-contained, self-propelled pavers, with activated screeds or strike-off assemblies, heated if necessary, and capable of spreading and finishing courses of HMA in accordance with the Plans.

423.3.4.4 Compaction Equipment
Provide a sufficient number, weight, and type of rollers to obtain the required compaction and specified pavement density while the HMA is in a workable condition.

423.3.5 Placement Operations
Before placing the HMA, prepare the Subgrade and Base Course as follows:
1. Clean of loose or Deleterious Materials;
2. Free of frozen material; and
3. Meet the moisture and density requirements.

Dump the HMA from the haul Equipment directly into the paving machine or on the paving surface and then load it into the paving machine. Do not dump the HMA more than 250 ft in front of the paving machine or allow the loading Equipment to exert any vertical load on the paver. Pick up and load all of the HMA into the paver. When dumping directly into the paver from haul Equipment, avoid jarring the machine or moving it out of alignment. Coordinate the speed of the paving machine with the production of the plant and keep enough haul Equipment available to achieve continuous operation.

Use the control system on the paving machine to control the elevation of the screed at each end by either of the following methods:
1. One end directly and the other indirectly through controlling the transverse slope; or
2. Each end independently, including screed attachments.

Suspend operations if the control system does not achieve the typical section in accordance with the Plans. Place, spread, and finish the courses of HMA according to the following:
1. Without segregation or tearing (within the specified tolerances);
2. True to the line, grade, and crown in accordance with the Plans; and
3. With self-propelled pavers, except as otherwise directed.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing Equipment impracticable, dump, spread, and level the HMA by other methods to achieve the required compacted thickness.

423.3.5.1 Weather Limitations
Do not place HMA on wet or frozen surfaces or if weather conditions prevent proper handling, finishing, and compacting.
423.3.5.2 Compaction
Compact the HMA thoroughly and uniformly, immediately after placement. Operate rollers at speeds slow enough to minimize displacement of the HMA, including the lines and grades of the asphalt edges. Remove marks from pneumatic rollers and immediately correct any displacement. The Department will not allow the use of Equipment that crushes the aggregate excessively.

Prevent the HMA from sticking to the roller wheels by keeping the wheels moistened with water; water mixed with very small quantities of detergent or other approved Material. Do not use diesel fuel or other petroleum diluents. At locations inaccessible to the rollers, compact the HMA with hot hand tampers, smoothing irons, or mechanical tampers. The Contractor may use a trench roller or cleated compression strips under the roller to transmit compression to depressed areas.

Remove areas that become loose, broken, mixed with dirt, segregated or defective, replace with fresh HMA, and compact to match the surrounding area, at no additional cost to the Department. Immediately correct areas that have excessive or deficient asphalt binder.

423.3.5.3 Miscellaneous Paving
Construct miscellaneous paving in accordance with Section 417, “Miscellaneous Paving.”

423.3.5.4 Joints
Place the HMA as continuously as possible. Do not pass rollers over the unprotected end of a freshly laid mixture. When placing open-graded friction course over HMA, stagger longitudinal joints at least 6 in relative to the longitudinal joints of the underlying course.

Unless otherwise specified, taper transverse and longitudinal joints as follows:
1. At least a 3 ft taper for transverse joints, with a taper slope no steeper than 24:1;
2. At least a 1 ft taper for longitudinal joints, with a taper slope no steeper than 6:1.
3. Cut and square off transverse tapers before commencing new Work;
4. Clean and tack coat longitudinal joints from previous operations.

Completely bond joints. Smooth the surface of each course at the joints. The Department will not allow deviations greater than 3/16 in when tested with a 10 ft straightedge in any direction. When paving under traffic, schedule the daily surfacing operations so that tapered longitudinal joints are not exposed for longer than 7 Days.

423.3.5.5 Surface Tolerances
Smooth the surface of each completed course and prevent deviations larger than 1/8 in using a 10 ft straightedge in any direction. Immediately correct deviations exceeding this tolerance. Provide a final HMA surfacing course that conforms to Section 401, “Pavement Smoothness Measurement.”

423.3.5.6 Plan Surfacing Depths
Monitor and record plan depths, for new or reconstruction projects, throughout the surfacing operations as directed by the Project Manager. If a plan depth is deficient by more than 0.5 in and corrections cannot be applied, submit a corrective action plan to the Project Manager for approval. The Department will pay for the Material in-place or up to the planned pavement thickness.

423.3.6 Sampling and Testing
423.3.6.1 Contractor Quality Control
Administer a Quality Control Plan, referred to hereafter as “the Plan,” to provide a product in accordance with the Contract. The Plan will conform to Section 901.2, “Contractor Quality Control.”
The Plan will do the following:
1. Address elements that affect the quality of the asphalt concrete including, but not limited to, the following:
   1.1. Mix design;
   1.2. Aggregate production;
   1.3. Quality of components;
   1.4. Stockpile management;
   1.5. Proportioning;
   1.6. Mixing, including addition of hydrated lime or anhydrite based material, and/or asphalt additive, if required;
1.7. Transporting;
1.8. Placing and finishing;
1.9. Joints;
1.10. Compaction;
1.11. Smoothness;
1.12. Thickness, when required; and
1.13. Shakedown period.

2. Employ testing personnel who are either under the direct supervision of a TTCP certified technician or who are themselves currently certified to perform the required quality control testing. Provide the Project Manager with a listing of all testing personnel that summarizes their TTCP certifications or, if they are not TTCP certified to perform a particular test, which TTCP certified technician is supervising their testing. Keep the Project Manager notified, by providing an updated listing, of any changes.

Provide testing Equipment that meets all applicable ASTM and AASHTO requirements to accomplish required sampling and testing. Establish a Laboratory for the project separate and distinct from the Department’s Laboratory and quality assurance facilities. Submit verification that all quality control and assurance testing Equipment meets the applicable standards and has been calibrated per the requirements of AASHTO R-18. Remove any Equipment that does not meet the applicable standards or calibration requirements.

Sample and test HMA in accordance with Section 901, “Quality Control/Quality Assurance (QC/QA).” Provide at least two TTCP certified technicians, as follows:

2.1. The Process Control Technician (PCT) is responsible for inspection performed at the crushing operations, hot mix plant and at the Contractor’s field Laboratory. The PCT shall use Laboratory test results and other quality control practices to assure the quality of aggregate sources and other mix components. The PCT shall adjust and control mix proportioning to meet the mix design. The PCT shall be responsible for periodically inspecting all Equipment used in proportioning and mixing to assure its proper operating condition and to assure that proportioning and mixing is in conformance with the mix design and other requirements;

2.2 The QCT is responsible for inspection, sampling, and testing performed at the paving site. The QCT shall ensure that the delivered Materials meet the requirements. The QCT shall be responsible for periodically inspecting all Equipment used in transporting, placing, finishing, and compacting to assure its proper operating condition. The QCT shall assure that placing, finishing, joint construction, compaction, and thickness, when required, are as specified;

3. Define and document the coordination of activities between the PCT and QCT. This shall include the frequency of each type of test, the criteria used by the PCT and QCT to reject or correct unacceptable Materials, and a description of proposed corrective actions;

4. Describe, in detail, the proposed process control and acceptance sampling and testing programs, including the method of determination of random sampling locations. Develop sample locations for acceptance tests so that the center of the sample is at least 12 in from a joint or edge of the pavement layer.

423.3.6.1.1 Contractor Quality Control of Aggregate

Test samples in accordance with Section 910, “Aggregate Index.” Take representative samples after the aggregate Material is combined but before the addition of hydrated lime or anhydrite based material and mixing with asphalt binder. Use these samples to test the following (excluding RAP):

1. Gradation;
2. Minus 200 wash;
3. Plasticity index;
4. Sand equivalent;
5. Fine aggregate angularity;
6. Flat and elongated particles count; and
7. Fractured Face count.

The Department will base the acceptance of aggregates on these test results. The Project Manager may sample and test the aggregate at any time during production or...
423.3.6.1.2 Contractor Quality Control for Compaction

Monitor the compaction process by determining the density of the HMA with a portable nuclear densometer in accordance with ASTM D 2950. Establish calibration of the portable nuclear densometer from cut pavement samples. Determine the density readings of the cut pavement samples in accordance with AASHTO T 166 (weight, volume method) and determine the density readings of the pavement by the portable nuclear densometer in accordance with ASTM D 2950. Correlate these test results. Conduct testing in accordance with Section 901, “Quality Control/Quality Assurance (QC/QA),” and provide test results to the Project Manager. The target density for acceptance of HMA will be 94.50% of the theoretical maximum density as determined from AASHTO T 209. In addition, each individual test value obtained within an acceptance section or sublot shall be from 92% to 96% of the theoretical maximum density. When an individual test result falls outside of this range, the Contractor may perform additional testing to verify the test result, with the Project Manager’s approval. The District Construction Engineer will make the final decision by:

1. Accepting the section or sublot;
2. Determining that a portion of the Material in that section or sublot shall be removed or replaced at no additional cost to the Department;
3. Determining that a portion of the Material in that section or sublot shall be paid for at a 50% pay factor.

For purposes of acceptance and pay factor determination, determine the density from cut pavement sections (cores) with 6-inch diameters extending through the full thickness of the HMA. Determine the theoretical maximum density using an average of the maximum specific gravity values obtained by the Department and the Contractor the day the core’s Material was placed. Obtain and test a minimum of two samples and ensure the Department obtains and tests a minimum of one sample for maximum specific gravity for each day that the HMA is placed. Perform quality control density testing while the asphalt mixture is hot enough to permit further compaction. Do not roll for compaction when it becomes ineffective or damages the HMA. Do not use vibratory mode when the temperature of the mix is below 200 °F.

423.3.6.1.3 Adherence to Specifications and Rejection of Nonspecification Material

The Contractor shall produce Material in substantial compliance with all specification requirements, regardless of whether the requirements are used for acceptance and/or pay factor determination. Evaluation of test results for specification compliance and treatment of Material that does not meet specifications will be done in accordance with Section 920, “Evaluation of Properties for Hot-Mix Asphalt (HMA).” All Material that is rejected shall be removed and replaced with specification Material at the Contractor’s expense.

423.3.6.2 Department Quality Assurance

423.3.6.2.1 Acceptance

The Department will evaluate Materials for acceptance in accordance with this section, Section 901, “Quality Control/Quality Assurance (QC/QA),” and Section 920, “Evaluation of Properties for Hot-Mix Asphalt (HMA).” Sample and test the mixture and pavement on a statistically random basis in accordance with Table 901.7:6, “Minimum Acceptance Guidelines.”

423.3.6.2.1.1 Non-QLA

The Department will evaluate Departmental test results from projects with Bid quantities less than 20,000 tons for specification compliance and treatment of Material that does not meet specifications in accordance with Section 920, “Evaluation of Properties for Hot-Mix Asphalt (HMA).” If the mean of the test results for each property is within the Acceptance Tolerances as listed in Table 423.3.6.2.1.1, “Acceptance Testing Tolerances,” the Material will be accepted at full contract price except that Roadway density will be adjusted in price in accordance with Section 423.5.1.2.1, “Price Adjustment for Roadway Density (Bid Quantities Less than 20,000 Tons).” If the mean of the test results for any of the listed properties is outside of the tolerances as listed in Table 423.3.6.2.1.1, “Acceptance Testing Tolerances,” then the Department will determine acceptance of the Material in accordance with 901.1.3, “Acceptance Sampling and Testing,” and Section 901.5, “Quality Level Analysis.” A composite
pay factor of more than 1.00 is not allowed for projects with Bid quantities less than 20,000 tons. The Department will also consider the quality of the Material produced as placed and the Contractor’s efforts to control the process to provide a quality product. Remove and replace rejected Material with specification Material at no additional cost to the Department.

423.3.6.2.1.2 QLA

On projects with Bid quantities of 20,000 tons or more, the Department will determine acceptance of the Materials in accordance with Section 901.5, “Quality Level Analysis,” using the acceptance limits in Table 423.3.6.2.1.1, “Acceptance Testing Tolerances”:

<table>
<thead>
<tr>
<th>Characteristic (less than 20,000 tons)</th>
<th>Tolerance</th>
</tr>
</thead>
</table>
| Density%                             | 93-96%

*a*All gradation, VMA, and VFA values shall be determined using the AASHTO T 308 testing results.

*b*Shall be determined based on daily tank straps. Obtain the TV from the approved JMF.

*c*The “Nominal Maximum Sieve” for a SP-II HMA gradation shall be the 1-inch sieve, for a SP-III HMA gradation shall be the ¾ in sieve, and for a SP-IV HMA gradation shall be the 1/2 in sieve.

*d*Density payment will be adjusted in accordance with Section 423.5.1.2.1

*e*If Gmm fluctuates more than ±0.03 on a consistent basis, it is recommended that the Specific Gravity of the aggregates be checked in order to verify VMA.

Sample the HMA mixture from behind the paver and determine the asphalt content. Prepare the aggregate gradation of this sample for analysis per AASHTO T 308. Individually calibrate each oven used to perform AASHTO T 308 in accordance with the State Materials Bureau’s, *Ignition Oven Calibration Factors* procedure. If any quality control or quality analysis oven has not been calibrated by this procedure within 5 Days after the start of production of a JMF, the Project Manager will suspend paving operations until calibration of the ovens has been completed at no additional cost to the Department if the oven in question is a quality control oven. If the non-calibrated oven is a quality assurance oven then an equitable adjustment in time will be made for suspension of operations required that is not the fault of the Contractor.

423.3.6.3 Independent Assurance Testing

The Department will perform independent assurance sampling and testing in accordance with Section 901.3, “Independent Assurance Testing.”

423.4 METHOD OF MEASUREMENT

If the Department measures HMA by the square yard, the Department will use the average width of the HMA in place and the length from station to station along the centerline of the Roadway when calculating quantities.

423.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA Complete</td>
<td>Ton</td>
</tr>
<tr>
<td>HMA</td>
<td>Ton or Square Yard</td>
</tr>
</tbody>
</table>
The Department will pay for accepted quantities at the Bid Item Unit Price, adjusted in accordance with Section 423.5.1, “Price Adjustments.”

423.5.1 Price Adjustments

423.5.1.1 Projects with Bid Quantities of 20,000 Tons or Greater

The Department will pay for accepted quantities of HMA at the Bid Item Unit Price, adjusted in accordance with Section 901.5, “Quality Level Analysis.” The Department will pay for HMA in a lot-by-lot basis at a price determined by multiplying the Bid Item Unit Price by the weighting factor. The Department will use Table 423.5.1.1:1, “Weighting Factors,” to calculate the weighting factor.

Table 423.5.1.1:1
Weighting Factors

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>“F” Factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air voids</td>
<td>50</td>
</tr>
<tr>
<td>Hydrated Lime or Anhydrite based Material</td>
<td>5</td>
</tr>
<tr>
<td>Nominal sieve</td>
<td>10</td>
</tr>
<tr>
<td>3/8 in sieve</td>
<td>10</td>
</tr>
<tr>
<td>No. 4 sieve</td>
<td>5</td>
</tr>
<tr>
<td>No. 200 sieve</td>
<td>15</td>
</tr>
<tr>
<td>Voids in the mineral aggregate (VMA)</td>
<td>25</td>
</tr>
</tbody>
</table>

423.5.1.2 Projects with Bid Quantities Less than 20,000 Tons

The Department will pay for accepted quantities of HMA at the Bid Item Unit Price if the mean of the test results for each property is within the testing tolerances as listed in Table 423.3.6.2.1:1, “Acceptance Testing Tolerances.” Pavement density will be adjusted in accordance with Section 423.5.1.2.1, “Price Adjustment for Pavement Density (Bid Quantities Less than 20,000 Tons).” If the mean of the test results for any of the listed properties is outside of the testing tolerances as listed in Table 423.3.6.2.1:1, “Acceptance Testing Tolerances,” then the Department will determine the price adjustment for the Material in accordance with the Department’s Price Reduction Procedures current at the time of the Project letting.

423.5.1.2.1 Price Adjustment for Pavement Density (Bid Quantities Less than 20,000 Tons)

The Department will adjust the Bid Item Unit Price for the HMA pay item (HMA Complete or HMA), based on the Roadway density, in accordance with Table 423.5.1.2.1:1, “Price Adjustments for Pavement Density.” The Department will apply the price adjustments to the HMA pay item for each lot. The Department will base price adjustments on the average of all density tests for the lot.
Table 423.5.1.2.1:1
Price Adjustments for Pavement Density

<table>
<thead>
<tr>
<th>Average Density</th>
<th>Pay factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 98.00</td>
<td>a</td>
</tr>
<tr>
<td>97.00 – 98.00</td>
<td>90</td>
</tr>
<tr>
<td>96.00 – 96.99</td>
<td>95</td>
</tr>
<tr>
<td>95.00 – 95.99</td>
<td>100</td>
</tr>
<tr>
<td>94.00 – 94.99</td>
<td>102</td>
</tr>
<tr>
<td>93.00 – 93.99</td>
<td>100</td>
</tr>
<tr>
<td>92.00 – 92.99</td>
<td>95</td>
</tr>
<tr>
<td>91.00 – 91.99</td>
<td>90</td>
</tr>
<tr>
<td>90.00 – 90.99</td>
<td>80</td>
</tr>
<tr>
<td>&lt; 90.00</td>
<td>a</td>
</tr>
</tbody>
</table>

*aRemove and replace these lots, unless the District Construction Engineer agrees in writing that it is in the best interest of the Department to accept the lot at 50% of the Bid Item Unit Price.*
450.1 DESCRIPTION
This Work consists of constructing PCCP in one course on a prepared Subgrade or Base Course.

450.2 MATERIALS
Portland cement, air-entraining admixtures, chemical admixtures, mineral admixtures, water, and aggregate will meet the requirements of Section 509, “Portland Cement Concrete Mix Designs.”

450.2.1 Dowels and Tie Bars
Dowels and tie bars will meet the applicable requirements of Section 540, “Steel Reinforcement.”

450.2.2 Joint Sealing Material
Joint sealing Material will meet the requirements of Section 452, “Sealing and Resealing Concrete Pavement Joints.”

450.2.3 Curing Compound
Use curing compound that complies with the requirements of AASHTO M 148 for Class 2, Type 1-D or Type 2 pigmented curing compounds.

450.2.4 Sheet Materials for Curing and Protecting Concrete
Sheet materials for protecting concrete will meet the requirements of AASHTO M 171. The Contractor shall only use the white reflective type.

450.3 CONSTRUCTION REQUIREMENTS
450.3.1 Proportioning
Use a Class F concrete mix that has been approved by the State Concrete Engineer. If the concrete is not slip-formed, an approved Class AA concrete mix will be used instead of Class F.
Mix and place all concrete in accordance with Section 510, “Portland Cement Concrete.”
Use a concrete mix that has been approved for use in the Freeze-Thaw zone, as defined in Section 509.2.8.2, “Freeze-Thaw Risk Zones” in which the project is located.
Keep a copy of the approved mix design available on the jobsite when using the concrete mix.

450.3.2 Equipment
450.3.2.1 Batching Plant
Use batching plants and Equipment that meet the requirements of Section 510.3.2.1, “Batching Plant.”

450.3.2.2 Mixers
Use mixers that meet the requirements of Section 510.3.2.6, “Mixing.”

450.3.2.3 Transporting
Use truck mixers, truck agitators or non-agitating trucks that comply with Section 510.3.3, “Transporting.”

450.3.2.4 Slip-Form Paver
Place the concrete with an approved slip-form paver designed to spread, consolidate screed, float, and finish the concrete in one complete pass to create a dense and homogeneous pavement. Minimize the use of hand finishing.
The vibrators of the slip-form paver must be located behind the auger.
 Equip slip-form pavers with internal vibrators that meet or exceed the following specifications at 10,000 cycles per minute under no-load conditions:
1. Amplitude (peak to peak) = 0.070 in; and
2. Centrifugal force = 1,200 lb
Equip the slip-form paver with an electronic monitoring device capable of the following:
3. Displaying the operating frequency of each internal vibrator;
4. Continuously recording at a minimum the following:
   4.1 Time of day;
   4.2 Station location;
   4.3 Paver track speed; and
   4.4 Operating frequency of each vibrator.

Store all information captured by the electronic monitoring system throughout the project. This information is to be used only for project information by the Department, and will be provided to the Project Manager at his request during the course of the project and at the completion of the project.

Position the vibrators no further apart than the manufacturer’s recommendations for horizontal spacing; but do not exceed 18 in, center-to-center. Ensure that the space from the outer edge of the pavement to the center of the outside vibrator does not exceed 9 in, or 1/2 of the maximum recommended spacing, whichever is less.

450.3.2.5 Concrete Jointing Equipment

Provide enough sawing Equipment or joint insertion Equipment to complete the Work within the allotted time. The Contractor may use a water-cooled diamond edge saw blade, an abrasive wheel, an "early entry dry cut" type with a skid plate, as defined by ACI 302 or a control joint insertion system approved by the State Materials Bureau.

450.3.2.6 Curing Compound Application Equipment

Apply curing compounds with Equipment that uses a pressure tank or pump. Ensure that the Equipment has a feed tank agitator that provides continuous agitation of the compound during spraying operations. Use a nozzle that contains enough air to thoroughly atomize the compound.

450.3.3 Operations

For slip-form paving, construct the Subgrade of sufficient width to accommodate the slip-form Equipment.

Provide enough lateral support to construct the section in accordance with the Contract. Maintain the smoothness and compaction of the Base Course in the specified condition until the concrete placement is completed.

Moisten untreated aggregate base layer, if used, before paving.

450.3.3.1 Handling, Measuring, Batching, and Mixing Materials

Handle, measure, batch, and mix the Materials in accordance with Section 510, “Portland Cement Concrete.” The maximum mixing time for either truck mixers or non-agitating mixers is specified in Section 510.3.4.2, “Mixing Time.”

450.3.3.2 Placing, Spreading, and Compacting Concrete

Place concrete with the specified thickness along the full width of the lane or area being paved. Prevent segregation and minimize redistribution. Place the concrete continuously between transverse joints without using intermediate bulkheads.

When using dowel baskets, do not end-dump the concrete directly onto the dowel baskets. The Contractor may use end-dumps to transfer the concrete to the Equipment designed to place it completely across the grade. Do not windrow the concrete.

If using mechanical dowel bar inserters, the final alignment and location of the dowels shall be within +/- 1/2 in of the specified alignment. Confirm with ground-penetrating radar, magnetic or ferro-magnetic detection Equipment, or other method previously approved by the State Materials Bureau.

When placing concrete adjacent to a newly constructed PCCP lane, do not operate Equipment or traffic on the lane until the concrete has achieved a compressive strength of at least 3,000 psi, as determined by the Maturity Method, as described in Section 510.3.5.2, “In-Place Concrete Strength Measurements.”

When working on existing pavement, use Equipment with protective pads on crawler tracks or rubber-tire wheels. Set the crawler tracks or rubber-tire wheels far enough from the pavement edge to prevent damage to the pavement.
450.3.3.2.1 Slip-Form Paving

Use a slip-form paver that complies with Section 450.3.2.4, “Slip Form Paver” to distribute the concrete uniformly. Vibrate the full width and depth of the concrete to produce maximum consolidation without segregation. Ensure that the vibration produces uniform concrete that will stand normal to the surface with sharp well-defined edges.

Vary the vibration frequency proportionately to the rate of travel to create a non-segregated cross-section with uniform density and air content.

Coordinate concrete mixing, delivering, and spreading operations in order to provide uniform progress and to eliminate stopping and starting the paver. If it is necessary to stop the paver, also stop the vibratory and tamping elements immediately. Do not apply external tractive force to the machine; the machine must be self-propelled.

450.3.3.2.2 Other Paving

For paving operations that are not slip formed, the Contractor will place Class AA concrete pavement between stationary side forms. Compact the concrete by internal vibration and finish it to the required surface smoothness using the hand-float method or other suitable means. Cure the concrete with approved methods.

Leave wood or metal forms in place at least 12 h after placing the concrete. If necessary, take additional efforts to prevent thermal cracking of the concrete. Clean and oil the forms each time they are used. Apply a curing compound to the concrete surfaces exposed by removal of the forms immediately after removing the forms.

Check the form’s alignment and grade elevations and make the necessary corrections before placing the concrete. If a form is disturbed or if the Base Course under a form becomes unstable, reset and recheck the form, as directed by the Project Manager.

450.3.3.3 Temperature and Weather Limitations

Refer to Section 511.3.3, “Temperature and Weather Limitations.”

450.3.3.4 Rate of Evaporation Limitations

Continuously monitor the evaporation potential at a height not to exceed 5 ft above the surface of the concrete as determined from Figure 512.3.8.2:1, “Surface Evaporation from Concrete” at the actual placement location. Computerized Equipment can be used for this purpose, if the Equipment has been pre-approved by the State Materials Bureau before the placement. Take a reading at least once every 5 min beginning at least 15 min before the placement begins, and continuing until the final application of the curing compound has been completed.

Do not place (or continue to place) PCCP if the average evaporation potential over any 10 min period of time is greater than 0.2 lb per square foot per hour. If the evaporation exceeds the maximum allowable, the following actions can be attempted to reduce the rate of evaporation to below the specified rate, as approved by the Project Manager:

1. Use an evaporation retarder (If used, this cannot be used as a finishing aid);
2. Erect windbreaks to reduce the wind velocity over the concrete surface;
3. Place concrete during nighttime or early morning hours;
4. Lower the fresh concrete temperature during hot weather by using cool aggregate and chilled water, by adding ice as part of the mixing water, or by adding liquid nitrogen to the concrete mix after all mix ingredients have been placed into the ready mix truck;
5. Increase the relative humidity at the site with a fog spray maintained over the entire concrete surface until the final finish has been achieved and the curing system has been applied.

450.3.3.5 Change in Atmospheric Conditions

Repair or replace concrete damaged due to weather conditions, as determined by the District Construction Engineer, at no additional cost to the Department.

450.3.4 Joints

Submit a joint layout plan to the Project Manager for review and approval at least 28 Days before starting concrete slab construction. The Department’s Pavement Design Section will either approve or reject the submittal within 14 Days from the date of submittal. Construct joints at the locations, intervals, and dimensions specified in the Contract, and seal them in accordance with Section 452, “Sealing and Resealing Concrete Pavement Joints.”
is recommended that the spacing between joints not exceed 24 times the thickness of the concrete. However, the spacing between joints can not be greater than 15 ft, and the maximum length to width ratio for the resulting slab is 1.5:1. Ensure there are no re-entrant corners. Avoid tapered corners; if a tapered corner is formed, place a control joint at:

1. One-half the distance between the end of the taper and the opposite side, if the base leg is less than or equal to 10 ft and longer than 5 ft; or
2. Third points along the base leg, if the base leg is longer than 10 ft.

Construct joint faces perpendicular to the PCCP surface.

Install dowels at any joints added to control cracking in exactly the same way as the standard joints.

Construct transverse and longitudinal contraction joints by inserting control joints while the concrete is still plastic, or by sawing the freshly hardened concrete as soon as possible after placing it. Make transverse contraction and longitudinal joints in two-phases. Make the initial saw cut or inserted joint wide enough and deep enough to ensure that a sufficiently weakened cross-section exists. Make the second sealant reservoir-shaping saw cut in accordance with the details shown in the Plans. Do not damage the steel reinforcement with any saw cut.

The Contractor will take whatever actions are necessary to prevent all uncontrolled cracks in the concrete.

Change saw blades (and the skid plates, when using the early entry dry cut method) as often as required to control and minimize spalling.

Saw joints sequentially. However, the Contractor may saw control transverse joints at intervals shown in the Contract, or at an interval that will most effectively minimize the possibility of uncontrolled cracking.

If necessary, perform the sawing operations day and night, regardless of weather conditions. Do not saw a joint if a crack occurs at or near the joint location before sawing. Immediately discontinue sawing of a joint when a crack develops ahead of the saw. Immediately repair damage to the concrete resulting from the sawing operations after the sawing is completed at no additional cost to the Department.

450.3.4.1 Longitudinal Joints

Place tie bars perpendicular to the longitudinal joints using approved Equipment, or secure the joints with chairs or other approved supports. Do not place tie bars within 15 in of transverse joints. Only paint or coat tie bars, if it is necessary to repair the corrosion-resistant coating.

Use a two-part threaded tie bar and splice coupler system, or bend the tie bars, unless otherwise directed by the Project Manager. Only bend tie bars made of Grade 60 steel. Bend tie bars at right angles against the form of the first lane constructed and then straighten them into final position before placing the concrete of the adjacent lane.

If construction of PCCP abuts existing pavement, drill the holes at mid-depth of the thinner slab. Drill the face of the existing PCCP to accept half of the tie bar length. Ensure that the drill holes are a diameter that provides a close fit for the tie bars to be epoxied into the drill holes. Construct joints with tie bars as shown on the Plans.

450.3.4.2 Transverse Joints

Construct transverse contraction joints with load transfer devices (dowels). Hold dowels in position parallel to the surface and centerline of the slab with chairs or other approved supports. Submit shop drawings of welded dowel assemblies for approval. Do not place concrete until the Department approves the welded dowel assemblies.

Ensure that the dowels remain properly aligned and in the proper locations before and during the placing procedures.

Lightly and uniformly coat each dowel along its full length with an approved form release agent. Do not use grease to lubricate the dowels.

Create transverse contraction joints in the surface of the pavement with an approved saw or joint insertion system.

450.3.4.3 Transverse Construction Joints

Make construction joints with approved corrosion resistant dowels. Use a dowel size and spacing that is adequate for the joint.

If construction of PCCP abuts existing pavement, drill the holes at mid-depth of the thinner slab. Drill the face of the existing PCCP to accept half of the dowel length.
Do not construct a transverse construction joint within 10 ft of a contraction joint or weakened plane. If concrete placement stops, the final slab must measure at least 10 ft. If the final slab is less than 10 ft, remove the excess concrete to the preceding joint.

Prevent uncontrolled structural cracking and loss of pavement durability by whatever means necessary, including but not limited to placing construction joints or contraction joints wherever necessary.

450.3.5 Finishing

After the concrete has been discharged from the truck, no additional water will be added to the concrete.

Provide a final surface finish that complies with the project requirements for IRI, measured in accordance with Section 450.3.5.2, “Surfacing Smoothness Requirements.”

Correct pavement edge slumping (exclusive of specified edging) in excess of 1/4 in before the concrete hardens. If edge slump exceeds 1/2 in within 10 ft, or less, of hardened concrete, replace the entire panel between the transverse and longitudinal joints.

Before the concrete’s initial set, work the edges and joints with approved tools to produce a well-defined and continuous radius with a smooth and dense mortar finish. Minimize disturbance of the slab surface during finishing operations.

Thoroughly clean the sawed area and, after completion of the sawing process, seal the joint immediately.

Give the pavement a final wearing surface by tining or grooving as required in the Contract. Perform grooving and grinding in accordance with Section 455, “Diamond-Grinding and Diamond-Grooving of Portland Cement Concrete Pavement.”

Stamp the concrete surface near the right-hand edge of the panel at the start and end of paving each day, indicating the date, month, and year of placement.

Stamp the concrete surface at 500 ft intervals near the right-hand edge of the pavement indicating the Roadway station.

450.3.5.1 Protection of Fresh Concrete

Protect the fresh concrete from storm events.

450.3.5.2 Surfacing Smoothness Requirements

Test the longitudinal smoothness of the PCCP finished surface in each through traffic lane and passing lane with an approved profilometer, in accordance with Section 401, “Pavement Smoothness Measurement.”

The Department will exclude the following locations from the profilometer measurement. Evaluate them using a straightedge in accordance with Section 401, “Pavement Smoothness Measurement.”

1. Horizontal curves with a centerline radius of curvature less than 1,000 ft and the super elevation transition to such curves; and
2. Shoulders, ramps, tapers, holding lanes, turn-outs, medians, concrete pavement slab removal and replacement, intersections not paved integrally with the mainline, and other non-mainline pavement.

450.3.5.3 Straightedge Measurements

Measure the surface of PCCP not subject to profilometer measurements using an approved 10 foot straightedge at both right angles and parallel to the centerline. Correct surface deviations greater than 1/4 in within 10 ft.

450.3.6 Curing

Immediately after completing finishing operations and as soon as possible after the concrete is placed, cure the entire surface of the newly placed concrete by applying an approved curing system.

450.3.6.1 Application of Curing Compound

Before placing the curing compound in the spray tank, thoroughly agitate it with compressed air, or other approved means, until the pigments in the original container are uniformly suspended. Do not dilute or alter the curing compound.

Place the curing compound directly into the spray tanks from the manufacturer’s original containers bearing the manufacturer’s name, brand, and lot number.

If, because of cold temperature, the curing compound becomes too viscous for proper
stiffening or application, or if portions of the curing compound have been precipitated from solution, follow the manufacturer’s recommendations to restore proper fluidity.

Apply curing compound to the entire area of the exposed concrete surface with an approved mechanical spray machine. Protect the fog spray from the wind with an adequate shield and apply uniformly until it completely covers the entire surface without gaps or openings in the coverage, at an application rate equal or greater than the minimum rate recommended by the manufacturer. Provide the actual rate of application to the Project Manager. Immediately reapply the curing compound over any control joints that were cut through previously applied coatings of curing compound.

Do not apply the curing compound during or immediately after rainfall. If it becomes necessary to leave the pavement uncoated, cover the pavement with plastic sheeting material and leave in place until weather conditions are favorable for applying the curing compound.

If rain falls on freshly applied curing compound before it has dried enough to resist damage, or if the surface is otherwise damaged, apply an additional coat of curing compound.

Protect the applied curing compound areas from automobile and pedestrian traffic for at least 7 Days or the concrete has achieved an in-place compressive strength of 3000 psi as determined by the Maturity Method, in accordance with Section 510.3.5.2, “In-Place Concrete Strength Measurements.”

450.3.6.2 Use of Sheeting Materials

When chosen, place sheeting Materials over the pavement immediately after completing finishing operations.

Place the sheeting so that individual sheets overlap at least 24 in. Weigh down the overlapped areas with earth or boards to prevent movement by the wind. Extend the sheeting to completely cover the edges of the pavement, and the surface of the Subgrade to a distance of at least 12 inches beyond the edge of the pavement and secure them to the Subgrade with a continuous bank of earth or surfacing Material.

Protect sheeting from damage and keep in place for at least 7 Days or until the compressive strength has reached 3000 psi, as determined by the Maturity Method, in accordance with Section 510.3.5.2, “In-Place Concrete Strength Measurements.” Immediately patch holes in the sheeting.

450.3.7 Grooving of PCCP

450.3.7.1 Tining

When tining, use a mechanical device such as a wire broom or comb having a single row of tines 1/8 inch +/-1/64 in width. The depth of groove in the plastic concrete shall be 1/8 in +/-1/16.

Perform the tining operation at such time and manner that the desired surface texture will be achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Where a butting pavement is to be placed, the grooving shall extend as close to the edge as possible without damaging the edge. If abutting pavement is not to be placed, the 6 in area nearest the edge or 1 ft from the face of the curb shall not be grooved. All uniform width slabs of 20 ft or narrower and less than 600 ft in length, as well as mainline and ramp pavement during Equipment breakdowns, may be grooved by hand methods.

450.3.7.1.1 Transverse Tining

The tines shall be randomly spaced from 3/8 in to 1 5/8 in with no more than 50% of the spacing exceeding 1 in. Leave a 4 in to 6 in wide un-tined strip of pavement surface centered over each transverse joint.

450.3.7.1.2 Longitudinal Tining

The tines shall be uniformly spaced at 3/4 in intervals. Use Equipment with horizontal and vertical controls to ensure straight, uniform depth grooves. A 2 in to 3 in wide strip of pavement surface shall be protected from longitudinal surface grooving for the length of and centered over the longitudinal joint.
450.3.7.2 Diamond Grooving

When diamond grooving, allow concrete to cure, but no sooner than 48 hours, groove the surface of the concrete in accordance with Section 455, “Diamond-Grinding and Diamond-Grooving of Portland Cement Concrete Pavement.”

450.3.8 Protections from, and Opening to, Traffic

Protect new pavement against public traffic and operational and employee traffic. Provide personnel to direct traffic. Erect and maintain warning signs, lights, pavement bridges, or crossovers in accordance with the Contract’s traffic control requirements. Do not open to traffic for at least 7 Days or until the concrete has reached a compressive strength of 3,000 psi as determined by the Maturity Method, in accordance with Section 510.3.5.2, “In-Place Concrete Strength Measurements.”

Clean the pavement of loose materials and debris before opening to traffic.

450.3.9 Sampling and Testing

450.3.9.1 Contractor Quality Control

Prepare a quality control plan that complies with Section 901.2, “Contractor Quality Control.”

Ensure the plan addresses all elements that affect the quality of the PCCP, including:

1. Mix designs;
2. Aggregate production;
3. Quality of components;
4. Stockpile management;
5. Batching;
6. Mixing;
7. Transporting;
8. Placing;
9. Vibration and consolidation;
10. Finishing;
11. Joints;
12. Smoothness; and
13. Thickness.

Ensure the plan identifies personnel responsible for sampling and testing of PCCP, and how to contact them at any time. Ensure that qualified sampling and testing personnel perform PCCP sampling and testing in accordance with Section 901, “Quality Control/Quality Assurance (QC/QA).” Provide at least two qualified technicians, as follows:

14. The PCT is responsible for performing inspection, at the concrete batching facility and at the Contractor’s field Laboratory. The PCT shall use Laboratory test results and other quality control practices to assure the quality of aggregate sources and other mix components, and adjust and control mix proportioning to meet the mix designs. The PCT shall periodically inspect Equipment used in proportioning and mixing to assure its proper operating condition and to assure that the Contractor performs proportioning and mixing in accordance with the mix design and other requirements;

15. The QCT is responsible for inspection, sampling, and testing at the paving site. The QCT shall assure that the delivered Materials comply with the requirements of the Contract. The QCT shall periodically inspect Equipment used to transport, place, and finish the concrete to assure its proper operating condition, and to assure that the Contractor provides a final constructed product in accordance with the Contract.

The plan must coordinate and document the activities of the PCT and QCT. This includes the frequencies for each test, the criteria to reject or correct unsatisfactory Materials, and a description of when and how to take corrective actions. Ensure the plan details the sampling and testing programs, including methods to determine and apply random sampling locations. Perform sampling and testing in accordance with Table 901.7.3, “Minimum Process Control Guidelines, Aggregates and Base Courses,” and Table 901.7.5, “Minimum Process Control Guidelines, Portland Cement Concrete Pavement.”
450.3.9.2 Department Quality Assurance

450.3.9.2.1 Acceptance

Sample and test the material on a statistically random basis in accordance with Section 901, “Quality Control/Quality Assurance (QC/QA).” See Table 901.7:6, “Minimum Acceptance Guidelines,” for acceptance guidelines. The Department will determine acceptance in accordance with Section 901.5, “Quality Level Analysis,” using Table 450.3.9.2.1:1, “Acceptance Limits.”

Table 450.3.9.2.1:1
Acceptance Limits

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification limits, from TV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrained air (from approved mix design)</td>
<td>± 1.5%</td>
</tr>
<tr>
<td>Compressive strength (from approved mix design)</td>
<td>± 1,000 psi</td>
</tr>
<tr>
<td>Thickness (from Project Specifications)</td>
<td>± 1 in/-1/4 in.</td>
</tr>
</tbody>
</table>

Unless otherwise provided in the Contract, TVs for acceptance shall be as follows:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Target Air Content from Mix Design</th>
<th>Target strength from mix design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrained air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressive strength</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness</td>
<td>Nominal Plan thickness +1 in</td>
<td></td>
</tr>
</tbody>
</table>

450.3.9.3 Independent Assurance Testing

The Department will perform independent assurance sampling and testing in accordance with Section 901.3, “Independent Assurance Testing.”

450.4 METHOD OF MEASUREMENT—Vacant

450.5 BASIS OF PAYMENT

The Department will adjust the Concrete Pavement Bid Item Unit Price in accordance with Section 901.5, “Quality Level Analysis.” The Department will pay for Concrete Pavement on a lot-by-lot basis at a price determined by multiplying the Bid Item Unit Price by the weighting factor. The Department will use Table 450.5:1, “Weighting Factors,” to calculate the weighting factor.

Table 450.5:1
Weighting Factors

<table>
<thead>
<tr>
<th>Measured characteristic</th>
<th>Factor “f” (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrained air</td>
<td>50</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>50</td>
</tr>
<tr>
<td>Thickness</td>
<td>50</td>
</tr>
</tbody>
</table>

Pay Item: Concrete Pavement Pay Unit: Square Yard
SECTION 451: PORTLAND CEMENT CONCRETE PAVEMENT

451.1 DESCRIPTION
See Section 450.1, “Description.”

451.2 MATERIALS
See Section 450.2, “Materials.”

451.3 CONSTRUCTION REQUIREMENTS
451.3.1 Proportioning
See Section 450.3.1, “Proportioning.”

451.3.2 Equipment
See Section 450.3.2, “Equipment.”

451.3.3 Operations
See Section 450.3.3, “Operations.”

451.3.4 Joints
See Section 450.3.4, “Joints.”

451.3.5 Finishing
See Section 450.3.5, “Finishing.”

451.3.6 Curing
See Section 450.3.6, “Curing.”

451.3.7 Grooving of PCCP
See Section 450.3.7, “Grooving of PCCP.”

451.3.8 Protection from, and Opening to, Traffic
See Section 450.3.8, “Protection from, and Opening to, Traffic.”

451.3.9 Sampling and Testing
451.3.9.1 Contractor Quality Control—Vacant
451.3.9.2 Department Quality Assurance
451.3.9.2.1 Acceptance

The Department will accept the finished pavement, with respect to strength, in accordance with Section 510.3.4.3, “Concrete Sampling and Testing.” The Department will accept the finished pavement, with respect to thickness, based on test areas less than 2,400 yd2 in size, randomly selected by the Project Manager. The Department will make thickness determinations using cores located in a random pattern with at least two cores in each test area. The Contractor shall complete corrective work in accordance with Section 450.3.5.2, “Surfacing Smoothness Requirements,” before the Department determines pavement thickness.

The Department will accept test areas when an average of the cores is not less than 1/4 in from the required thickness, and when any core is not less than 3/4 in from the required thickness.

451.3.9.3 Independent Assurance Testing
The Department will perform independent assurance sampling and testing in accordance with Section 901.3, “Independent Assurance Testing.”

451.4 METHOD OF MEASUREMENT—Vacant

451.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Pavement __ in</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

The Department will only pay for the average thickness of pavement in accordance with the Plans.

The Department considers dowels, tie bars, joint Materials, and required coring, including filling the core holes with concrete, incidental to the Work in accordance with Section 452, “Sealing and Resealing Concrete Pavement Joints.”

451.5.1 Price Adjustments
451.5.1.1 Thickness

The Department will apply price adjustment for concrete pavement with deficient
thickness based on a structural engineering analysis conducted by the Department that will determine the percent loss of traffic carrying ability based on the original design ESAL.

451.5.1.2 **Strength**
   See Section 510.3.5.5, “Price Adjustments.”

451.5.1.3 **Final Adjustment in Bid Item Unit Price per Lot**
   When test results allow price adjustments, the resultant adjustment will be cumulative.
SECTION 452: SEALING AND RESEALING CONCRETE PAVEMENT JOINTS

452.1 DESCRIPTION
This Work consists of cleaning, priming, and sealing concrete pavement joints. This Work also consists of removing joint sealant, sawing, cleaning, priming, and resealing joints. Seal only joints between adjacent portland cement concrete surfaces. Seal joints between PCCP and asphalt pavement in accordance with Section 411, “Hot-Poured Crack Sealant,” unless otherwise shown on the Plans.

452.2 MATERIALS
452.2.1 Sealant
Joint sealant Material will either be a Type NS or SL single component silicone formulation meeting the requirements of ASTM D 5393 or a single component low modulus polyurethane formulation meeting the requirements of ASTM C 920 and Table 452.2.2:1, “Polyurethane Sealant Physical Requirements.”

Provide a qualified manufacturer’s representative on the project for at least the first day of sealant application. Prepare and seal the joints in accordance with proper procedures approved by the manufacturer’s representative.

Obtain the manufacturer’s written verification of primer, backer, and sealant compatibility.

452.2.2 Certification
For each lot of sealant applied to concrete pavement joints, the Contractor shall provide certified test results in accordance with ASTM D 5893 or ASTM C 920 and Table 452.2.2:1, “Polyurethane Sealant Physical Requirements,” except as otherwise provided in the Contract.

Provide sealant test results and verification that the product is currently within the manufacturer’s recommended shelf life to the Project Manager at least 10 Days before sealant installation. Certification will show areas of primer use.

Table 452.2.2:1 Polyurethane Sealant Physical Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Stress, 150% Elongation, 21 Day cure @ 77°F and 45 – 55% R.H., psi</td>
<td>ASTM D 412 Die C</td>
<td>150 - 200</td>
</tr>
<tr>
<td>Tack-Free Time, h, maximum</td>
<td>ASTM C 679</td>
<td>2 - 6</td>
</tr>
<tr>
<td>Adhesion &amp; Cohesion under cyclic movement</td>
<td>ASTM C 719</td>
<td>Pass</td>
</tr>
<tr>
<td>Artificial Weathering</td>
<td>ASTM C 793</td>
<td>Pass</td>
</tr>
<tr>
<td>Weight (mass) Loss, %, maximum</td>
<td>ASTM C 792</td>
<td>10</td>
</tr>
<tr>
<td>Ozone and U.V. Resistance</td>
<td>ASTM C 793</td>
<td>Note 1</td>
</tr>
<tr>
<td>Movement Capability and Adhesion</td>
<td>Note 2</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: The sealant shall show no chalking, cracking, or bond loss after 250 hours.

Note 2: The sealant shall show no adhesive or cohesive failure after 10 cycles of ± 50% of joint width with the rate of extension or compression being no greater than 1/8-in per hour.

452.2.3 Bondbreaker
The bondbreaker is a round closed cell, nonabsorbent material compatible with the sealant Material, that is at least 1/8 in larger in diameter than the width of the joint being sealed. If primer is required, ensure that no adverse reaction occurs between the bondbreaker and sealant or primer.
452.3 CONSTRUCTION REQUIREMENTS

452.3.1 General
Repair damage to the pavement surface, at no additional cost to the Department. Perform these repairs to the concrete surfaces before beginning sealing operations, as directed by the Project Manager.

Dispose of old sealant materials in accordance with Section 107, “Legal Relations, Environmental Requirements, and Responsibility to Public.”

452.3.2 Temperature and Weather Limitations
Perform joint sealing or resealing only under the following conditions:
1. The air and pavement temperatures are 40 °F or higher;
2. The pavement temperature is above the dew point;
3. The pavement and joint faces are dry and frost free; and
4. Weather conditions are dry.

452.3.3 Resealing Operations
Saw the transverse and longitudinal joints to the specified width, depth, and configuration.

452.3.4 Joint Preparation
Use a router to follow the path of random cracks and widen the top of the crack to the required section.
Sandblast joints and clean with compressed air.
Provide a 1 in wide border of clean, dry, newly exposed concrete before applying the bondbreaker and sealant at the joint and adjacent pavement.
Use cleaning wands that provide compressed air with at least 100 psi of pressure at the outlet nozzle. Ensure that the compressed air is free of oil and moisture.

452.3.5 Sealant Application
Apply the sealant according to the manufacturer’s recommendations, unless otherwise specified and approved by the Project Manager. Obtain Project Manager approval of the manufacturer’s sealant application instructions before beginning Work.
Place the bondbreaker to maintain the specified depth of the sealant Material.
Provide a finished joint seal surface that is concave and 1/4 in ± 1/8 in below the surface of the concrete pavement.
The Project Manager will cease operations if the Contractor seals joints inconsistently. Correct inconsistencies in joint sealing operations and remove and replace non-conforming sealant at no additional cost to the Department.

452.4 METHOD OF MEASUREMENT—Vacant

452.5 BASIS OF PAYMENT
Pay Item Pay Unit
Sealing Concrete Pavement Joints Linear Foot
Resealing Concrete Pavement Joints Linear Foot
SECTION 454: CRACKING AND SEATING CONCRETE PAVEMENT

454.1 DESCRIPTION
This Work consists of cracking and seating existing portland cement concrete pavement.

454.2 MATERIALS—Vacant

454.3 CONSTRUCTION REQUIREMENTS

454.3.1 Equipment
Use impact hammers capable of cracking the pavement’s full depth. Equip the breaker with a plate-type shoe or use one designed to prevent penetration, spalling, and shattering of the existing surface, use other Equipment approved by the Project Manager. Do not use a headache, drop ball, or whip hammer.
If required, provide a screen to protect vehicles in the adjacent lane from flying chips during the cracking process.
Use pneumatic tire rollers that weigh a minimum of 50 ton.

454.3.2 Cracking Operations
Before cracking the concrete, remove existing asphalt patches. Before cracking, the Project Manager will designate test sections. Crack the test sections using varying energy and striking patterns to establish an optimum pattern for cracking the pavement. Wet the pavement surface test section to determine the extent and pattern of cracking.
Use the established pattern to crack the pavement on the remainder of the project, provided the cracked pavement continues to meet the specified size requirements. Adjust the energy and striking pattern as directed by the Project Manager. Wet pavement surfaces at least once an hour to determine the extent and pattern of cracking.
Crack the existing concrete pavement so that the dimensions of the majority of pieces of pavement are from 18 in to 24 in, with a maximum dimension of 30 in. Ensure that 80% of pavement pieces are smaller than 24 in. The Project Manager will determine the adequacy of pavement breakage.
Perform cracking one lane at a time with an impact hammer.
Prevent damage to underground utilities, drainage facilities, Bridge approach slabs, and Bridge decks. Repair damage at no additional cost to the Department.

454.3.3 Seating Operations
After cracking the concrete pavement, clean the surface of loose and spalled concrete and foreign material.
Roll the cracked concrete with a pneumatic tire roller within 24 h before overlaying with HMA until it is well seated and thoroughly and uniformly compacted. Crack slab sections (that do not seat well under the roller) into smaller sections and roll them again. The Project Manager will determine when the pavement is properly cracked and seated.
The Department will allow traffic on the cracked pavement before overlaying. When routing traffic over the cracked pavement, ensure the pavement’s condition is satisfactory to carry the traffic.

454.4 METHOD OF MEASUREMENT—Vacant

454.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cracking and Seating Concrete Pavement</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>
455.1 DESCRIPTION
This Work consists of diamond-grinding and/or diamond-grooving PCCP, and includes the removal of slurry and residue resulting from the Work.

455.2 MATERIALS—Vacant

455.3 CONSTRUCTION REQUIREMENTS

455.3.1 Equipment
Use power-driven, self-propelled machines equipped with diamond blades specifically designed to grind, groove, and texture PCCP. Ensure the grinder has a depth control device to detect variations in the concrete surface and adjust the cutting head height to maintain the depth of the specified groove. Equip the grinding machine with alignment control devices. Ensure the Equipment grinds and grooves the pavement surface to the specified smoothness tolerances and textures, without causing excessive raveling of the joints or cracking or fracturing of the aggregates.

455.3.2 Grinding and Grooving Operations
Begin and end longitudinal grinding and grooving at lines normal to the pavement centerline, unless otherwise specified in the Contract.

Grind designated areas until the pavement surfaces on both sides of transverse joints and cracks are on the same plane. Ensure that grinding produces a uniform finished surface, eliminates joint or crack faults, and provides positive lateral surface drainage by maintaining a constant cross-slope within the grinding limits of each lane.

Grind auxiliary or ramp lane transitions from the mainline edge to provide positive drainage and an acceptable riding surface.

Make grooving patterns in accordance with Section 512.3.10.3, “Grooving of Hardened Concrete,” unless otherwise specified in the Contract.

455.3.3 Slurry Removal
Continuously remove the slurry from the Work.
Do not allow the slurry to flow across lanes open to traffic or into gutters or other drainage facilities.

455.3.4 Final Surface Finish
Produce a pavement surface in accordance with Section 450.3.5.2, “Surfacing Smoothness Requirements.”

Ensure the texture has parallel longitudinal corrugations that present a narrow ridge corduroy-type appearance. Make the peaks and grooves approximately 0.08 in apart in elevation. Make the grooves from 0.08 in to 0.16 in wide, and the peaks from 0.08 in to 0.12 in wide. Determine the appropriate number of grooves per yard to produce the specified surface requirements.

455.3.5 Acceptance
Inspect transverse joints and random cracks to ensure that adjacent surfaces are in the same plane. Regrind as directed by the Project Manager, at no additional cost to the Department.

455.4 METHOD OF MEASUREMENT
The Department will measure the Diamond Grinding and Diamond Grooving of Portland Cement Concrete Pavement actually ground or grooved on the top width and length of the pavement if paid by the unit. If no Bid Item exists for Diamond Grinding and Diamond Grooving of Portland Cement Concrete Pavement, payment will be incidental to Section 450, “Portland Cement Concrete Pavement (QLA)” or Section 451, “Portland Cement Concrete Pavement”, as applicable.
### 455.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
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<td>Diamond Grinding of PCCP</td>
<td>Square Yard</td>
</tr>
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<td>Diamond Grooving of PCCP</td>
<td>Square Yard</td>
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501.1 DESCRIPTION
The Work consists of providing and placing bearing piles, including splicing additional pile lengths and cut-offs.

501.2 MATERIALS

501.2.1 Standards

Provide Materials in accordance with Table 501.2.1:1, “Applicable Pile Standards.”

<table>
<thead>
<tr>
<th>Material description</th>
<th>Standard</th>
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<td>Structural Steel piles and columns (HP)</td>
<td>ASTM A 36/A 36 M</td>
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<tr>
<td>Backing rings for steel pipe pile splices</td>
<td>ASTM A 252, Gr. 3</td>
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<td>End plate for closed end pipe piles</td>
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<td>Portland cement concrete, Class G</td>
<td>Section 509, “Portland Cement Concrete Mix Designs.”</td>
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<tr>
<td>Precast pre-stressed concrete piles</td>
<td>Section 518, “Pre-Stressed Concrete Members.”</td>
</tr>
<tr>
<td>Paint</td>
<td>Section 544, “Protective Coating of New Structural Steel.”</td>
</tr>
</tbody>
</table>

*Continuous spiral weld pipe will not be used.

501.2.2 Piles

501.2.2.1 Steel Piles

Use no more than one field splice to make steel piles that are from 30 ft to 80 ft long. Use no more than two field splices to make steel piles longer than 80 ft. The minimum acceptable splice length is 6 ft. Do not use more than two splices per steel pile. The Department will not accept camber and sweep more than the mill tolerance.

501.2.2.2 Precast Pre-stressed Concrete Piles

Manufacture pre-cast pre-stressed concrete piles in accordance with Section 518, “Pre-Stressed Concrete Members.” Provide the piles without field splices.

501.2.2.3 Pile Splices

Provide Materials in accordance with Table 501.2.1:1, “Applicable Pile Standards.” Use prefabricated splices only when specified. If the Contract requires additional length due to inadequate bearing, construct splices in accordance with Section 501.3.5.5, “Splices.”

501.2.3 Submittals

Submit the following to the Project Manager:

1. Three certified copies of MTRs for the following:
   1.1 Structural Steel piles;
   1.2 Pipe columns;
   1.3 Steel pipe piles and pipe pile columns;
   1.4 Splice plates;
   1.5 Backing rings;
   1.6 End plates;
   1.7 Pipe shoes;
   Indicate heat numbers on test reports and on each pile provided.
2. Welder Certification in accordance with Section 541, “Steel Structures,” sufficient for welding field splices and end plates;
3. Class G concrete mix design approved by the State Concrete Engineer in accordance with Section 509, “Portland Cement Concrete Mix Designs;”
4. Pre-cast pre-stressed concrete piles certification and testing in accordance with Section 518, “Pre-Stressed Concrete Members;”
5. Paint certification in accordance with Section 544, "Protective Coating of New Structural Steel."

501.2.3.1 Pile Driving Equipment Submittals

Submit pile driving Equipment information to the Project Manager 30 Days before beginning pile driving. Submit the information on the Department’s Pile and Driving Equipment Data Form. Provide information required on the form including the following:

1. Pile hammer make, model number, and serial number;
2. Driving head assembly, type, model number, and weight;
3. Hammer cushion, material, size, and thickness; and
4. Pile cushion, material, size, and thickness.

The Department has 10 Days to accept or reject the proposed pile driving Equipment after the Project Manager receives the Pile and Driving Equipment Data Form. Acceptance will be in accordance with Section 501.3.1.4, “Approval of Driving System.”

If the Department rejects the Equipment, modify or replace the pile driving Equipment and revise and resubmit the form. The Department will have 7 Days to accept or reject the revised Pile and Equipment Data Form.

Submit the manufacturer’s chart showing stroke and blows per minute when proposing the use of open-end (single-acting) diesel hammers.
Submit a chart equating bounce chamber pressure and hose length to either equivalent energy or stroke when proposing use of closed-end (double-acting) diesel hammers. Specify hose lengths for closed-end hammers. Calibrate the chart to atmospheric pressure based on the project site elevation to the nearest 1,500 ft elevation.
Submit a chart equating the plant operating pressure to the equivalent delivered energy of the hammer, including losses in the hose, when proposing the use of double acting or differential acting air/steam hammers. Calibrate the chart to atmospheric pressure based on the project site elevation to the nearest 1,500 ft elevation.
Submit a certificate of calibration to the Project Manager for the pressure gauge required for double acting hammers. Provide certificate of calibration from a National Institute of Standards and Technology traceable Laboratory performed no more than six months before use.

501.3 CONSTRUCTION REQUIREMENTS

501.3.1 Equipment

501.3.1.1 Pile Hammers
Use steam, air, diesel, or hydraulic hammers for driving piles. Only use gravity hammers where specified for use in dynamic testing of drilled shafts.

501.3.1.1.1 Steam and Air Hammers
Provide the plant and Equipment with pressure gages that are easily accessible to the Inspector. Use air and steam hammers with striking parts that weigh at least 1/3 the weight of drive head and pile or 2,750 lb, whichever is more.

501.3.1.1.2 Diesel Hammers
Use open-end diesel hammers that allow the Inspector to see the hammer stroke during pile driving operations, unless accompanied by a saximeter stroke measurement device.
Use closed-end diesel hammers equipped with a bounce chamber pressure gauge, mounted with a hose long enough for the Inspector to read.

501.3.1.1.3 Hydraulic Hammers
Use hydraulic hammers equipped with a digital display of delivered hammer energy for each stroke. Provide certification of hammer energy measurement read-out to the Project Manager.

501.3.1.2 Driving Apparatus

501.3.1.2.1 Hammer Cushion
Equip impact pile driving Equipment (except gravity and hydraulic hammers) with hammer cushion material to prevent damage to the hammer or pile and to ensure uniform driving. Use hammer cushions made in accordance with the hammer manufacturer’s guidelines. Do not use wood, wire rope, or asbestos hammer cushions. Place a manufacturer-recommended striker plate on the hammer cushion to ensure uniform
501.3.1.2.2 Drive Head

Equip impact hammer driven piles with a steel drive head to distribute the hammer blow. Align the drive head axially with the hammer and the pile. Ensure that it is guided by leads and not free-swinging.

Use a drive head that fits around the pile head to maintain the proper alignment of the hammer and pile and not transfer the torsional forces during driving. Cut pile heads squarely. Provide a drive head insert to fit the pile type and dimensions, as recommended by the hammer manufacturer.

For pre-cast concrete and pre-stressed concrete piles, use a pile head that is perpendicular to the longitudinal axis of the pile to prevent eccentric impacts.

501.3.1.2.3 Pile Cushion

Before driving, place a plywood pile cushion that is at least 4 in thick on the pile head. Greater thicknesses may be required if the Wave Equation Analysis (per Section 501.3.2.1.1, “Wave Equation Analysis”) or dynamic testing (per Section 501.3.2.1.2, “Dynamic Formula”) determines that the pile compressive or tensile stresses are unacceptable.

501.3.1.2.4 Leads

While being driven, support piles in line and position with leads. Construct pile driver leads to allow the hammer free movement while maintaining alignment of the hammer and the pile to ensure concentric impacts.

Do not extend the pile section being driven above the leads. Embed the leads in the ground or restrain by a rigid brace to maintain alignment. Ensure that the leads are long enough to make a follower unnecessary, and design the leads to permit alignment of batter piles.

Use fixed or swinging leads. Fit swinging leads with a pile gate at the bottom. For batter piles, use a horizontal brace between the crane and the leads.

501.3.1.2.5 Pile Extensions

Do not use followers. Where required and approved by the State Geotechnical Engineer, use an extra length pile with splices and ensure that the leads are of adequate length so that followers will not be required. After cut-off, undamaged extra length pile may be re-used as a production pile.

501.3.1.2.6 Templates

Use securely anchored heavy metal templates to maintain pile positions when driving a pile bent.

501.3.1.2.7 Pre-Boring Equipment

Use pre-boring Equipment in accordance with Section 501.3.3.2, “Pre-Boring.”

501.3.1.2.8 Inspection Equipment

Provide and use Equipment to illuminate the entire interior length of pipe piles after they are driven.

501.3.1.3 Minimum Manufacturer’s-Rated Hammer Energy

Unless the Contract specifies a minimum hammer energy, use a manufacturer-rated hammer at or above the appropriate minimum energy level corresponding to the required ultimate pile capacity in accordance with Table 501.3.1.3.1, “Required Hammer Energy.”
501.3.1.3.1 Required Hammer Energy

Table 501.3.1.3.1:1

<table>
<thead>
<tr>
<th>Ultimate Pile Capacity (Kips)</th>
<th>Minimum Manufacturer’s Rated Hammer Energy (Ft - lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 225</td>
<td>22,500</td>
</tr>
<tr>
<td>226 – 350</td>
<td>30,000</td>
</tr>
<tr>
<td>351 – 400</td>
<td>37,500</td>
</tr>
<tr>
<td>401 – 450</td>
<td>42,500</td>
</tr>
<tr>
<td>≥ 451</td>
<td>Wave Equation Analysis required</td>
</tr>
</tbody>
</table>

501.3.1.4 Approval of Driving System

The State Geotechnical Engineer will approve the driving system. The driving system includes the hammer and driving apparatus proposed on the Department’s Pile and Driving Equipment Data Form. Transporting the driving system to the project site before it is approved will be done at the Contractor’s risk.

The State Geotechnical Engineer will approve the driving system based on the following:

1. The driving system meets the requirements of Sections 501.3.1.1, “Pile Hammers,” and 501.3.1.2, “Driving Apparatus;”
2. The manufacturer’s rated hammer energy meets or exceeds the minimum hammer energy requirements established in Section 501.3.1.3, “Minimum Manufacturer’s-Rated Hammer Energy;”
3. The Wave Equation Analysis indicates that the expected driving resistance (required ultimate capacity) can be achieved at less than 10 blows per inch;
4. The Wave Equation Analysis indicates that the pile stresses will not exceed the allowable stresses at the expected driving resistance (required ultimate capacity) as indicated in Table 501.3.1.4.1:1, “Wave Equation Analysis Allowable Driving Stress;”
5. When dynamic tests are specified in accordance with Section 504, “Load Testing of Bearing Piles,” and acceptance of the hammer system is based on the measured energy transfer efficiency in accordance with Section 501.3.4, “Variations of Approved Driving Systems.”

Table 501.3.1.4.1:1

Wave Equation Analysis Allowable Driving Stress

<table>
<thead>
<tr>
<th>Description</th>
<th>Maximum stress*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steel piles</strong></td>
<td></td>
</tr>
<tr>
<td>Compressive stress</td>
<td>90% of yield strength (0.90 $F_y$)</td>
</tr>
<tr>
<td><strong>Concrete piles</strong></td>
<td></td>
</tr>
<tr>
<td>Compressive stress</td>
<td>85% of the compressive strength* minus the effective pre-stress $(0.85 F'c - $effective pre-stress$)$</td>
</tr>
<tr>
<td>Tensile stress</td>
<td>$(3\sqrt{F'c + effective pre-stress})$</td>
</tr>
</tbody>
</table>

*If the pile stresses determined by Wave Equation Analysis exceed the allowable stresses, the Department may approve the hammer system if a heavier pile section approved by the State Geotechnical Engineer is substituted. If necessary, provide heavier piles at no additional cost to the Department.

If the pile stresses determined by Wave Equation Analysis exceed the allowable stresses, the Department may approve the hammer system if additional static or dynamic testing is performed and verifies that pile driving resistances will produce stresses in the pile within acceptable ranges. Perform additional testing at no additional cost to the Department.

Compressive strength at 28 Days.

501.3.2 Driven Pile Capacity

The ultimate pile capacity will generally be the design load of the pile multiplied by an appropriate safety factor, unless specified otherwise. The safety factor depends on the specified pile testing and the specified method for monitoring the pile capacity. Determine safety factors in accordance with Table 501.3.2.1:1, “Safety Factors for Driven Piles,” unless other wise specified.
### Table 501.3.2.1: Safety Factors for Driven Piles

<table>
<thead>
<tr>
<th>Capacity monitoring test method</th>
<th>Method</th>
<th>Safety factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static load test</td>
<td>Wave Equation Analysis</td>
<td>1.90</td>
</tr>
<tr>
<td>Dynamic load test</td>
<td>Wave Equation Analysis</td>
<td>2.25</td>
</tr>
<tr>
<td>None performed</td>
<td>Wave Equation Analysis</td>
<td>2.75</td>
</tr>
<tr>
<td>None performed</td>
<td>Dynamic Formula</td>
<td>3.50</td>
</tr>
</tbody>
</table>

In some cases, the required ultimate pile capacity shown may be higher than the service pile design load multiplied by the specified factor of safety. In these cases, the required ultimate pile capacity includes resistance to be encountered penetrating unsuitable layers in addition to the actual design load, multiplied by the specified safety factor.

#### 501.3.2.1 Determination of Pile Capacity with Impact Hammer

##### 501.3.2.1.1 Wave Equation Analysis

The State Geotechnical Engineer will determine the ultimate pile capacity based on a Wave Equation Analysis. Drive piles to the required resistance based on the operating energy of the hammer. The Pile Driving Acceptance Chart will indicate the resistance criteria.

Obtain pile penetration by achieving the Wave Equation resistance criteria in accordance with Section 501.3.5.2, “Minimum Penetration Elevation,” and Section 501.3.5.3, “Estimated Penetration Elevation.” If the predicted pile penetration varies from the Plan length by ± 25% or more, the State Geotechnical Engineer will perform a revised Wave Equation Analysis in accordance with Section 501.3.4.2, “Revised Wave Equation Analysis.”

##### 501.3.2.1.2 Dynamic Formula

Use the dynamic formula to determine ultimate pile capacity only if specified or approved by the State Geotechnical Engineer. Drive piles to the depth necessary to obtain the ultimate pile capacity according to the following equation and in accordance with Section 501.3.5.2, “Minimum Penetration Elevation”:

\[
R_u = 1.75 \sqrt{E \log_{10}(10N)} - 100
\]

where

- \( R_u \) is the ultimate pile capacity in kips;
- \( E \) is the manufacturer’s hammer energy in ft-lbs, at the ram stroke observed in the field;
- \( N \) is the number of hammer blows per 1 in at final penetration.

#### 501.3.3 Preparation for Driving

##### 501.3.3.1 Abutment Piles

Unless otherwise shown, and before driving the abutment bearing piles, place and compact the approach Embankment Material underneath and adjacent to the abutment to the required density. After compaction, ensure that the surface of the approach Embankment is not lower than the elevation of the bottom of the abutment.

##### 501.3.3.2 Pre-Boring

If specified, pre-bore holes at pile locations to the depths and size in accordance with the Plans. If the Contract does not specify pre-bored, but the State Geotechnical Engineer approves the use of pre-bored holes, drill the holes to the depth established by the State Geotechnical Engineer. Ensure that the depth permits the piles to be driven to the minimum penetration elevation and required bearing capacity without overstress or damage to the piles. Pre-bore holes in the presence of the Inspector. After placing pile, fill voids remaining around the pile with sand or other approved material.
501.3.3.2.1 Obstructions
If the Contractor encounters subsurface obstructions, the Contractor may increase the borehole diameter to the smallest dimension adequate for pile installation. Penetrate obstructions in accordance with Section 502.3.4.2.2, "Obstructions."

501.3.3.2 Rock Sockets
If the Contract requires the Contractor to drive a pile in a rock socket and the bore hole is larger than the diameter of the pile, fill around that part of the pile in solid material with Class G Substructure concrete. Place concrete in accordance with Section 502.3, "Construction Requirements." Fill the part of the pile above the solid material with sand or other suitable material.

501.3.3.2.3 Application of Pre-Bored Holes
Only use pre-bored holes as specified, or when demonstrated to the satisfaction of the State Geotechnical Engineer that a pile cannot be driven to the minimum penetration elevation in accordance with Section 501.3.5.2, "Minimum Penetration Elevation."
The Department will determine the need for pre-bored pile holes based on the following driving resistances:
1. Steel piles: when, in 10 blows, the set is less than 3/4 in with the hammer delivering the minimum energy required;
2. Pre-cast concrete piles: when, in 10 blows, the set is less than 1 in with the hammer delivering the minimum energy as required in the Contract;
3. All piles: if the resistance is sufficient to overstress the pile as indicated by the Wave Equation Analysis Field Acceptance Chart for the approved hammer system.

501.3.3.2.4 Diameter of Pre-bored Holes
The State Geotechnical Engineer will establish the diameter of pre-bored holes. In general, the diameter established will be as shown in Table 501.3.3.2.5:1, "Diameter of Pre-Bored Holes in Soil," or Table 501.3.3.2.5:2, "Diameter of Pre-Bored Holes in Rock, Shale, or Conglomerate."

501.3.3.2.5 Temporary Casing
Temporary casing may be required if the soil sloughs or caves into the hole or if a hole is required to be kept dry from groundwater, such as socketed holes into shale. Increase the diameter of the drilled hole as necessary to place the temporary casing. Pull the casing after driving the pile and after the hole is backfilled with the appropriate Material.

<table>
<thead>
<tr>
<th>Table 501.3.3.2.5:1 Diameter of Pre-Bored Holes in Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pile type</td>
</tr>
<tr>
<td>Cylindrical concrete piles</td>
</tr>
<tr>
<td>Square concrete piles</td>
</tr>
<tr>
<td>H-piles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 501.3.3.2.5:2 Diameter of Pre-Bored Holes in Rock, Shale, or Conglomerate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pile type</td>
</tr>
<tr>
<td>Cylindrical concrete and pipe piles</td>
</tr>
<tr>
<td>Square concrete piles and H-piles</td>
</tr>
</tbody>
</table>

501.3.3.3 Pile and Hammer Cushion Preparation
Before the drive head is attached, make the pile heads plane and perpendicular to the longitudinal axis of the pile. Protect pre-cast concrete pile heads with a pile cushion in accordance with Section 501.3.1.2.3, "Pile Cushion." Provide a new pile cushion for each pre-cast concrete pile. Replace the pile cushion if it is either compressed more than one-half of the original thickness or begins to burn during driving.

Inspect the hammer cushion with the Inspector present when beginning pile driving at each Structure or after each 100 h of pile driving, whichever is less. If the hammer cushion thickness is reduced by more than 25% of the original thickness, replace the cushion before
501.3.3.4 Conditions to Proceed
The Contractor shall not drive production piles until it meets the following conditions:
1. The State Geotechnical Engineer approves the driving system in accordance with Section 501.3.1.4, “Approval of Driving System;”
2. The Inspector completes the **Pile Driving Field Inspection Form** and the Project Manager approves it;
3. All required load testing is complete as specified and in accordance with Section 504, “Load Testing of Bearing Piles;”
4. The **Pile Driving Acceptance Chart** is complete by the State Geotechnical Engineer and submitted to the Project Manager;
5. The hammer and leads are aligned with the pile plan in vertical or battered position; and
6. The Inspector is present before beginning operations.

501.3.4 Variations of Approved Driving Systems
Only use the approved pile driving system. Submit a new **Pile and Driving Equipment Data Form** to the Project Manager for variations to the approved driving system. The Project Manager will notify the Contractor of acceptance or rejection within 72 h of the receipt of the data form. The time required for submission, review, and approval of a variation in the driving system will not constitute a basis for a Contract Time extension.

501.3.4.1 Variations Due to Dynamic Testing
The State Geotechnical Engineer will reject the hammer if the hammer is unable to transfer sufficient energy to perform the dynamic testing in accordance with Section 504, “Load Testing of Bearing Piles.” Reasons for rejection include pre-ignition from overheating or malfunctioning of the injection system and poor hammer or capblock maintenance. After rejection, repair or replace the hammer.

501.3.4.2 Revised Wave Equation Analysis
The Department will perform a revised Wave Equation Analysis to establish revised driving resistance criteria when the following conditions occur:
1. Variations in the driving system;
2. Pre-boring not originally specified in the Contract is used to facilitate pile penetration; or
3. The pile penetrations are considerably more or less than that estimated in the Contract.

Do not drive piles until the Project Manager receives the revised Pile Acceptance Chart.

501.3.5 Pile Driving Operations
Approval of a pile hammer relative to allowable driving stresses will not relieve the Contractor of responsibility for damaged piles for the following reasons:
1. Misalignment of the leads;
2. Failure of capblock or cushion material;
3. Failure of splices;
4. Malfunctioning of the pile hammer; or
5. Other improper construction methods.

If the State Geotechnical Engineer determines that damage caused by one of the above reasons impairs the pile strength, or questions the measured resistance, replace the piles at no additional cost to the Department.

Schedule pile driving to prevent vibrations and pressure from damaging piles or other in-place concrete structural components that have reached their initial set, but that do not have sufficient strength to resist damage.

Replace the hammer cushion and pile cushion when necessary in accordance with Section 501.3.3.3, “Pile and Hammer Cushion Preparation,” to avoid excessive compression or damage.

501.3.5.1 Pile Measurement and Recording
Ensure that the first pile driven at each Substructure element is accessible so the Inspector can measure and mark the pile in 12-inch increments. On the first pile driven, the
Inspector will record blows per 12 in of penetration until the pile tip is within 6 ft of the specified penetration elevation or until the pile begins to set up, whichever comes first. Then, the Inspector will measure and record the penetration in inches per 10 or 20 blows, as directed by the State Geotechnical Engineer, until the Contractor achieves the specified set.

501.3.5.2 Minimum Penetration Elevation
If the Contract specifies a “Minimum Penetration Elevation” and the driven piles do not develop the required ultimate bearing capacity at that elevation, the Contractor shall continue driving the piles until the required resistance is obtained. If the piles develop a set, determined in accordance with Section 501.3.3.2.3, “Application of Pre-Bored Holes,” before the pile tip reaches the minimum penetration elevation, the Contractor shall perform drilling to prevent damaging the pile while driving to the minimum penetration elevation.

501.3.5.3 Estimated Penetration Elevation
If the Contract specifies an estimated penetration elevation, drive the piles to the required ultimate capacity. If the piles attain the required resistance above the estimated penetration elevation, terminate driving and the Department will accept the piles at the shallower penetration.

501.3.5.4 Pile Groups
If driving multiple rows of piles for pile cap foundations, drive the piles to the estimated or minimum penetration elevation, before determining pile capacity for acceptance. After driving the piles in the group to the required tip elevation, re-strike to determine the pile ultimate capacity. If the piles do not develop the required ultimate bearing capacity at that elevation, continue to drive until the required resistance is attained.

501.3.5.5 Splices
Ensure that steel pile splices are in accordance with Section 541, “Steel Structures.” Make splices for closed-end pipe piles watertight.

Use the cement dowel method to make splices for pre-cast concrete piles unless the State Geotechnical Engineer approves an alternate splice detail. Select mechanical splices for concrete or steel piles from the Department’s Approved Products List.

501.3.5.6 Cut-Off Lengths
Cut off the tops of all permanent piles at the elevation shown or as directed. Remove the cut off lengths from the project.

501.3.5.7 Filling Closed-End Pipe Piles
After driving closed-end steel-pipe piles, inspect for water or other Deleterious Material inside the piles. Remove water and foreign substances from inside the piles. After the Project Manager approves the piles, fill them with Class A concrete with a 4-inch to 6-inch slump. Place the concrete in accordance with Section 502.3.4.4, “Concrete Placement.”

501.3.5.8 Filling Open-End Pipe Piles
After driving open-end steel pipe piles, inspect for water inside the piles. If water is present, place pea gravel in the pile to an elevation of three feet above the water level. If the Project Manager approves the piles, fill them with Class A concrete with a 4 in to 6 in slump. Place the concrete in at least the upper 5 ft of the piles in accordance with Section 502.3.4.4, “Concrete Placement.”

501.3.6 Pile Acceptance

501.3.6.1 Pile Load Capacity and Penetration
Drive piles to the required ultimate capacity as determined by the specified capacity monitoring method in accordance with Section 501.3.2, “Driven Pile Capacity.”

If specified, install piles to the penetration elevation in accordance with Section 501.3.5.2, “Minimum Penetration Elevation.”

501.3.6.2 Location and Alignment Tolerances
Do not pull laterally on piles to correct misalignment or splice a properly aligned section on a misaligned section to meet tolerances.
501.3.6.2.1 Trestle and Abutment Beam Piling
Drive trestle piling and abutment beam piling with a maximum variation of 1/4 in per foot from the vertical or batter shown, with the pile varying no more than 3 in from the Plan position at any point along its length.

501.3.6.2.2 Foundation Piling
Drive foundation piling capped below grade with a maximum variation of 1/4 in per foot from the vertical or batter shown, with the tops of the piles at cut off elevation varying no more than 3 in from the Plan position.

501.3.6.2.3 Edge Distance
Do not place piles within 9 in of an edge of a cap or beam. Increase the size of the cap or beam to meet this edge distance requirement at no additional cost to the Department.

501.3.6.2.4 Pile Orientation
Ensure that H-piles do not rotate more than 30° out of Plan orientation of the strong axis and weak axis of the pile shown.

501.3.6.2.5 Pile Tops
Cut off the tops of piles perpendicular to the longitudinal axis of the pile or to a specified bevel, and within the specified tolerance.

501.3.6.3 Damaged Pile Limitations
The Department will reject damaged piles based on the following criteria:
1. Piles that are broken, cracked, or split;
2. Pre-cast concrete piles that show signs of crushing and spalling of the concrete, splitting, or visible cracks that affect the strength or service life of the pile;
3. Steel piles bent or deformed during installation and exceed mill tolerances for sweep and camber; or
4. Closed-end pipe piles that show evidence of groundwater infiltration, or breaks or deformation that would impair the strength of the completed piles.

501.3.6.4 Correcting Rejected Piles
Correct piles damaged during driving because of internal defects or improper driving with methods approved by the Project Manager, at no additional cost to the Department.

If the Contractor exceeds the location or alignment tolerances, and the State Geotechnical Engineer determines that corrective measures are necessary, the Contractor shall design and construct corrective measures at no additional cost to the Department. The State Geotechnical Engineer will approve the design.

Corrective methods may include the following:
1. Removing and replacing the pile with a new, and when necessary, longer pile;
2. Driving additional piles next to the defective piles; or
3. Extending the footing to properly embed the pile.

501.4 METHOD OF MEASUREMENT

501.4.1 Pile Extensions
The Project Manager will include any approved extension lengths in the pile measurement.

501.4.2 Driven Piles
The Department will measure Driven Piles below the cut-off elevation to the nearest foot.

501.4.3 Pile Cut-Offs
The Department will calculate Pile Cut-Offs to the nearest foot by subtracting the total lengths of the in-place piles (after cut-off) from the total Plan lengths.

501.4.4 Pre-bored Holes for Bearing Piles
The Department will only measure that portion of Pre-Bored Holes for Bearing Piles below the Plan grade elevation. The Department will not measure that portion of pre-bored holes drilled through soil or rock layers (overburden) that the Contractor later excavates.
501.4.5 Pile Splices

The Department will measure Pile Splices required for piles driven deeper than the estimated penetration elevation to achieve the required ultimate capacity. The Department will only measure up to two splices per pile.

501.5 BASIS OF PAYMENT

The Department will only pay for two Pile Splices per pile if it was necessary for the Contractor to make those splices in order to drive the piles beyond the specified penetration elevation to meet the required resistance.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driven Piles (type)</td>
<td>Foot</td>
</tr>
<tr>
<td>Pre-bored Holes for Bearing Piles, ___ in diameter</td>
<td>Foot</td>
</tr>
<tr>
<td>Pile Splices</td>
<td>Each</td>
</tr>
<tr>
<td>Pile Shoes</td>
<td>Each</td>
</tr>
<tr>
<td>Pile Cut-Offs</td>
<td>Foot</td>
</tr>
</tbody>
</table>

501.5.1 Work Included In Payment

The following work will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

A. Extra length pile used as a follower;
B. Material and backfill placement for prebored holes for bearing piles, including Class G concrete in rock sockets;
C. Temporary casing and oversizing of prebored holes to accommodate temporary casing;
D. Steel reinforcement required in steel pipe piles filled with concrete;
E. Furnishing and driving pile to replace piles which were previously accepted by the Project Manager and are subsequently damaged through improper handling, driving, or construction operations prior to completion of the contract;
F. Increases to the contract quantity of prebored holes for bearing piles which are not called for in the contract, but are approved by the State Geotechnical Engineer, will be paid for at a negotiated unit price per foot as established by the Project Manager;
G. Piles that have been driven or partially driven and are subsequently rejected by the Project Manager and are pulled or left in place;
H. Class A concrete and placement in closed-end pipe piles;
I. Mobilization and time lost due to re-mobilization of new hammer due to poor hammer performance or as determined by dynamic testing;
J. Restriking of piles in pile groups to determine pile capacity.
502.1 DESCRIPTION
This Work consists of constructing drilled shafts. Drilled shaft construction, with or without under-reamed bottoms (“bell bottoms”), includes reinforcing steel placement and concrete.

502.1.1 Work Experience
Demonstrate to the State Geotechnical Engineer that the Contractor is able to perform the Work in accordance with the Contract. Provide evidence of two projects within two years of the Bid date involving drilled shaft construction and use a Superintendent with experience on one of those projects.

502.1.2 Submittals
Submit construction and field designs to the Project Manager for review and approval by the State Geotechnical Engineer.

502.2 MATERIALS
502.2.1 General
Provide Materials in accordance with Table 502.2.1:1, “Applicable Bearing Pile Standards.”

<table>
<thead>
<tr>
<th>Material description</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland cement concrete, Class G</td>
<td>Section 510, “Portland Cement Concrete”</td>
</tr>
<tr>
<td>Reinforcing steel cage</td>
<td>Section 540, “Steel Structures”</td>
</tr>
<tr>
<td>Reinforcing steel HP pile</td>
<td>ASTM A 36/A 36 M</td>
</tr>
<tr>
<td>Permanent steel pipe casing</td>
<td>ASTM A 36/A 36 M</td>
</tr>
</tbody>
</table>

502.2.2 Additional Requirements
502.2.2.1 Concrete
For Class G concrete requirements see Section 509, “Portland Cement Concrete Mix Designs.”

502.2.2.2 Temporary Casings
Provide temporary steel casings with an outside diameter equal to the shaft size in accordance with the Contract. Ensure the casings are smooth, clean, watertight, and of ample strength to withstand both handling and driving stresses, pressures of concrete, and the surrounding soils.

502.2.2.3 Permanent Casings
Provide permanent casing with a wall thickness that is at least the thickness specified for the shaft construction. Provide a greater wall thickness if necessary to withstand handling and installation stresses. The casing dimensions are subject to the American Pipe Institute tolerances applicable to regular steel pipe. If approved by the Project Manager, the Contractor may use casings larger than specified, at no additional cost to the Department.

502.3 CONSTRUCTION REQUIREMENTS
502.3.1 Equipment
502.3.1.1 Excavation and Drilling Equipment
Use excavation and drilling Equipment that can excavate a hole of the specified diameter 20% deeper than what is shown in the Contract. Use excavation Equipment that can complete a flat shaft bottom. Ensure that the cutting edges are normal to the vertical axis of the Equipment within a tolerance of 0.36 in per foot of diameter. Ensure that under-reaming tools do not allow the base diameter to exceed three times the specified shaft diameter. The State Geotechnical Engineer may approve a change in other under-reaming Plan dimensions to accommodate the Equipment. When the State Geotechnical Engineer requires over-reaming of the shaft sidewall, use an over-reaming bucket, grooving tool, or other approved Equipment. Use an over-reaming tool that over sizes the shaft diameter from 0.6 in to 3 in. If the Contractor cannot drill the material with conventional earth augers, the Contractor shall
use special drilling Equipment, such as core barrels, rock tools, blasting materials, and other Equipment, as necessary. Obtain the Project Manager's approval before blasting.

502.3.1.2 Slurry Equipment
Use desanding Equipment to keep the slurry sand content to less than 8% by volume for mineral slurry and less than 1% by volume for polymer slurry. This is required during shaft excavation to maintain mix consistency of the slurry in the shaft. Use slurry tanks for slurry circulation, storage, and treatment. Do not use excavated slurry pits in place of slurry tanks without the written permission of the Project Manager. Use a slurry-sampling tool to conduct the slurry control tests in accordance with Section 502.3.4.1.3.3, “Slurry Control Tests.” Use a slurry sampler consisting of a cable with a weighted cone shaped stopper, a cylindrical sampler center stayed for alignment and a top stopper with a hole drilled through the center for slipping onto the cable.

502.3.1.3 Concrete Placement Equipment
Depending on the type of shaft construction, place the concrete in the excavated shaft with a rigid tremie pipe, a concrete pump line, or a drop chute.

502.3.1.3.1 Tremies
Use a rigid tremie pipe that can deposit concrete at the shaft bottom. Do not use a tremie with aluminum parts that will have contact with the concrete. Ensure the inside diameter is at least 10 in. Ensure the tremie’s inside and outside surfaces are clean and smooth. Ensure that the tremie is watertight. In slurry displacement shafts, use a plug, valve, or bottom plate to separate the concrete from the displacement fluid until the concrete is flowing through the orifice. Ensure that plugs left in the shaft concrete are made of material approved by the Project Manager. Construct the discharge end of the tremie to permit the free radial flow of concrete during placement operations.

502.3.1.3.2 Concrete Pumps and Lines
Use watertight pump lines with a diameter of at least 5 in. Use schedule-40 steel pipe or heavier. Use plugs in accordance with Section 502.3.1.3.1, “Tremies.”

502.3.1.3.3 Drop Chutes
Use rigid-pipe drop chutes that are either one-piece or sectional. Ensure they can be added and removed from a metal hopper. Do not use flexible trunk line hose.

502.3.2 Submittals
Provide the required drilled shaft submittals to the Project Manager for the State Geotechnical Engineer's review and approval. The Contractor may use documented work experience (per Section 502.3.2.1, “Work Experience”) and proposed construction procedure submittals (per Section 502.3.2.2, “Proposed Construction Procedure”) approved on previous Department projects of similar size, difficulty, and geology, in lieu of the detailed submittal requirements listed below.

502.3.2.1 Work Experience
Submit documentation verifying the required work experience in accordance with Section 502.1.1, “Work Experience.” Include the names and phone numbers of references that can verify successful completion of the listed projects.

502.3.2.2 Proposed Construction Procedure
At least 30 Days before the drilled shaft concrete bearing pile work begins, submit a complete written proposal of the construction procedure. The following information is required:
1. Superintendent name and experience record;
2. List of proposed Equipment including: cranes, drills, augers, bailing buckets, final cleaning Equipment, desanding Equipment, slurry pumps, core sampling Equipment, tremies or concrete pumps, casing, etc.;
3. Description of construction operation sequence;
4. Description of shaft excavation methods;
5. Details of mixing, circulating, and slurry desanding methods;
6. Manufacturer and type of apparatus for testing slurry;
7. Description of methods for cleaning the shaft excavation;
502.3.2.3 Review and Approval
The State Geotechnical Engineer will evaluate the proposed construction procedure and will notify the Contractor if additional information is required and changes are necessary within 14 Days after receiving the proposed construction procedure. Procedural approvals are subject to field trial.

502.3.3 Construction Preparations
502.3.3.1 Site and Subsurface Conditions
The Department’s test results and rock core samples are available for examination upon request.

502.3.3.2 Protection of Existing Structures
If specified, submit a preventative-measures plan to the Project Manager, at least 14 Days before the construction of the shaft.

502.3.3.3 Site Preparation
If footings are present, excavate to the footings’ bottom elevation before beginning shaft construction, unless the Contract or Project Manager allows otherwise. If the Contractor drills shafts in conjunction with placing Embankment, the Contractor shall drill the shafts after placing the fill, unless the Contract or Project Manager allows otherwise.

502.3.3.4 Proof Drilled Shafts
Construct a proof drilled shaft, when specified, at the location shown in the Contract. Construct the shaft after the State Geotechnical Engineer approves the Equipment and methods. If specified in the Contract, load test the proof shaft in accordance with the Contract and Section 504, “Load Testing of Bearing Piles.” Drill the shaft to the maximum depth of any production shaft unless otherwise shown in the Contract. Underream the proof shaft to establish the feasibility of under-reaming in a specific soil strata or rock. Fill the proof shaft with concrete in the same way as the production shafts. If the methods and Equipment produce inadequate results, the Project Manager will require the Contractor to demonstrate acceptable results with another proof shaft. Once the proof shaft is approved, construct production shafts using the same means and methods. Do not change the means or methods without written approval from the State Geotechnical Engineer. Cut off the proof shafts 5 ft below finished grade and leave in place. Restore the proof shaft sites to their original condition.

502.3.4 Construction of Drilled Shafts
502.3.4.1 Construction Methods
502.3.4.1.1 Dry Construction Method
The State Geotechnical Engineer will approve the dry construction method when the following occurs:
1. The shaft accumulates less than 12 in of water above the base over a 1 hr period without pumping;
2. The shaft remains stable without caving, sloughing or swelling over a 4 hr period immediately following excavation; and
3. The Contractor can remove loose material and water before inspection and concrete placement.
Use the slurry-displacement construction method or the casing construction method for shafts that do not meet these requirements.
The dry method consists of the following:
4. Drilling the shaft;
5. Removing accumulated water and loose material from the excavation;
6. Placing the reinforcing cage; and
7. Concreting the shaft.
502.3.4.1.2 Casing Construction Method

Use the casing construction method when called for in the Contract or where the dry construction method is inadequate. If necessary, use the casing method combined with the slurry displacement or dry construction method. Place the casing by twisting, driving, or vibrating into the ground before cleaning it out, unless the Contract requires the Contractor to place the casing in a predrilled hole. If the Contractor elects to use casings or shafts larger than those specified the Contractor shall provide the concrete necessary to fill the additional volume, at no additional cost to the Department.

502.3.4.1.2.1 Temporary Casing

The Department will consider subsurface casing to be temporary unless shown as permanent in the Contract. Remove the temporary casing when placing concrete for the drilled shaft when the concrete is in a fluid state. If the Contractor removes a casing or replaces it with a longer or larger diameter, casing through caving soils, the Contractor shall stabilize the excavation with slurry before installing the new casing. Other methods to control the stability of an excavation require approval of the State Geotechnical Engineer. Before withdrawing the casing, ensure that the level of concrete in the casing is at least 10 ft above either the hydrostatic water level or the drilling fluid level, whichever is higher. Maintain a concrete level in the casing as it is removed so that fluid trapped behind it is displaced upward and discharged without contaminating or displacing the shaft concrete. Temporary casings that become bound or fouled during shaft construction, and cannot be practically removed, constitute a defect. Repair defective shafts using one of the following methods without compensation or an extension of contract time:

1. Remove the shaft concrete and extend the shaft deeper to compensate for loss of frictional capacity in the cased zone;
2. Provide straddle shafts to compensate for capacity loss; or
3. Provide a replacement shaft.

502.3.4.1.2.2 Permanent Casing

Make permanent casing continuous from top to bottom. Cut off the permanent casing at the prescribed elevation after installation. Complete the shaft by placing the reinforcing steel and concrete in the casing. If using temporary casings in conjunction with permanent casings, keep the temporary inner casing aligned with the permanent outer casing. Maintain a water-tight seal between the two casings during excavation and concrete placement where an oversized hole or temporary casing is approved by the Project Manager, to aid in the placement of the permanent casing, the exterior annular space outside of the permanent casing shall be postgrouted, such that the direct contact between casing and the surrounding soil/rock is created.

502.3.4.1.3 Slurry Displacement Construction Method

Use the slurry displacement method at sites where maintaining a dry excavation is not possible. Use a mineral or polymer slurry, or water to maintain stability around the hole’s perimeter while advancing excavating, placing the reinforcing cage, and placing concrete. Displace the slurry during final cleaning of the excavation with a bailing bucket, air lift, or submersible pump. Place concrete with a tremie or concrete pump beginning at the shaft bottom. During construction, keep the slurry level in the shaft excavation high enough to prevent caving and at least 5 ft above the highest expected piezometric pressure head along the depth of the shaft. If not using permanent casings, provide temporary surface casings to aid shaft alignment and to prevent sloughing, unless otherwise approved by the State Geotechnical Engineer. If the slurry construction method does not produce the necessary results, discontinue operations and make corrective modifications to the procedures and Equipment.

502.3.4.1.3.1 Polymer Slurry Requirements

Use polymer slurry that will stabilize the hole and inhibit the influx of ground water. Table 502.3.4.1.3.1:1, “Polymer Slurry Requirements, Emulsified or Dry Phpa Polymer,” lists acceptable ranges of values for slurry viscosity and gel.
Table 502.3.4.1.3.1:1
Polymer Slurry Requirements, Emulsified or Dry Phpa Polymer

<table>
<thead>
<tr>
<th>Requirements at time of introduction or before concreting</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (pcf)</td>
<td>62.4 – 64.0</td>
</tr>
<tr>
<td>Viscosity (seconds/quart)</td>
<td>50–120</td>
</tr>
<tr>
<td>pH</td>
<td>8–11.7</td>
</tr>
<tr>
<td>Sand Content (% by volume)</td>
<td>0–1</td>
</tr>
</tbody>
</table>

**Note:** Perform tests when the slurry temperature is above 40 °F.

Premix the polymer slurry according to the manufacturer’s directions. Prevent the slurry from losing the required viscosity and gel characteristics in the shaft. Neutralize expended polymer slurry with bleach and remove from project to a site approved by the Project Manager.

502.3.4.1.3.2 Mineral Slurry Requirements
Use Attapulgite, in lieu of Bentonite, where saline or chemically contaminated groundwater occurs. Use mineral slurry with a grain size that remains in suspension and has sufficient viscosity and gel characteristics to transport excavated material to the screening system. Provide mineral slurry in accordance with Table 502.3.4.1.3.2:1, "Mineral Slurry Requirements, Sodium Bentonite or Attapulgite in Fresh Water."

Table 502.3.4.1.3.2:1
Mineral Slurry Requirements, Sodium Bentonite or Attapulgite in Fresh Water

<table>
<thead>
<tr>
<th>Property (units)</th>
<th>At time of slurry introduction</th>
<th>In hole at time of concreting</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (pcf)</td>
<td>N/A</td>
<td>64.0 – 75.0</td>
<td>Density Balance</td>
</tr>
<tr>
<td>Viscosity (seconds/quart)</td>
<td>28–45</td>
<td>N/A</td>
<td>Marsh Cone</td>
</tr>
<tr>
<td>pH</td>
<td>8–10</td>
<td>8–10</td>
<td>pH paper</td>
</tr>
<tr>
<td>Sand Content (% by volume)</td>
<td>N/A</td>
<td>0–4</td>
<td>API Method</td>
</tr>
</tbody>
</table>

**Note:** Perform tests when the slurry temperature is above 40 °F.

Premix the slurry according to the manufacturer’s directions. Prevent the slurry from “setting up” in the shaft. Dispose of the slurry offsite in accordance with Section 107.14.8, “Disposal of Other Materials and Debris.”

502.3.4.1.3.3 Slurry Control Tests
Perform control tests on the mineral slurry to determine density, viscosity, pH, and sand content. Do not place concrete unless the Inspector has approved the bottom hole test results and after test results show acceptable values. Provide test reports to the Project Manager upon completion of each drilled shaft.

502.3.4.1.3.3.1 Pre-entry Tests
Perform tests to determine viscosity and pH before pumping the slurry into the excavation. Take at least two sets of tests during the first 8 h of slurry processing. Decrease the testing frequency to one set every eight hours when the results are consistent.

502.3.4.1.3.3.2 Bottom Hole Tests
Test slurry samples taken from the shaft base before placing concrete in any shaft excavation. Test until samples produce acceptable values for density, pH, and sand content.

502.3.4.2 Shaft Excavation
Extend drilled shaft tip elevations when the State Geotechnical Engineer determines that the material encountered during excavation is unsuitable. Dispose of materials from the shaft excavation as directed by the Project Manager.
When using vibrating casing, do not place adjacent casings or excavate shafts until 48 h after pour completion of an adjacent shaft, or when concrete from the adjacent shaft pour breaks at least 2,000 psi, whichever comes first. This requirement applies to excavating any shaft within four shaft diameters of another.

502.3.4.2.1 Underream and Overream
Sidewall overreaming is when the State Geotechnical Engineer determines the sidewall has: softened due to excavation methods; swelled due to concrete placement delays; or, degraded because of slurry cake build-up. The State Geotechnical Engineer will direct the thickness and elevation of sidewall overreaming.

502.3.4.2.2 Obstructions
Remove surface and subsurface obstructions. Obstructions may include manmade materials, such as old concrete foundations, or natural materials, such as boulders or nested cobble zones. The Department's Foundation or Geotechnical Report includes the soil boring and rock core information, as well as groundwater conditions present at the time of the field investigation. Use this information to anticipate conditions. When obstructions are encountered, notify the Department Inspector as shown in Section 502.4.3, "Obstruction Removal." Do not allow workers to enter the excavation for any reason unless:

1. Suitable casing is installed;
2. The water level is lowered and stabilized; and
3. Safety Equipment is provided to workmen entering the excavation.

502.3.4.2.3 Soil Samples and Rock Cores
Take soil samples or rock cores at the locations shown in the Contract or as directed by the State Geotechnical Engineer to determine the character of material directly below the bottom shaft elevation. Perform soil borings before excavating the shafts. Perform rock cores before excavating the shaft from the bottom of an exploration hole at no additional cost to the Department. Extract and ship the core samples in accordance with the Department's Manual of Highway Structure Foundation Investigation and Subsurface Exploration. Unless otherwise specified in the Contract, begin bore holes or rock cores at the top of the rock socket elevation to at least 10 ft below the bottom of the drilled shaft excavation. Record the rock quality designation, percent recovery, joint orientation and infilling, and joint water from the rock cores extracted. After exploration, fill the core holes with grout, slurry, or mortar having a minimum compressive strength of 3,000 psi at 28 Days. Deliver the geologist's field log cards to the Project Manager after completing the logs. The Department will not require the Contractor's geotechnical consultant to perform Laboratory testing on soil samples or rock cores unless specifically specified in the Contract. The State Geotechnical Engineer will notify the Contractor of the final required shaft depth after receiving the geologist's field log sheets and the lab testing results. This notification may take as long as 48 h from the time the State Geotechnical Engineer receives the field log sheets or the soil and rock samples test results.

502.3.4.2.4 Shaft Excavation Inspection
Measure the final shaft depths. Ensure that at least 50% of each shaft base has less than 1.0 in of sediment when placing the concrete. Ensure that the sediment depth or debris at any place on the shaft base does not exceed 1.5 in. For dry shafts, ensure that the water depth does not exceed 3 in before pouring concrete. Inspect slurry displacement shafts using the methods that the State Geotechnical Engineer deems appropriate.

502.3.4.2.4.1 Inspection Procedures
The Project Manager will notify the Contractor which procedures will be used for the shaft inspections. Supply Equipment and labor, the Project Manager will need to inspect the shaft. Inspection procedures may include:

1. Inserting a casing in the shaft excavation temporarily for alignment, cleanliness, and dimension checks;
2. Inserting a rigid rod assembly with several 90° offsets equal to the shaft diameter;
3. Using Department video Equipment; or
4. Using a weighted tape and evaluation of results of desanding and density tests for slurry displacement excavations.
502.3.4.2 Remedial Work for Substandard Excavation
If the State Geotechnical Engineer determines that a shaft excavation is substandard, develop, propose, and implement corrective measures. Corrective measures may include:

1. Overdrilling to a larger diameter to permit reinforcing steel placement with the required minimum cover;
2. Overreaming sidewalls of the shaft;
3. Increasing steel reinforcement bar number and size; or
4. Enlarging the underream within allowed tolerance.

502.3.4.3 Reinforcing Steel Unit Placement
The reinforcing steel unit consists of longitudinal bars and circular ties or a structural steel shape. Place the structural shape or the reinforcing steel cage as a unit immediately after the State Geotechnical Engineer approves the shaft excavation and before placing concrete. Tie and support the reinforcing steel unit in the shaft so that it remains within allowable tolerances given in Section 502.3.5, “Location and Alignment Tolerances.” Use concrete spacers or other approved non-corrosive spacing devices at sufficient intervals, near the bottom and at maximum intervals of 10 ft up the shaft, to ensure concentric spacing for the entire reinforcement unit length. Use spacers equal in quality and durability to the concrete specified for the shaft. Inspect the bottom of the shaft immediately before placing of the cage to ensure that there is no sloughing.

Check the top elevation of the reinforcement unit before and after placing the concrete. If the reinforcement unit is not maintained within the specified tolerances, make corrections. Do not construct additional shafts before modifying the reinforcement unit support to the satisfaction of the Project Manager. Maintain the reinforcement unit at the proper elevation and orientation with an approved support mechanism at the ground surface. Alternatively, support the reinforcement unit at the proper elevation by extending the vertical bars from the reinforcement unit to keep the unit off the bottom of the hole. Use only if the unit does not buckle. Provide approved cylindrical concrete feet (bottom supports) to support the bottom of the reinforcement unit at the proper distance above the base, when using the alternative support method. When supporting with vertical reinforcement, use stiffener bars and spacers similar to the primary cage reinforcement. Tie reinforcement is not required for the vertical extension bars, unless otherwise directed by the Project Manager. Place shaft concrete immediately after installing the cage. If more than 24 h elapses between the placement of the cage and concrete placement, remove the cage and inspect the shaft for sloughing or other damage.

502.3.4.4 Concrete Placement
Place concrete in accordance with Section 511, “Concrete Structures.” Place concrete as soon as possible after placing reinforcing steel.

Ensure that the time from when the concrete is batched at the plant to placement does not exceed 2 h. The Project Manager may approve a longer time period if the concrete mixture remains workable and plastic. Use admixtures for the job conditions so the concrete remains in a workable plastic state through the approved placement limit.

502.3.4.4.1 Concrete Placement by Free Fall
Use free fall placement in relatively dry holes where the maximum water depth does not exceed 3 in. Ensure that free fall-placed concrete falls directly to the base without contacting either the rebar cage or hole sidewall. Use a hopper at the top of the shaft or a rigid pipe extension from the hopper. Ensure that free fall placement does not exceed 60 ft below the bottom of the hopper or the rigid pipe extension. Do not use free fall in slurry displacement shafts. If the Project Manager determines that concrete cannot be placed using the free fall method, use either a tremie or pumping to accomplish the pour.

502.3.4.4.2 Concrete Placement with Tremie or by Pumping
Use rigid tremie pipe or concrete pumps for concrete placement in either dry or slurry displacement shafts. Do not begin underwater placement before placing the tremie or pump line within one tremie or pump line diameter of the shaft base elevation. Remove plugs from the excavation if the Project Manager does not specifically approve them to remain in the shaft. Keep the discharge end continually immersed at least 5 ft in concrete after starting the flow of concrete. Keep the concrete flow continuous. Maintain the concrete in tremies or pump lines continuously at a positive pressure differential to prevent water or slurry intrusion.
into the shaft concrete. When lifting pump lines during concrete placement, temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation. If at any time during the concrete pour, the orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the Department will consider the shaft defective. The Contractor may at its own risk and cost, remove the reinforcing cage and concrete to complete the necessary sidewall removal as directed by the State Geotechnical Engineer. The Department will base final acceptance in accordance with Section 502.3.7, “Acceptance.”

502.3.5 Location and Alignment Tolerances
Adhere to the following construction tolerances unless otherwise stated in the Contract or directed by the Project Manager:

1. Ensure the drilled shaft and the concentric reinforcement steel unit is within 3 in of Plan position at the top of the shaft;
2. Do not vary the vertical alignment of a vertical drilled shaft from the Plan alignment by more than 1/4 in per foot of depth. Do not vary alignment of a battered drilled shaft by more than 0.5 in per foot of depth from the specified batter;
3. Ensure that the top of the reinforcing steel unit is no more than 6 in above and no more than 3 in below Plan elevation; and
4. Ensure that the top elevation has a tolerance of +1 in or −3 in from the Plan top of shaft elevation.

502.3.6 Load Testing
When the Contract includes load testing, complete the testing before construction of production shafts, unless otherwise approved by the State Geotechnical Engineer. Allow three Working Days after the last load test is completed before receiving tip elevations of the production shafts from the State Geotechnical Engineer and proceeding with the construction of production shafts. After testing is completed, cut off the test shafts and reaction shafts at an elevation of 5 ft below the finished ground elevation.

502.3.7 Acceptance
502.3.7.1 Concrete Strength
The Department will accept drilled shafts after the 28-Day compressive strength is verified. If the Contractor does not achieve the 28-Day compressive strength, the Department may completely reject the shafts or accept them in place in accordance with subsection 510.3.5.5, “Price Adjustments.”

502.3.7.2 Location and Alignment Tolerances
The Department will accept drilled shafts if the construction tolerances are satisfied in accordance with Section 502.3.5, “Location and Alignment Tolerances.” If the shafts exceed the location or alignment tolerances, the Department will reject the shafts. If the State Geotechnical Engineer determines that the extent of overloading is not detrimental to the performance of the shaft, the Department will accept the shaft.

502.3.7.3 Shaft Integrity
If applicable, the Department will accept shafts when the pile integrity testing reports verify the structural integrity of the piles. The Department may reject a shaft if integrity testing shows conclusive evidence that a defect exists in the shaft that may result in inadequate or unsafe performance under service loads. If the report is inconclusive, the State Geotechnical Engineer may require the Contractor to drill a core hole in the shaft. If the State Geotechnical Engineer confirms the defect, the Department will not pay the coring costs. If the State Geotechnical Engineer does not find a defect, the Department will pay for coring costs, including pressure grouting.

502.3.8 Correction of Defective Drilled Shafts
If the Department determines that a shaft is unacceptable, submit a plan for remedial action to the Project Manager for approval. Provide calculations and Working Drawings, stamped by a registered professional engineer for all foundation elements affected by the proposed corrections. Make corrections to drilled shafts as directed by the State Geotechnical Engineer, at no additional cost to the Department.
502.4 METHOD OF MEASUREMENT
502.4.1 Drilled Shafts
The Department will not measure additional shaft depth or additional shafts used due to defective procedures.
The Department will only measure the first proof shaft constructed in place.

502.4.2 Soil Borings and Rock Cores
The Department will measure Soil Borings from the bottom of the exploration hole to existing grade.
The Department will measure Rock Cores from the point at which rock cores are recovered to the bottom of the rock coring.

502.4.3 Obstruction Removal
The Department will measure an obstruction vertically beginning where it is encountered and ending where conventional drilling Equipment adequately advances the hole. To qualify for Obstruction Removal measurement, get the Department Inspector’s authorization and meet the following requirements:
1. Hole advancement requires special procedures and tools, such as: chisels; boulder breakers; percussion hammers; core barrels; air tools; hand excavation; temporary casing; or increasing hole diameter; or
2. The rate of auger advancement is decreased to where the drilling rate through the obstruction is less than 50% of the drilling rate above the obstruction.

Obstruction Removal cost will include delay costs. The Department will not allow additional Contract Time unless the Project Manager approves a detailed schedule analysis establishing the critical path of the additional time required to complete the Obstruction Removal. The Department will not measure Obstruction Removal outside the specified shaft diameter.

502.5 BASIS OF PAYMENT
Pay Item Pay Unit
Drilled Shaft Foundation Diameter Foot
Permanent Casing Diameter Foot
Steel Shape Reinforcement Pound
Soil Borings Foot
Rock Cores Foot
Obstruction Removal Foot

502.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:
A. Methods employed by the Contractor to maintain stability of the shaft, including the use of temporary casings, slurry assisted shaft excavation, or use of grout collars;
B. All work associated with sidewall overreaming;
C. Drilled shaft concrete required to fill shafts including oversized excavations, underreams, and overreams;
D. Excavation of anticipated materials shown in the contract of different densities and character including employment of special tools and procedures necessary to accomplish the excavation through bedrock;
E. Additional wall thickness required for handling and installation of permanent casing;
F. The equipment and labor required for the shaft inspection procedure.
SECTION 504: LOAD TESTING OF BEARING PILES

504.1 DESCRIPTION
This Work consists of static axial compressive load tests (pile load test), static axial tensile load tests (pile pullout tests), and high strain dynamic measurements (dynamic measurements) of piles for the purpose of determining ultimate bearing capacity and pile pullout capacity.

For driven piles, dynamic measurements determine driving stresses, pile integrity, and hammer efficiency. For cast-in-place concrete piles (drilled shafts), dynamic measurements verify pile integrity.

504.1.1 Contractor's Responsibilities
504.1.1.1 Dynamic Measurements
Provide labor, Equipment, and Materials necessary to drill the dynamic test piles holes and for mounting transducers. Provide the analysis Equipment power supply.

Where dynamic measurements are to be made on cast-in-place piles, provide a gravity drop hammer and pile cushioning. Excavate around the pile, cut the permanent casing, drill holes in the test pile(s) and provide impacts on cast-in-place dynamic test piles as required.

504.1.1.2 Pile Load and Pile Pullout Tests
Provide everything necessary to perform pile load or pile pullout tests. Record load measurement and pile movement readings, and produce a report(s) showing the load displacement curve(s).

504.1.2 Department's Responsibilities
504.1.2.1 Dynamic Measurements
The Department will provide the Equipment to perform dynamic measurements. The Department will provide personnel to take the dynamic measurements.

504.1.2.2 Pile Load and Pile Pullout Tests
The Contract will specify the anchor pile requirements. The Department will provide personnel to observe and monitor the Contractor's test apparatus, test methods, and data collection.

504.1.3 Pile Testing Mobilization
Mobilize testing Equipment as needed and as designated by the Contract or authorized by the State Geotechnical Engineer. Mobilize testing Equipment only after receipt of written authorization.

504.2 SUBMITTALS
504.2.1 Load Test Frame
Submit the proposed load test frame and anchorage method, details, and design computations 30 Days before the start of pile load tests and pile pullout tests. Use a professional engineer licensed in New Mexico to prepare and seal the proposed loading apparatus detail plans.

504.2.2 Certificates of Calibration
Submit a calibration certificate and a calibration chart relating pressure to load for the load pressure gauge(s) from a certified Laboratory before use. Calibrate each jack and its gauge as a unit. Submit a calibration certificate for load cell(s). Calibrate gauges and cells within six months before use.

504.2.3 Pile and Equipment Data Form
Submit a Pile and Driving Equipment Data Form as required in Section 501.2.3.1, “Pile Driving Equipment Submittals,” when proposing a gravity drop hammer for dynamic measurements of cast-in-place piles.
Section 504: Load Testing of Bearing Piles

504.3 EQUIPMENT

504.3.1 Equipment for Dynamic Testing

504.3.1.1 Power Supply

Provide dynamic test equipment electric power that supplies 10 A, 115 V, 55 Hz to 60 Hz., A.C. only. If a field generator is used as the power source, provide functioning voltage and frequency level monitoring meters.

504.3.1.2 Gauge Mounting Equipment

Provide a power drill, bits, taps, and expandable masonry anchor studs to drill holes in the dynamic test piles for bolting transducers to the piles. Provide a 6 lb rubber mallet hammer when dynamic testing is specified on precast concrete piles.

504.3.1.3 Personnel Lift

To assist the Department’s installation of instruments, provide a hydraulic, telescoping-arm personnel lift. Provide a personnel lift with adequate length to reach the top of the pile located in the leads.

The Contractor may use an alternative to a personnel lift in accordance with Section 504.3.4.1.2, “Preparation for Testing.”

504.3.1.4 Gravity Drop Hammer

Provide a gravity drop hammer and pile cushion when cast-in-place piles dynamic testing is specified. Provide the minimum hammer ram weight and free fall height and cushion thickness specified in the Contract. Equip gravity hammers with guides to ensure concentric drive head impact.

If approved by the State Geotechnical Engineer, the Contractor may use a diesel hammer with the minimum required ram weight and impact energy. Cut-off the fuel flow.

504.3.2 Equipment for Pile Load Test

Provide testing equipment and measuring systems in accordance with ASTM D 1143, except as modified within these specifications.

504.3.2.1 Load System

Provide a load system capable of applying 250% of the required ultimate pile capacity. Provide a load test frame design compatible with the anchor pile requirements in accordance with Section 504.3.4.2.1, “Test Pile and Anchor Pile Requirements.”

Construct the apparatus so that it is possible to place load increments gradually without causing test pile or load test frame vibration.

504.3.2.2 Load Application System

Use hydraulic jacks to apply the load. When using multiple jacks, fit each jack with a pressure gauge in addition to the master hydraulic pressure gauge. Use jacks from the same manufacturer with the same rated capacity. Connect jacks to a common manifold with pressure supplied by one hydraulic pump.

504.3.2.3 Load Measuring System

Provide a dual load measuring system (gauge and load cell) to verify the test pile load. Calibrate the load cell and mount it between the load frame and the pile head to confirm the load recorded from the pressure gauge.

504.3.2.4 Settlement Measuring System

Use a dual settlement measuring system. Provide two dial gauges bearing on the reference beams at opposite sides of the pile, below the test plate. Support the reference beams outside of pile-soil movement influences. Provide two linear variable differentiating transformers, with remote digital read-outs bearing on reference beams on opposite sides of the pile.

504.3.3 Equipment for Pile Pullout Test

Use testing equipment and measuring systems in accordance with Section 504.3.2, “Equipment for Pile Load Test,” except as modified within these specifications.
504.3.3.1 Load System
Provide a load system capable of applying 200% of the required ultimate pile pullout capacity.

504.3.3.2 Reaction System
It is permissible to use suitable cribbing or other bearing plates for reaction points instead of anchor piles. Use cribbing or bearing plates of sufficient size and stiffness to limit undesirable reaction frame movement.

504.3.4 Testing Requirements
504.3.4.1 Dynamic Pile Testing Requirements
Perform dynamic testing during the pile driving as described in the Contract as “Dynamic Test Piles.” The State Geotechnical Engineer may decide to designate additional piles shown in the Contract as dynamic test piles.

504.3.4.1.1 Notification to Proceed
Notify the Project Manager at least 21 Days before commencing dynamic test pile testing. Confirm the testing schedule with the Project Manager 3 Days before the testing date. Notify the Project Manager promptly of any changes in the schedule. Test dynamic test piles before any other piles are driven or installed, unless the Project Manager approves otherwise.

504.3.4.1.2 Preparation for Testing
Prepare dynamic test piles as follows:
1. Drilling for Mounting Transducers. Drill holes for mounting the transducers. Bolt the instruments near the head of the pile at the location and using a bolt pattern designated by the State Geotechnical Engineer.
   Drilling requirements for each test pile include the following:
   1.1. Steel pipe piles: Seven holes drilled with a 7/32 in diameter bit, tapped to accommodate ¼ in bolts;
   1.2. Steel HP piles: Five holes drilled with a 5/16 in diameter bit through the web;
   1.3. Precast concrete or cast-in-place concrete piles: Seven ¼ in x 1 ½ in holes with ¼ in expandable anchor studs set in the holes to accommodate ¼ in bolts;
2. Wave Speed Measurements. When precast concrete piles are specified as dynamic test piles, place the pile horizontally on wooden sleepers so that it is not in contact with the ground or with other piling. The State Geotechnical Engineer will take wave speed measurements for the Pile Driving Analyzer (PDA) by hitting the pile with a 6 lb rubber mallet hammer.
   The Department will not require wave speed measurements for steel piles;
3. Transducer Installation. Install the instruments while the pile is in the leads using a man-lift raised to the top of the pile.
   As an alternative to the man-lift requirement, the State Geotechnical Engineer may install the instruments after the pile is driven to a tip elevation of 10 ft above the Plan tip elevation.

504.3.4.1.3 Procedure for Testing Driven Piles
The following are the procedures for testing driven piles:
1. Drive the test pile in accordance with Section 501.3.5, “Pile Driving Operations,” while the State Geotechnical Engineer monitors the dynamic measurements;
2. Monitor the test pile stresses that result from the driving to ensure that the compressive or tensile stresses do not exceed the allowable driving stresses as defined in Table 501.3.1.4:1, “Wave Equation Analysis Allowable Driving Stress.” If the monitored pile stresses exceed these criteria, stop driving. Perform necessary modifications to the driving operation to ensure that pile damage does not occur;
3. Monitor the test pile stresses on individual gauges to determine if non-axial driving is indicated. If the pile bends beyond acceptable allowances, stop driving and realign the driving system;
4. If the Contract specifies an estimated penetration elevation, drive the first dynamic test pile until the required ultimate capacity or the estimated penetration elevation is achieved;
   If the Contract specifies a minimum penetration elevation, drive the first dynamic test pile to that elevation;
If the test pile does not achieve the required ultimate capacity at the estimated or minimum penetration elevation, splice the test pile with additional length of pile. Remove and relocate the instruments to the spliced section. Proceed with driving until the ultimate driving capacity is achieved;

5. Forty-eight hours after the initial drive, restrike each test pile previously driven with the dynamic measuring Equipment installed. The State Geotechnical Engineer may allow shorter wait periods depending on soil and test conditions. Alternatively, the Contract may require longer wait periods, multiple restrike intervals, or both on a given test pile. Use a “warm” hammer that has previously driven at least one pile other than the test pile(s), to restrike the test pile(s). The maximum total number of hammer blows for the restrike is 40.

504.3.4.1.4 Procedure for Testing Cast-in-Place Piles

The following are the procedures for testing cast-in-place piles:

1. When the Contractor casts the dynamic test pile(s), the Inspector will make three test cylinders of concrete or grout for each test pile in accordance with AASHTO T 23M. Provide concrete that will achieve a compressive strength at 7 Days of 3,000 psi;

2. After 7 Days, weigh the three concrete test cylinders and report the average unit weight to the State Geotechnical Engineer. Test one concrete cylinder at 7 Days. If the compressive strength is at least 3,000 psi, test the other two cylinders. Report the average of the three breaks to the State Geotechnical Engineer.

3. If the first test cylinder breaks at less than 3,000 psi, report the result to the State Geotechnical Engineer. The State Geotechnical Engineer may decide either to have the last two cylinders tested the same day or to wait up to a maximum of 14 additional Days before breaking the last two cylinders. The day the last two cylinders are tested, re-weigh the cylinders and determine the average unit weight of the concrete. Perform the dynamic test on the test pile the same day that the cylinders are broken;

4. Use the average compressive strength and the average unit weight of the concrete to estimate the modulus of elasticity and the wave speed of the concrete for input into the PDA;

5. Perform excavation around the test pile as needed to mount the gauges. Typically, the required depth of excavation will be twice the diameter of the pile;

6. Attach the instruments to the pile head and impact the pile with the ram at the free fall height directed by the State Geotechnical Engineer. Each test pile will not require more than 40 blows. Monitor the pile stresses that result from the ram impact to ensure that the compressive or tensile stresses do not exceed the allowable pile driving stresses defined in Table 501.3.4.1.1, “Wave Equation Analysis Allowable Driving Stress.” If the monitored pile stresses exceed these criteria, the Department will direct the Contractor to reduce the ram free fall height or add pile cushioning.

504.3.4.1.5 Case Pile Wave Analysis

After re-striking a dynamic test pile, the State Geotechnical Engineer may phone an approved firm and transmit a record of a representative blow from the dynamic test pile. The firm must have proven experience using the Case Pile Wave Analysis Program model and be capable of returning analysis results to the State Geotechnical Engineer within one Working Day from the time of transmission.

At the option of the State Geotechnical Engineer, Department personnel may perform the Case Pile Wave Analysis Program.
504.3.4.2 Pile Load and Pile Pullout Testing Requirements

504.3.4.2.1 Test Pile and Anchor Pile Requirements

1. Driven Piles. Apply the load to a production pile driven in the final Plan location, unless otherwise specified in the Contract, and apply the test frame against anchor (tension) piles; Use production piles driven in final Plan locations for the anchor piles unless the layout of the test frame reaction points is fixed and inconsistent with the production pile layout or unless an alternative pile type is required to develop adequate pullout resistance. The Project Manager will decide if anchor piles that are not final production piles may be cut-off below final grade or pulled after the testing is completed;

2. Cast-in-Place Piles. Apply the load to a production pile located in the final Plan location, unless otherwise shown in the Contract. Use either driven piles or cast-in-place piles as anchor piles. Do not use anchor piles as final production piles. Provide cast-in-place anchor piles with reinforcement capable of carrying the pile tension force.

504.3.4.2.2 Commencement of Load Test

Unless otherwise specified in the Contract, wait a minimum of 24 h between driving or installing anchor piles or the test pile and commencing with the pile load or pile pullout test. When testing pipe piles filled with concrete or cast-in-place concrete piles, begin load tests after the concrete has attained a compressive strength of 2,500 psi.

504.3.4.2.3 Load Testing Procedures

Conduct pile load tests and pile pullout tests in accordance with the following requirements:

1. Perform the Quick Load Test Method for Individual Piles in accordance with ASTM D 1143, but take the load test to the first of either failure of the test pile or capacity of the load system;

2. Test pile failure is defined as total vertical pile movement equal to the greater of either 5% of the pile diameter or 2 in;

3. If failure occurs, remove the test load in four approximately equal amounts with a five-minute interval between removals;

4. For pile load tests where piles are 24 in or less in diameter or width, the ultimate capacity is the load that produces a settlement of the pile head in accordance with the following equation:

   \[ S_f = S + (0.15 + 0.008D) \]  

   where  
   \( S_f \) is the settlement at the ultimate pile capacity in inches  
   \( D \) is the pile diameter or width in inches  
   \( S \) is the elastic deformation of pile length in inches  

   Use the following equation for piles with diameters or widths greater than 24 in:

   \[ S_f = S + \frac{D}{30} \]  

   where  
   \( S_f \) is the settlement at the ultimate pile capacity in inches  
   \( D \) is the pile diameter or width in inches  
   \( S \) is the elastic deformation of pile length in inches  

5. For pile pullout tests, the State Geotechnical Engineer will determine when the ultimate pile capacity is attained.

504.3.4.3 Completion of Dynamic Testing of Driven Piles

After completing the dynamic test pile(s) at a Substructure element, prepare the pile(s) for any specified pile load or pile pullout test(s).

If no load testing is required as determined in Section 501.3.6, “Pile Acceptance,” the required field acceptance criteria for the production piles is dynamic testing. When dynamic
testing alone is specified, the State Geotechnical Engineer will require up to 36 h after completion of the last test pile to provide the driving criteria.

Drive production piles no deeper than the estimated or minimum penetration elevation before receiving the field acceptance criteria. Record the average hammer stroke and pile set after driving of each pile to determine pile acceptance once the driving criteria is established. After receiving the field acceptance criteria, drive piles until attaining the required ultimate capacity.

504.3.4.4 Completion of Dynamic Testing of Cast-in-Place Piles

Base the required production pile tip elevation on the dynamic testing and load testing results if specified. The State Geotechnical Engineer will require up to 36 h after completion of the last test pile to provide the pile tip elevation.

Unless the State Geotechnical Engineer directs otherwise, place no other piles until receiving the production pile tip elevation.

504.3.4.5 Completion of Load Testing

After completing the specified load test(s) to the Project Manager’s satisfaction, dismantle the test apparatus and Equipment and remove from the site. Use the load test results to determine the ultimate pile capacity acceptance criteria of driven piles as established under Section 501.3.6, “Pile Acceptance,” and to confirm ultimate pile capacities determined by dynamic pile tests.

Pulled anchor piles of the same type as the production piles may be reused as production piles if not rejected by the Project Manager due to damage as covered in Section 501.3.6.3, “Damaged Pile Limitations.”

For cast-in-place piles, use the load test results to determine the pile penetration requirements if no subsequent dynamic testing is specified.

The State Geotechnical Engineer will require up to 36 h after completion of the last test pile to provide the pile tip elevation.

Re-drive production piles used as anchor piles in accordance with Section 501.3.6, “Pile Acceptance.”

504.4 METHOD OF MEASUREMENT—Vacant

504.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
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<td>Lump Sum</td>
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<td>Pile Load Test</td>
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<td>Pile Pullout Test</td>
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<td>Pile Dynamic Test</td>
<td>Each</td>
</tr>
<tr>
<td>Case Pile Wave Analysis Test</td>
<td>Each</td>
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</tbody>
</table>

504.4.1 Work Included in Payment

The following work will be considered as included in the payment for the mail item(s) and will not be measured or paid for separately: Non-production anchor and test piles which will not remain in use as part of the permanent structure.
505.1 DESCRIPTION

505.1.1 General
This Work consists of pile integrity testing for verifying structural integrity and determining the extent and location of pile defects. Defects may include internal voids, necking of the pile’s perimeter, transverse cracks, soil intrusions, weak concrete or grout in drilled shaft foundations.

505.1.2 Test Methods
Use crosshole sonic logging (CSL) or low strain integrity (LSI) testing for integrity testing. The Department may require LSI testing to corroborate the results of CSL testing that show potential defects. Only an approved Integrity Testing Consultant or Department personnel will perform CSL or LSI Testing.

505.1.3 Consultant Integrity Testing
If an Integrity Testing Consultant is required, the consultant’s qualifications must meet the requirements of the Geotechnical Design Section and the Equipment used must meet the requirements of Section 505.3.1.1, “CSL Testing Equipment,” and Section 505.3.1.2, “LSI Testing Equipment.” Perform field testing with an experienced technician or engineer having at least one year of experience with the integrity testing methods. Use a licensed professional engineer having at least three years of experience in the integrity testing methods performed to interpret the recorded measurements.

505.1.4 Department Integrity Testing
Department personnel will only perform integrity testing when the Contract specifies CSL or LSI Department testing. Department personnel will use Department-owned Equipment to perform testing.

505.1.5 Assistance
Provide additional labor to perform the testing if required by the testing consultant or Department personnel. Provide access to the piles. If required, provide a 110 V, 55 Hz to 60 Hz, AC power supply.

505.2 MATERIALS

505.2.1 CSL Access Tubes
Use 2 in internal diameter (ID) access tubes of schedule 40 PVC with a round, regular ID free of defects or obstructions to allow passage of the source and receiver probes. Provide watertight tubes with clean internal and external surfaces to ensure a good bond between the concrete and tubes. Fit the tubes with glued caps at the bottom and threaded caps at the top.

505.3 CONSTRUCTION REQUIREMENTS

505.3.1 Equipment

505.3.1.1 CSL Testing Equipment
Use CSL Equipment in accordance with the following requirements:
1. Use ultrasonic source and receiver probes capable of producing records with strong signal amplitude and energy through uniform, high quality concrete. Use probes with a diameter and cabling that will descend freely through 2 in-ID pipe for the full pile depth;
2. Record probe depth;
3. Use a microprocessor-based CSL measurement system for analog-digital conversion and data recording, individual record display, receiver response analysis, and log printing;
4. Ensure that the CSL system has filter/amplification of data and cables;
5. Use a CSL system that has a synchronized triggering feature with the ultrasonic pulse for the recording system.

505.3.1.2 LSI Testing Equipment
Use LSI Testing Equipment that meets the following requirements:
1. Use Equipment that has a digital data acquisition system with a dynamic signal analyzer, magnetic disk storage and hardcopy plotting capabilities. Ensure that the
Section 505: Pile Integrity Testing

505.3.2 CSL Testing Requirements

505.3.2.1 Preparation of CSL Access Tubes

Place access tubes in drilled shafts where the wet-hole construction method was used, or as directed by the State Geotechnical Engineer. Install access tubes as shown in the Plans. Fasten the tubes to the exterior reinforcement cage, so the tube bottoms are 6 in above the shaft bottom and the tube tops are 12 in above the shaft top. Tie the tubes to the cage and glue the tubes together while lowering the cage into the shaft. Immediately after concrete or grout placement, fill the tubes with clean water and cap.

505.3.2.2 CSL Testing Procedure

Before construction of the Substructure above the foundation, direct the CSL consultant to test the completed piles from 2 Days to 10 Days after completing concrete or grout placement. Provide information about the pile’s bottom and top elevations, tube lengths and positions, and construction dates to the Integrity Testing Consultant or Department personnel before logging.

Log between each adjacent pair of tubes in the pile. Place the source and receiver probes in the same horizontal plane unless test results indicate potential defects. If potential defects are indicated, evaluate the area further using angled tests with the source and receiver vertically offset in the tubes. Additional testing of other untested tube pair combinations may be required.

Simultaneously pull the probes from the tube bottom of the over the depth wheel or other measuring device, once the slack is taken out of the cables, to provide accurate depth measurements. Take the CSL measurements at 2 3/8 in intervals or less from the bottom to top of the pile. Report defects indicated by longer pulse arrival times and significantly lower amplitude/energy signals to the State Geotechnical Engineer. The State Geotechnical Engineer may require further tests to evaluate the extent of the defects.

Refill CSL tubes with water after testing the shafts containing defects indicated by the initial CSL testing.

505.3.2.3 CSL Testing Results

Report the results of completed CSL testing at a given Substructure element within 5 Days after testing completion for that element. Provide report copies to the State Geotechnical Engineer and the Project Manager that contain the following information:

1. CSL logs (indicate defect zones on the CSL logs);
2. Initial pulse arrival time versus depth and pulse amplitude/energy versus depth analyses; and
3. Narrative.

505.3.3 LSI Testing Requirements

505.3.3.1 Pile Head Preparation

Ensure that the pile head is perpendicular to the pile’s vertical axis and is made of sound concrete. Remove weak, poor quality, or broken concrete from the pile head to expose sound concrete. Clearly expose the pile head and free it of debris and water. Ground the pile head center impacted by the impulse hammer smooth along with the pile edge area where transducers are attached to provide a flat, horizontal surface for the LSI test.

505.3.3.2 LSI Testing Procedure

Perform LSI testing only when specified or when required by the State Geotechnical Engineer due to potential defects indicated by CSL testing results. Impact the pile head with a hammer that can produce a compression wave capable of being reflected from the pile toe. LSI testing may only be effective to depths of 20 times to 30 times the pile diameter. Take LSI testing measurements in both the time and frequency domains.

Display the motion record (pile top velocity) on a hard copy as a function of time. High soil friction may require velocity signal magnification using integration with exponentially
increasing magnitude to enhance the pile toe reflection. Average several consistent records. In addition to the velocity records as a function of time, the amplified and averaged difference between velocity and force may be displayed to provide additional information about the pile top quality, including dynamic stiffness.

Use transient response or impulse response, using hammer force in the frequency domain (mobility) to provide additional defect determination of the pile.

505.3.3 LSI Testing Results

Report LSI testing results completed at a given Substructure element within 10 Days after completing testing for that element. Provide report copies to the State Geotechnical Engineer and the Project Manager that contain the following information:
1. Pile length and concrete quality analyses;
2. Pile integrity opinions based on LSI testing;
3. Correlation of potential defects to those indicated by the CSL test results, if performed;
4. Pile head dynamic stiffness;
5. Mobility, a measure of cross-sectional area and concrete quality;
6. Plots of the averaged, amplified velocity and acceleration versus time, and, if required, the mobility versus frequency; and
7. Narrative.

505.3.4 Acceptance and Rejection of Piles

The Department will accept piles if pile integrity testing reports verify the structural integrity of the piles. Pile rejection will require conclusive evidence that a defect exists that may result in inadequate or unsafe performance under service loads. If the report is inconclusive, the State Geotechnical Engineer may require the Contractor to drill a core hole into the defective pile.

The Department will reject shafts where velocities are less than 10,000 ft per second and the anomalous velocity is less than 25% of the baseline velocity of the CSL record. Such rejection may be due to tubes not being tied in a plumb position and with equal offsets from adjacent tubes.

If a pile is unacceptable, submit a remedial action plan to the State Geotechnical Engineer. Provide calculations and Working Drawings stamped by a registered professional engineer for foundation elements affected by modifications to the foundation piles and load transfer mechanisms caused by the remedial action.

505.4 METHOD OF MEASUREMENT—Vacant

505.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSL Consultant Testing</td>
<td>Each</td>
</tr>
<tr>
<td>CSL Department Testing</td>
<td>Each</td>
</tr>
<tr>
<td>LSI Consultant Testing</td>
<td>Each</td>
</tr>
<tr>
<td>LSI Department Testing</td>
<td>Each</td>
</tr>
</tbody>
</table>

505.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and no direct payment will be made therefore;
A. Furnishing all materials, labor, tools and equipment necessary to complete the work;
B. Assistance to the consultant or Department personnel necessary to complete the work;
C. CSL Access tubes; and
D. Calculations and working drawings stamped by a registered professional engineer for all foundation elements requiring remedial action, and all labor and materials necessary to complete corrections for rejected piles. If a defect is confirmed by coring of the concrete, materials and labor for coring will be at the expense of the Contractor. If no defects are found, the Department will pay for all coring costs, including pressure grouting of the core holes. The time period allowed to perform testing shall be no less than 48 hours to no more than 10 days from time of completion of the construction of the pile.
SECTION 506: MECHANICALLY STABILIZED EARTH RETAINING STRUCTURES

506.1 DESCRIPTION
This Work consists of designing, providing, and constructing mechanically stabilized earth (MSE) retaining Structures.

506.2 MATERIALS
506.2.1 Precast Concrete Elements
Provide precast concrete elements conforming with Section 517, “Precast Concrete Structures.” Provide Class AA concrete. The precast concrete Supplier shall prepare the mix design and the State Materials Bureau will approve it.

506.2.1.2 Casting
Place the precast concrete face panels on a horizontal surface with the front face of the panel at the bottom of the form. Set connection hardware in the rear face. Place the concrete in each precast concrete panel without interruption and consolidate it with an approved vibrator and hand tamping to force the concrete into the corner of the forms and eliminate the formation of stone pockets or cleavage planes. Use clear form oil throughout the casting operation.

506.2.1.3 Finish
506.2.1.3.1 Non-exposed Surfaces
Screed the rear faces of precast concrete panels to create a uniform surface texture that is free of open pockets of aggregates and surface distortions greater than 3/16 in. Apply a Class I finish, per Section 511 “Concrete Structures,” to other non-exposed surfaces.

506.2.1.3.2 Exposed Surfaces
Provide the type of finish on the exposed surface per the Contract. If the Contract requires an exposed aggregate finish, produce as follows:
1. Before placing concrete, apply a set retarder to the casting forms in accordance with the manufacturer’s instructions;
2. After removing the forms and after the concrete has set sufficiently to prevent dislodging, expose the aggregate with a combination of brushing and washing (using clean water) to a depth of between 3/8 in and 1/2 in; and
3. Apply an acrylic resin sealer, consisting of 80% thinner and 20% acrylic solids by weight, to the exposed aggregate surface at a rate of 1 gal per 250 ft².

506.2.1.4 Tolerances
Manufacture the precast concrete elements in accordance with the following tolerances:
1. Dimensions within precast concrete panels, ± 0.2 in.
2. Surface defects:
   2.1. Smooth formed surfaces not greater than ± 3/16 in within 5 ft;
   2.2. Textured-finish surfaces not greater than ± 5/16 in within 5 ft.
3. Differences in diagonal lengths not greater than 1/2 in.

506.2.1.5 Identification and Markings
Inscribe the manufacture date, the production lot number, and the piece mark on a non-exposed surface of each element.

506.2.1.6 Handling, Storage, and Shipping
Handle, store, and ship units in a manner that eliminates damage and discoloration.

506.2.1.7 Compressive Strength
Do not ship or place elements in the wall until the design strength is reached. Cast wall panels on a flat area and fully support them until the concrete reaches a minimum compressive strength of 1,000 psi as determined by the Maturity Method detailed in Section 510.3.5.2, “In-Place Concrete Strength Measurements.” Unless otherwise specified by the wall manufacturer, do not handle the elements until they reach a compressive strength of 1,000 psi.
506.2.1.8 Rejection
The following defects are sufficient cause for rejection:
1. Connection defects and out-of-tolerance connection imbeds/inserts;
2. Defects indicating imperfect molding;
3. Defects indicating honeycombing or open texture concrete;
4. Cracked or severely chipped panels;
5. Color variation on front face of panel due to excess form oil or other reason; and
6. Presence of oil on panels.

506.2.2 Reinforcing Steel
Provide reinforcing steel in accordance with Section 540, “Steel Reinforcement.”

506.2.3 Soil Reinforcement
Do not use geosynthetics for soil reinforcement. Galvanize steel connection hardware in accordance with AASHTO M 111. Support the soil reinforcement while lifting and placing so that the galvanization remains intact and does not crack.

506.2.3.1 Reinforcing Strips
Hot roll reinforcing strips from bars to the required shape and dimensions. Provide reinforcing strips with physical and mechanical properties in accordance with AASHTO M 223M, Grade 65, or equivalent. Provide shop-fabricated tie strips of hot rolled steel in accordance with ASTM A 1011, Grade 50, or equivalent. The minimum-bending radius of the tie strips is 1 in. Apply galvanization after strip fabrication.

506.2.3.2 Reinforcing Bar Mats
Provide reinforcing bar mats of cold-drawn steel wire in accordance with AASHTO M 32 and weld the mats into the finished mesh fabric in accordance with AASHTO M 55. Form mesh button heads so that variations between the longest and shortest wire in any mesh is less than 1 in. Apply galvanization after mesh fabrication. Provide a 1-inch coil embed of cold drawn steel wire in accordance with AISI C 1035.

506.2.3.3 Connector Pins
Provide connector pins and mat bars from A-36 steel and weld to the soil reinforcement mats. Provide connector bars of cold drawn steel wire in accordance with AASHTO M 32.

506.2.4 Fasteners
Provide fasteners in accordance with the Contract or the approved Working Drawings. Cast fasteners in the precast concrete panels so that the fasteners are in alignment. This will result in fasteners transferring a full and even load to the grid or strap reinforcement. The tolerance between the fastener and the reinforcement grid or straps for field installation is 3/16 in. Galvanize and provide fasteners in accordance with AASHTO M 164.

506.2.5 Precast Concrete Panel Joints
Where walls wrap around a corner, provide a corner block panel with flange extensions that will allow differential movement without exposing the panel joints. Provide joint filler, bearing pads, and filter fabric in accordance with the wall manufacturer’s recommendations and the approved Working Drawings.
If required, provide flexible foam strips for filler in vertical joints between panels, and in horizontal joints where pads are used, in accordance with the Plans.
Provide the following for horizontal joints between panels:
1. Pre-formed Ethylene Propylene Diene Monomer (EPDM) rubber pads in accordance with ASTM D 2000 for 4AA, 812 rubbers;
2. Neoprene elastomeric pads having a Durometer Hardness (ASTM D 2240) of 55 ± 5; or
3. High-density polyethylene pads with a minimum density of 60 lb per cubic foot in accordance with ASTM D 1505.
Cover the joints between panels on the backside of the wall with a geotextile meeting the requirements for filtration applications in accordance with Section 604.2.4 Separator Geotextile, Class 3. Provide a minimum lap width of 1 ft.
506.2.6 Backfill Material

Provide backfill that is free of shale, organic matter, and other soft particles of poor durability. Provide backfill with a soundness loss of 30 or less if tested in accordance with AASHTO T 104 using a magnesium sulfate solution with a test duration of four cycles. Determine gradations in accordance with AASHTO T 27 and Table 506.2.6:1, “Backfill Gradation Requirements,” unless otherwise specified.

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>% passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in</td>
<td>100</td>
</tr>
<tr>
<td>No. 40</td>
<td>0–60</td>
</tr>
<tr>
<td>No. 200</td>
<td>0–15</td>
</tr>
</tbody>
</table>

Provide backfill with a PI, no greater than 6 in accordance with AASHTO T 90.

506.2.6.1 Internal Friction Angle Requirement

Provide backfill that exhibits an angle of internal friction of at least 34° in accordance with AASHTO T 236 unless otherwise specified in the Contract. Run the test on the backfill Material passing the No. 10 sieve. Compact the sample in accordance with Section 506.3.5.1, “Compaction,” at optimum moisture content, to 95% of maximum density. The Department will not require direct shear testing for backfills when the gradation is less than 20% passing a 3/4 in sieve.

506.2.6.2 Electrochemical Requirements

Provide backfill in accordance with Table 506.2.6.2:1, “Electrochemical Requirements,” when using steel soil reinforcement.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph</td>
<td>5–10</td>
<td>AASHTO T 288</td>
</tr>
<tr>
<td>Resistivity</td>
<td>&gt;2,500 ohm/cm</td>
<td>AASHTO T 288</td>
</tr>
<tr>
<td>Chlorides</td>
<td>&lt;100 ppm</td>
<td>AASHTO T 291</td>
</tr>
<tr>
<td>Sulfates</td>
<td>&lt;200 ppm</td>
<td>AASHTO T 290</td>
</tr>
<tr>
<td>Organic content</td>
<td>&lt;1%</td>
<td>AASHTO T 267</td>
</tr>
</tbody>
</table>

The Department will not require electrochemical testing for backfills when the gradation is less than 20% passing a 3/4 in sieve and less than 5% passing the No. 200 sieve.

506.2.6.3 Rock Backfill

The Department defines “rock backfill” as the Material described in Section 506.2.6, “Backfill Material,” that is composed primarily of rock fragments (Material having less than 25% passing a ¾ in sieve). If using “rock backfill,” place a separator geotextile over the top of and vertically up the backside of the backfill Material before placing the top 2 ft of backfill. Provide a separator geotextile in accordance with the minimum requirements for filtration applications in AASHTO M 288 and Section 604, “Soil and Drainage Geotextiles.” Ensure the upper 2 ft of backfill does not contain stones larger than 3 in at their greatest dimension and is free of rock backfill.

506.2.7 Cast-in-Place Concrete

Provide cast-in-place concrete in accordance with Section 509, “Portland Cement Concrete Mix Designs,” Section 510, “Portland Cement Concrete,” and Section 511, “Concrete Structures.” Unless otherwise approved, use Class A concrete for cast-in-place concrete.

506.2.8 Submittals

Ensure a New Mexico registered engineer signs and seals Working Drawings and design calculations.
Section 506.2.8.1 Working Drawings
Submit Working Drawings to the State Bridge Engineer for review and approval at least 40 Days before beginning work on MSE retaining Structures. Submit three complete sets of half-size prints for preliminary review. The State Bridge Engineer will return one set of prints to the Contractor with notations. Make necessary corrections and submit eight sets of prints for final review, approval and distribution. Do not begin fabrication or erection before receiving written notification that the drawings are approved. Working Drawings shall include the following:

1. Layout of the wall including plan and elevation views;
2. Existing ground elevations field verified by the Contractor for each location that will involve wall construction wholly, or in part, on natural ground;
3. Complete details of elements and component parts required for the proper construction of the system;
4. A complete listing of Materials specifications;
5. Earthwork requirements, including specifications for Material and compaction; and
6. Other information required by the Contract or requested by the State Bridge Engineer.

Approval of the final Working Drawings covers the requirements for strength and detail, and the Department assumes no responsibility for errors or omissions in the Working Drawings. Provide three sets of the manufacturer’s written erection instructions with the final Working Drawings submittal.

506.2.8.2 Design Calculations
Along with the Working Drawing submittals, submit complete design calculations, including those required to establish service life, to the State Geotechnical Engineer for approval. Ensure the calculations confirm that the proposed design satisfies the design parameters in accordance with the Contract and AASHTO’s Standard Specifications for Highway Bridges, or FHWA Standards Publication, FHWA-NHI-00-043, Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines, whichever is more restrictive. Provide Structures in accordance with Table 506.2.8.2:1, “Design Parameters,” unless otherwise specified in the Contract.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Factor of safety against overturning</td>
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</tr>
<tr>
<td>Factor of safety against sliding</td>
<td>1.5</td>
</tr>
<tr>
<td>Service life</td>
<td>75 years</td>
</tr>
<tr>
<td>Service life (supporting structure loads)</td>
<td>100 years</td>
</tr>
<tr>
<td>Soil unit weight (retained)</td>
<td>120 lb/ft³</td>
</tr>
<tr>
<td>Soil unit weight (reinforced)</td>
<td>125 lb/ft³</td>
</tr>
<tr>
<td>Friction angle (retained soil)</td>
<td>30°</td>
</tr>
<tr>
<td>Friction angle (reinforced soil)</td>
<td>34°</td>
</tr>
<tr>
<td>Coefficient of sliding friction</td>
<td></td>
</tr>
<tr>
<td>Allowable bearing pressure</td>
<td>a</td>
</tr>
</tbody>
</table>

*aIn accordance with the Contract.

506.2.8.3 Certificates of Compliance
Provide the Project Manager with a Certificate of Compliance for the Material (excluding backfill and concrete) that certifies that the Material is in accordance with the Contract and the approved Working Drawings.

506.2.8.4 Exposed Surface Finish Panel Sample
If the Contract requires an exposed aggregate or other architectural finish, deliver a 36 in × 36 in panel, finished as specified, to the project for approval by the Landscape Architect.

506.3 CONSTRUCTION REQUIREMENTS
506.3.1 Excavation
Conduct wall construction excavation as unclassified excavation in accordance with Section 203, “Excavation, Borrow, and Embankment.”
506.3.2 Foundation Preparation
Grade the foundation for the structural volume level for the entire area of the base of the Structure plus 12 in on all sides, or as shown in the Contract. Before wall construction, proof-roll the foundation with a minimum of three passes of an 8 ton smooth-sheet vibratory roller, or equal, as approved by the Project Manager. Remove unacceptable foundation material, replace with suitable Material, and compact in accordance with this paragraph, unless otherwise approved by the State Geotechnical Engineer.

506.3.3 Concrete Leveling Pad
Provide a leveling pad in accordance with the approved Working Drawings. Cure the pads at least 12 h before placement of wall panels.

506.3.4 Wall Erection
Erect walls in accordance with the manufacturer’s written instructions. Ensure that a field representative from the manufacturer is available during the erection of the first 10% of the wall (and as directed by the Project Manager) to assist the Fabricator, Contractor, and Project Manager. Place panels so that their final position is vertical or battered in accordance with the Contract. Sequence the placement of panels in successive horizontal lifts during backfill placement in accordance with the Working Drawings.

506.3.4.1 Placement Tolerances
When placing backfill Material, maintain the panels in the specified vertical alignment with temporary wedges or bracing as recommended by the manufacturer. Ensure that vertical and horizontal alignment tolerances do not exceed .75 in if measured with a 10 ft straightedge. Ensure that the overall horizontal tolerance (plumbness) of the vertical wall does not exceed .5 in per 10 ft. Ensure that the offset at any panel joint does not exceed 0.4 in.

506.3.4.2 Placement of Reinforcement Elements
Place the reinforcement elements normal to the face of the wall, unless otherwise shown on the Plans. Ensure that the reinforcement bears uniformly on the compacted reinforced soil from the connection to the wall to the end of the reinforcing elements. Do not cut the reinforcement elements to accommodate obstructions within the reinforced soil zone. Do not weld soil reinforcements (shop or field welds) to extend lengths of longitudinal reinforcements. The Department will allow approved shop welds at the connections and approved spot-welds at the transverse and longitudinal intersections of bar mats.

506.3.5 Backfill Placement
Perform backfill placement immediately after erecting each level of wall panels. Place backfill carefully to avoid damage or disturbance of the wall Materials, misalignment of wall panels, or damage to soil reinforcement. Replace wall Materials damaged during backfill placement at no additional cost to the Department. If backfill placement causes misalignment or distortion of wall panels, correct at no additional cost to the Department.

506.3.5.1 Compaction
Compact backfill in accordance with AASHTO T 99, Method C (TTCP modified), Note 7, to 95% of the maximum density, except as modified in accordance with Section 506.3.5.1.1, “Compaction of Bridge Approaches,” and Section 506.3.5.1.2, “Compaction Against Faces of Walls.”

506.3.5.1.1 Compaction of Bridge Approaches
Compact the backfill to 100% of maximum density within 50 ft of the centerline of a bridge abutment. Control this density adjacent to and around pile or casing penetrations through the reinforced soil mass at the abutment.

506.3.5.1.2 Compaction Against Faces of Walls
Compact the backfill to 90% density within 3.3 ft of the wall. Compact with a minimal number of passes using a lightweight mechanical tamper, roller, or vibratory system. Determine the number of passes with a test section before compaction against the wall, as approved by the Project Manager. Use approved compaction Equipment from the test section for production work. If changing Equipment, create a new test section to determine the...
number of passes for the Project Manager’s approval.

506.3.5.2 Moisture Control

Uniformly distribute the moisture content of the backfill Material throughout each layer before and during compaction. Ensure that backfill Materials have an in-place moisture content of 3% less than optimum to optimum. Remove backfill Material with in-place moisture content greater than optimum and rework, or replace with acceptable backfill Material.

506.3.5.3 Lift Thickness

Ensure that the maximum lift thickness after compaction does not exceed 8 in. Decrease the lift thickness, if necessary, to obtain the specified density.

506.3.5.4 Protection of the Work

At the end of each day’s operation, slope the last level of backfill away from the wall to direct runoff away from the Structure. Do not allow surface runoff from adjacent areas to enter the wall construction site.

506.4 METHOD OF MEASUREMENT

The Department will measure the face of MSE Walls based on the dimensions shown in the Contract or approved modifications.

The Department will measure authorized Excavation of Unsuitable Foundation Material from the foundation surface to the depth of excavation in its original location. The Department will not measure material excavated outside the area bounded by vertical planes 2 ft beyond the limits of the material designated for removal.

506.5 BASIS OF PAYMENT

Pay Item | Pay Unit
--- | ---
MSE Wall | Square Foot
Excavation of Unsuitable Foundation Material | Cubic Yard

506.5.1 Work Included In Payment

The Department will consider the following Work as included in the payment for MSE Walls and will not pay for it separately:

1. Excavation for MSE retaining Structures other than authorized excavation of unsuitable foundation material, and including any required temporary shoring;
2. Placement and compaction of suitable Material for excavation of unsuitable foundation material;
3. Dewatering for excavation of MSE retaining Structures or authorized unsuitable foundation materials;
4. Leveling pads, facing elements, reinforcing bars, soil reinforcements, attachment devices, backfill, coping, foundation preparation, and geotextile fabric; and
5. Providing the manufacturer’s field representative.
509.1 DESCRIPTION
This Work consists of developing, submitting and getting approval to use PCC mix designs on Department projects.

509.2 MATERIALS
Test Materials in accordance with AASHTO and ASTM methods or other test procedures designated by the Department. The State Materials Bureau will decide questions about test procedure interpretation. Correct or remove and dispose of improperly graded or segregated material that fails to meet the requirements as directed by the Project Manager and at no additional cost to the Department.

Use pre-approved Materials in accordance with the current Department’s Approved Products List. The Department will not allow changes in the source or character of the Materials without notifying the State Materials Bureau and obtaining written approval.

509.2.1 Reserved

509.2.2 Portland Cement

Use Type II, low-alkali portland cement in accordance with ASTM C 150 unless otherwise specified. If the results of the alkali-silica reactivity (ASR) mitigation tests required in Section 509.2.4.5 “Alkali-Silica Reactivity” are less than 0.10% for each of the individual aggregates in the mixture, the Department will waive the low-alkali requirement.

509.2.2.1 Source Approval and Acceptance
The Department will accept portland cement based on certification of the approved sources and satisfactory test results from project verification samples. The State Materials Bureau must approve cement from a particular source or Contractor before use. Include the following information in the request for source approval:

1. The Supplier or company;
2. Cement plant location;
3. Storage facility type and capacity;
4. Average and maximum production capabilities;
5. Production procedures;
6. Details regarding the in-house quality control program information:
   6.1 Routine sampling and testing frequency;
   6.2 Documentation that the Laboratory responsible for the certified ASTM C 150, ASTM C 595, and ASTM C 1157 test results is currently participating in the Cement and Concrete Reference Laboratory (CCRL) proficiency sample and the pozzolan inspection programs;
   6.3 A copy of the Laboratory letter authorizing CCRL to send copies of the CCRL inspection programs and proficiency result reports directly to the State Materials Bureau;
   6.4. Documentation of measures taken to ensure that the Supplier keeps unacceptable cement separated from acceptable cement;
7. Copies of quality control program test reports for the previous six months, including at least one comprehensive ASTM C 150 analysis for each month.

The Department will maintain a list of approved sources.

509.2.2.2 Sources on Approved List
Provide the following information from approved sources to the State Materials Bureau monthly:

1. Copies of routine quality control program test results; and
2. A certified ASTM C 150 or ASTM C 595 analysis for each lot tested. An average over a period of time or over several different test lots will not be acceptable.

509.2.2.3 Withdrawal of Source Approval
The State Materials Bureau may withdraw source approval for any of the following reasons:

1. A change in Equipment or production procedure from that on the original request for approval;
2. Project sample failure to comply with specification requirements;
3. Chemistry or physical properties that vary more than allowed;
4. A source becomes inactive for a period of 3 months; or
5. A source does not provide cement to the Department for a period of 1 year;
6. The appropriate mill certificates are not regularly received.

Manufacture cement at the same production facility unless otherwise approved by the State Materials Bureau. Obtain approval for changes in cement sources. Submit a written source change request to the Project Manager. The State Materials Bureau will issue a written decision within 7 Days of receipt.

Provide documentation that the proposed source will provide cement that produces concrete with hardened properties equal to or better than the original source. Compliance with ASTM C 150 is not sufficient documentation.

509.2.2.4 Blended Portland-Fly Ash Cement

Use blended portland-fly ash cement in accordance with ASTM C 595 or ASTM C 1157. Blend or inter-grind portland cement with fly ash. Provide proof that the blended portland-fly ash cement contains the appropriate percentage of the proper fly ash by weight of the cement only, to mitigate ASR concerns for the aggregates used.

509.2.2.4.1 Approval of Blended Portland-Fly Ash Cement Source

Provide test data showing that the proposed source can provide blended portland fly ash cement that produces concrete in accordance with Table 509.2.8.1:1 “Concrete Classes for Laboratory Design of Concrete Mixtures” and Section 509.2.8.4, “Concrete Mix Design Development.”

509.2.2.5 Packaging

Mark portland cement and blended portland-fly ash cement packages with the name brand, the source manufacturing facility, and the cement type. Provide the same information on the shipping documents for bulk cement deliveries.

509.2.2.6 Storage

Protect cement from moisture. Store different brands or types of cement, or cement from different production facilities separately. Provide separate, identifiable blended portland-fly ash cement storage at the project or plant site. Store portland cement and portland-fly ash cement separately.

509.2.2.7 Cement Rejection

The Department will reject cement if it:
1. Has come in contact with moisture, fly ash, or other cements; or
2. Has partially set or is lumpy.

509.2.3 Fly Ash

Use fly ash that complies with the physical and chemical requirements of ASTM C 618 and the optional requirements for available alkaulis and reactivity with cement alkalis as modified by Table 509.2.3:1, “Fly Ash Requirements.” Use Class F fly ash if either the coarse or the fine aggregate is reactive. If both the coarse and the fine aggregate are non-reactive, the Contractor may use a C/F blend fly ash or a Class C fly ash.

<table>
<thead>
<tr>
<th>Table 509.2.3:1 Fly Ash Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics</td>
</tr>
<tr>
<td>Sum of Al₂O₃, SiO₂, and Fe₂O₃</td>
</tr>
<tr>
<td>Moisture content, maximum %</td>
</tr>
<tr>
<td>Loss on ignition, maximum %</td>
</tr>
<tr>
<td>Magnesium Oxide (MgO), maximum %</td>
</tr>
<tr>
<td>Available Alkalis, maximum %</td>
</tr>
<tr>
<td>Calcium Oxide (CaO), maximum %*</td>
</tr>
</tbody>
</table>

*NMDO will only consider a fly ash as Class F if the CaO is less than 8%. Fly ash meeting the requirements of ASTM C 618 and containing more than 8% by weight of bulk CaO is considered as Class C fly ash and can only be used in concrete that is not exposed to sulfate environments or with “potentially reactive”, or “reactive” aggregate.

Section 509: Portland Cement Concrete Mix Designs
Use waterproof and clearly labeled bags when supplying fly ash in bags. Label with the name brand, the manufacturer, type, and source. Provide an executed Certificate of Compliance with each fly ash shipment. Permission for blending Class C and Class F fly ash depends upon approval by the State Materials Bureau. Ensure the blended fly ash is in accordance with ASTM C 618 and is limited to concrete mixes in which the coarse and fine aggregates are non-reactive.

509.2.3.1 Source Approval and Acceptance
The Department will accept fly ash based on certification of approved sources and satisfactory test results on project verification samples. Obtain approval from the State Materials Bureau before using fly ash from a particular source or Supplier in PCC. Include the following in source approval requests:

1. Supplier or company name;
2. Source power plant location;
3. Coal type and origin;
4. Combustion process;
5. Storage facilities and capacity;
6. Production procedures;
7. Details regarding the Supplier’s quality control program including the following:
   7.1. Routine sampling and testing frequency;
   7.2. Documentation showing that the Laboratory responsible for the certified ASTM C 618 test results is currently participating in the CCRL proficiency sample and pozzolan inspection programs. Submit a letter authorizing CCRL to send the Laboratory’s inspection and proficiency reports directly to the State Materials Bureau; and
   7.3. Measures taken to ensure that fly ash not meeting specification requirements are kept separate from Material meeting the requirements;
8. Copies of the quality control program test reports for each lot tested for the previous six months including at least one complete ASTM C 618 analysis for each month.

The Department will maintain an approved products list. Do not substitute the approved Material source for a different source without prior Department approval. The Department will consider a fly ash source change only after receiving a written request. The State Materials Bureau will review the request and provide written approval once they have verification of the equivalency of the proposed Material. Compliance with ASTM C 618 is not sufficient documentation to permit a change of sources. Provide information that verifies the proposed source Material performs equally as Material from the original source.

509.2.3.2 Sources on Approved List
Sources on the approved list are required to provide the State Materials Bureau with the following information on a monthly basis:

1. Test results obtained in their routine quality control program; and
2. A certified ASTM C 618 analysis for each lot tested.

509.2.3.3 Withdrawal of Source Approval
The Department may withdraw source approval for any of the following reasons:

1. If there is a change in Equipment or production procedures from what was shown in the original request for approval;
2. If a project sample fails to comply with specification requirements;
3. If a source becomes inactive for 3 consecutive months or more; or
4. If a source does not furnish fly ash to the Department for a period of 1 year.

509.2.3.4 Storage
Protect fly ash from moisture. Store different brands or types of fly ash, or fly ash from different production facilities separately. Provide separate, identifiable blended portland-fly ash cement storage at the project or plant site. Store portland cement and portland-fly ash cement separately.

509.2.4 Aggregate
The Department will allow the Contractor to combine aggregates from two or more approved sources based on the following criteria:
1. Each source complies with Material requirements other than gradation; and
2. The blended Material meets all requirements.

509.2.4.1 Aggregate Testing

Test coarse and fine aggregate in accordance with the methods shown in Table 509.2.4.1:1, “Aggregate Test Methods.” Concrete mixture design approval involving a designated source will remain in effect as long as annual test results for specific gravity, absorption, gradation, and sand equivalent (for fine aggregate only) and annual tests for other requirements (except ASR) demonstrate Material compliance.

<table>
<thead>
<tr>
<th>Aggregate Test Methods</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling</td>
<td>AASHTO T 2</td>
</tr>
<tr>
<td>Clay lumps</td>
<td>AASHTO T 112</td>
</tr>
<tr>
<td>Amount of Material passing</td>
<td>AASHTO T 11</td>
</tr>
<tr>
<td>No. 200 sieve</td>
<td></td>
</tr>
<tr>
<td>Absorption &amp; Specific Gravity of Coarse Aggregate</td>
<td></td>
</tr>
<tr>
<td>Absorption &amp; Specific Gravity of Fine Aggregate</td>
<td>AASHTO T-85</td>
</tr>
<tr>
<td>Sieve analysis</td>
<td>AASHTO T 27</td>
</tr>
<tr>
<td>Soundness with magnesium sulfate</td>
<td>AASHTO T 104</td>
</tr>
<tr>
<td>Sand equivalent</td>
<td>AASHTO T 176</td>
</tr>
<tr>
<td>Soft fragments</td>
<td>AASHTO T 112</td>
</tr>
<tr>
<td>Flat and elongated pieces</td>
<td>ASTM D 4791</td>
</tr>
<tr>
<td>Alkali-Silica Reactivity</td>
<td>AASHTO T303 or ASTM C1293</td>
</tr>
</tbody>
</table>

509.2.4.2 Coarse Aggregate

Coarse aggregate is crushed stone, crushed gravel, or natural washed gravel. Unless otherwise specified, ensure that at least 50% of the aggregate by weight has a minimum of 1 Fractured Face. Ensure that Class G mixes are composed of at least 50% particles with no Fractured Faces. The Department may waive the Fractured Face requirement for mixes other than Class G mixes if less than 1.0% of the Material passes the No. 200 sieve.

509.2.4.2.1 Deleterious Materials

Do not exceed the deleterious substance tolerances in accordance with Table 509.2.4.2.1:1, “Deleterious Materials Tolerances for Coarse Aggregate.” Perform tests in accordance with Table 510.2.4.1:1, “Aggregate Test Methods.”

<table>
<thead>
<tr>
<th>Deleterious Materials Tolerances for Coarse Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substance</td>
</tr>
<tr>
<td>Soft fragments</td>
</tr>
<tr>
<td>Coal and lignite</td>
</tr>
<tr>
<td>Clay lumps</td>
</tr>
<tr>
<td>Materials passing No. 200 sieve</td>
</tr>
<tr>
<td>Flat and elongated pieces</td>
</tr>
</tbody>
</table>

*Ensure that Material larger than 3/8 in contains no more than 15% flat or elongated particles with a 3:1 or greater dimensional ratio in accordance with TTCP. Add the percentage of flat pieces to the percentage of elongated pieces to determine specification compliance. Count pieces that are both flat and elongated only once.

Provide aggregate that is free of organic matter. The Department will reject contaminated aggregate.
509.2.4.2 Coarse Aggregate Quality Requirements

Provide coarse aggregate with an AI of 25 or less, calculated in accordance with Section 910, “Aggregate Index.” The Department will reject aggregates with an AI greater than 25.

509.2.4.2.2 Coarse Aggregate Quality Requirements

Provide coarse aggregate with an AI of 25 or less, calculated in accordance with Section 910, “Aggregate Index.” The Department will reject aggregates with an AI greater than 25.

509.2.4.2.3 Coarse Aggregate Gradation Requirements

If the combined gradation procedure detailed in Section 509.2.8.3.1, “Combined Gradation” has been chosen by the Contractor, then the gradation requirements specified below do not apply. Comply with all other aggregate properties and characteristics, including the amount of Material passing the No. 200 sieve.

Use coarse aggregate that complies with Table 509.2.4.2.3:1, “Coarse Aggregate Gradation Requirements.”

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>% of aggregate passing sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 in</td>
<td>100</td>
</tr>
<tr>
<td>1.5 in</td>
<td>95–100</td>
</tr>
<tr>
<td>1.0 in</td>
<td>95–100</td>
</tr>
<tr>
<td>3/4 in</td>
<td>35–70</td>
</tr>
<tr>
<td>0.5 in</td>
<td>25–60</td>
</tr>
<tr>
<td>3/8 in</td>
<td>10–30</td>
</tr>
<tr>
<td>No. 4</td>
<td>0–5</td>
</tr>
<tr>
<td>No. 8</td>
<td>0–5</td>
</tr>
<tr>
<td>No. 200</td>
<td>0.0–2.0</td>
</tr>
</tbody>
</table>

Provide coarse aggregate that meets the following:
1. 50% of the Material has at least 1 Fractured Face; and
2. 2.0% or less (by weight) of the Material passes a No. 200 sieve.

The Department may accept coarse aggregate with more than the maximum percent passing the No. 200 sieve if the combined gradation of the coarse and fine aggregate percent passing the No. 200 sieve does not exceed 3.0%.

509.2.4.2.4 Portland Cement Concrete Pavement (PCCP) Gradations

Meet the coarse aggregate gradation requirements shown in Table 509.2.4.2.3:1, “Coarse Aggregate Gradation Requirements,” for PCCP, unless using the combined gradation procedure. Additionally, except when the gradation of the coarse and fine aggregate combined has less than 1.0% passing the No. 200 sieve, all of the particles retained on or above the 3/8 in sieve must have at least 1 Fractured Face. The Contractor may eliminate the Fractured Face requirement by washing the aggregate to produce a combined aggregate of which less than 1.0% passes a No. 200 sieve. Provide proof that the mix design meets performance and minimum specified hardened properties.

509.2.4.3 Fine Aggregate

Use fine aggregate that consists of natural sand, manufactured sand, or a combination of both.

509.2.4.3.1 Deleterious Materials

Provide fine aggregates in accordance with Table 509.2.4.3.1:1, “Deleterious Material Tolerances for Fine Aggregate.”

<table>
<thead>
<tr>
<th>Substance</th>
<th>Maximum % by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft fragments</td>
<td>2.0</td>
</tr>
<tr>
<td>Coal and lignite</td>
<td>1.0</td>
</tr>
<tr>
<td>Clay lumps</td>
<td>3.0</td>
</tr>
<tr>
<td>Materials passing No. 200 sieve</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Table 509.2.4.3.1:1
Deleterious Material Tolerances for Fine Aggregate
509.2.4.3.2 Fine Aggregate Quality Requirements

Provide fine aggregate with the following properties:

1. A soundness loss of 12 or less when tested in accordance with AASHTO T 104 using magnesium sulfate solution and a test duration of 5 cycles; and
2. A sand equivalent of at least 75 when tested in accordance with AASHTO T 176.

509.2.4.3.3 Fine Aggregate Gradation Requirements

If the combined gradation procedure detailed in Section 509.2.8.3.1, “Combined Gradation” has been chosen by the Contractor, then the gradation requirements specified below do not apply. Comply with all other aggregate properties and characteristics, including the amount of Material passing the No. 200 sieve.

Use well-graded fine aggregate in accordance with Table 509.2.4.3.3:1, “Fine Aggregate Gradation Requirements.” The gradation requirements represent the limits that the Department will use to determine source acceptability.

The Department will not approve fine aggregate that has more than 45% passing any sieve and retained on the next finer sieve shown in Table 509.2.4.3.3:1, “Fine Aggregate Gradation Requirements.” Use a fineness modulus, calculated in accordance with AASHTO M 6, to determine the degree of uniformity between representative samples. If the combined gradation procedure has not been chosen, the Department may reject fine aggregate from designated sources with variation in fineness modulus greater than 0.20 above or below the fineness modulus shown on the approved concrete mix designs. Variations in excess of these tolerances may be cause for rejection. The Department may accept the aggregate once the Contractor assures the State Materials Bureau that the source maintains the designated production tolerances.

<table>
<thead>
<tr>
<th>Table 509.2.4.3.3:1 Fine Aggregate Gradation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve size</td>
</tr>
<tr>
<td>3/8 in</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 50</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

The Department may accept fine aggregate with more than 3% percent passing the No. 200 sieve, but not more than 5% passing the No. 200 sieve if the combined fine and coarse aggregates passing the No. 200 sieve does not exceed 3.0%.

509.2.4.4 Alkali-Silica Reactivity

Prevent damage from ASR in accordance with the following procedures.

Perform the initial proof-of-reactivity-potential test using standard Rio Grande Type I-II low alkali cement from the Rio Grande Cement plant located at Tijeras, New Mexico. Use cement with an alkali content of from 0.5% to 0.6%. The Department considers aggregates with mean mortar bar expansions of greater than 0.10% at 14 Days potentially reactive and those less than 0.10% as non-reactive. Expansions greater than 0.20% are considered “Reactive.” If tested using ASTM C 1293, the Department will consider aggregate non-reactive if the average expansion at the end of one year is less than 0.04%. Once the State Materials Bureau decides a particular aggregate source is non-reactive, it will not require the source to reevaluate for three years unless concerns arise from possible aggregate source changes. Obtain a list of reactive, potentially reactive, and non-reactive aggregate sources tested to date from the State Materials Bureau.

If the results of the initial proof-of-potential-reactivity test show the aggregate to be “potentially reactive” or “reactive”, repeat the test procedure using the actual cement, fly ash and, if desired, any of the ASR inhibiting admixtures shown in Table 509.2.4.4:1 “ASR Inhibiting Admixtures.” Report the minimum amount of Class F fly ash, and the minimum amount of ASR inhibiting admixture required to provide a maximum expansion at 14 Days that is less than 0.10%. Report the Fly Ash required as a percentage of the cement weight.
### Table 509.2.4.4:1
ASR Inhibiting Admixtures

<table>
<thead>
<tr>
<th>Material</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly ash (Class F)</td>
<td>Section 510.2.9, “Fly Ash”</td>
</tr>
<tr>
<td>Blended cement (Only Class F Fly Ash may be used)</td>
<td>Section 510.2.4.4, “Blended Portland Fly-Ash Cement”</td>
</tr>
<tr>
<td>Ground granulated blast furnace slag (GGBFS), Grade 100 and 200</td>
<td>AASHTO M 302</td>
</tr>
<tr>
<td>Silica fume</td>
<td>AASHTO M 307</td>
</tr>
<tr>
<td>Lithium nitrate (LiNO₃)</td>
<td>Section 510.2.11, “Lithium”</td>
</tr>
</tbody>
</table>

Use admixtures in accordance with Table 509.2.4.4.2, “ASR Mitigation Dosage Rate Requirements,” unless it is determined that larger dosages are required to control the expansion.

### Table 509.2.4.4:2
ASR Mitigation Dosage Rate Requirements

<table>
<thead>
<tr>
<th>Material</th>
<th>Dosage Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly ash (Class F)</td>
<td>As required to mitigate ASR expansion, but not less than 20% by weight of cement only for binary blends; not less than 12% by weight for ternary blends as long as the total pozzolan dosage is at least 20%</td>
</tr>
<tr>
<td>Blended cement</td>
<td>As required, but not less than 20% by weight of cement only</td>
</tr>
<tr>
<td>GGBFS</td>
<td>As required, but not less than 25% by weight of cement only</td>
</tr>
<tr>
<td>Silica fume</td>
<td>As required, but not less than 10% by weight of cement only</td>
</tr>
<tr>
<td>Lithium nitrate</td>
<td>0.55 gal/yd³ of solution for each pound of cement sodium equivalent</td>
</tr>
</tbody>
</table>

### 509.2.4.4.1 ASR Mitigation Evaluation Criteria

The Department will consider an admixture effective if the mean mortar bar expansion at 14 Days is less than or equal to 0.10%, when tested in accordance with Section 509.2.4.4 “Alkali-Silica Reactivity.” Retest aggregates classified as “potential reactive” or “reactive” for ASR mitigation each time the comprehensive mix evaluation is performed. If the test results from AASHTO T 303 or ASTM C 1293 indicate “potentially reactive” or “reactive” Material, but the Contractor believes that the aggregates are non-reactive, submit the following documentation as proof of non-reactivity:

1. A letter signed and sealed by an engineer registered in New Mexico confirming direct knowledge of the fundamentals of ASR in concrete and stating that the subject aggregates have never caused ASR concrete deterioration; and
2. A report from an approved petrographer. The report will confirm that at least two different concrete core samples obtained from different 15-year old exposed structures that used the subject aggregates in a cement-only mixture were examined and that there is no evidence of ASR reactivity.

After receipt of a stamped letter from the registered professional engineer indicating no evidence of ASR gel found in either of the cores, the Department will consider the aggregate sources non-reactive.

### 509.2.5 Admixtures

Ensure the total admixture, or combinations of admixtures, of soluble and insoluble chloride content does not exceed 1,000 ppm. Use only admixtures on the Department’s Approved Products List.

#### 509.2.5.1 Air Entraining Admixtures

Use air-entraining admixtures that comply with AASHTO M 154.

#### 509.2.5.2 Chemical Admixtures

Use water-reducing and set-controlling admixtures set retarding admixtures, and non-
chloride set accelerating admixtures, that comply with Section 509.2.5, “Admixtures,” and AASHTO M 194.

509.2.6 Water
Test non-potable water before use in accordance with AASHTO T 26. Use water for mixing and curing concrete or washing concrete aggregates that does not contain acid, oil, alkali, organic matter, or other Deleterious Material that will adversely affect the concrete. Use water with a pH value of from 6.0 to 8.5 in accordance with AASHTO T 26. Do not use water with a sulfate content or chloride content that exceeds 1,000 ppm. Prevent contamination from silt, clay, organic matter, or other Deleterious Material. Do not use residual water, wash water, or recycled water generated by Equipment, mixer trucks, or central mixers in concrete mixtures.

509.2.7 Fibrous Concrete Reinforcement
Use fibers in the concrete mix at a minimum dosage rate of 1.5 lb per cubic yard of concrete. Use only 100% virgin polypropylene fibrillated fibers, containing no reprocessed olefin materials, and specifically manufactured for use in PCC.

509.2.8 PCC Mixture Design and Approval
509.2.8.1 Classifications
The classes of PCC are shown in Table 509.2.8.1:1, “Concrete Classes for Laboratory Design of Concrete Mixtures,” and as specified:

<table>
<thead>
<tr>
<th>Class</th>
<th>Use</th>
<th>Specified compressive strength at 28 Days, (psi)</th>
<th>Laboratory design slump a (in)</th>
<th>Percent air content b</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Cast in-place</td>
<td>3,000</td>
<td>4.5 to 5.5</td>
<td>—</td>
</tr>
<tr>
<td>AA</td>
<td>Cast in-place</td>
<td>4,000</td>
<td>4.5 to 5.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>structural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-structural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Slip form</td>
<td>2,500</td>
<td>4.5 to 5.5</td>
<td>—</td>
</tr>
<tr>
<td>E</td>
<td>Slip form</td>
<td>2,500 c</td>
<td>2.0 to 2.5</td>
<td>—</td>
</tr>
<tr>
<td>F</td>
<td>Slip form</td>
<td>3,000 c</td>
<td>2.0 to 2.5</td>
<td>—</td>
</tr>
<tr>
<td>G</td>
<td>Drilled shafts</td>
<td>3,000</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>HPD</td>
<td>Bridge decks</td>
<td>4,000</td>
<td>4.5 to 5.5</td>
<td>—</td>
</tr>
</tbody>
</table>

No entrained air agent allowed

The Special Provisions for the individual project will address special mix requirements.

a As determined by AASHTO T 119.

b Project risk zone requirements apply; see Section 510.3.2, “Freeze-Thaw Risk Zones.”

c The specified age for Class E and Class F is 14 Days.

509.2.8.1.1 Details for Table 509.2.9.1:1, “Concrete Classes for Laboratory Design of Concrete Mixtures”
Use Table 509.2.8.1:1, “Concrete Classes for Laboratory Design of Concrete Mixtures,” only for designing concrete mixes. Do not use to evaluate concrete delivered to Department projects.
Use the minimum air content shown below in the Laboratory mix:
1. High Risk Zones: 7.0%
2. Medium Risk Zones: 6.5%
3. Low Risk Zones: 6.0%
Use a minimum compressive strength over-design at least 1,200 psi greater than the specified compressive strength for new mixes if there is no additional information available.
For existing mixes with at least 15 compressive strength tests, or for plants which can provide at least 15 consecutive compressive strength tests for a similar mix (same entrained air and same specified compressive strength) determine the minimum allowable average compressive strength using one of the following equations. Use the equation that produces the largest value to determine the minimum allowable compressive strength.

\[
\begin{align*}
 f'_{cr} &= f'_{c'} + (1.34 \times k \times s) \\
 f'_{cr} &= f'_{c'} + (2.33 \times k \times s) - 500
\end{align*}
\]

where

\( f'_{cr} \) is the minimum laboratory compressive strength at the specified age

\( f'_{c'} \) is the specified compressive strength

\( k \) is the k-factor from Table 509.2.8.1.1:1, “k-Factor for Increasing Standard Deviation,” for standard deviation increase if the total number of tests is less than 30, but equal to or greater than 15

\( s \) is the standard deviation for the compressive strength tests submitted of the same specified strength

<table>
<thead>
<tr>
<th>Total number of tests</th>
<th>k-Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1.16</td>
</tr>
<tr>
<td>20</td>
<td>1.08</td>
</tr>
<tr>
<td>25</td>
<td>1.03</td>
</tr>
<tr>
<td>≥30</td>
<td>1.00</td>
</tr>
</tbody>
</table>

The Department will allow linear interpolation for an intermediate number of tests. A mix that was developed from a history of 15 or more test results from the preceding 12-month period is considered an existing mix. A mix developed without historical test results is considered a new mix.

Class E and Class F concrete must attain minimum strength at 14 Days. The minimum Class F over-design is 800 psi at 14 Days unless a lower value is calculated using the greater value from either Equation (1) or Equation (2). The minimum Class E over-design is 600 psi at 14 Days, unless a lower number is calculated using the greater value from either Equation (1) or Equation (2).

Class G shall have the following characteristics:

1. A minimum cementitious content of at least 611 lb;
2. A maximum water/cementitious ratio no greater than 0.44;
3. A maximum sized aggregate no greater than 0.75 in;
4. A sand/aggregate ratio between 40% and 42% by total aggregate volume;
5. A maximum air content no greater than 3.0%;
6. No air entrainment agent;
7. A slump range of 7.0 in ± 1.0 in, except when placing under a drilling fluid;
8. A slump range of 8.0 in ± 1.0 in for placement under a drilling fluid; and
9. Adjust admixtures for the job site conditions encountered so that the concrete remains workable and plastic for the 2 hr placement limit.

509.2.8.2 Freeze-Thaw Risk Zones

Design the concrete mixture for use in the freeze-thaw zone in which the project is located. One freeze/thaw cycle is defined as a day in which the lowest recorded temperature is equal to or less than 25°F as recorded on the Western Regional Climate Center database. The web address is www.wrcc.dri.edu. The risk levels are defined as follows:

1. **Low-Risk**. The annual average number of freeze/thaw cycles is equal to or less than 30 cycles per year;
2. **Medium-Risk**. The annual average number of freeze/thaw cycles is greater than 30 but less than or equal to 130 cycles per year;
3. **High-Risk**. The annual average number of freeze/thaw cycles is greater than 130 cycles per year.
Obtain the number of freeze/thaw cycles using the closest weather station to the project with the most similar environmental conditions. Use Table 509.2.8.2:1, “Statewide Concrete Risk Zones,” to determine the required risk zone.

<table>
<thead>
<tr>
<th>District no.</th>
<th>County name</th>
<th>Station name</th>
<th>Concrete risk zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dona Ana (County wide)</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Grant (County wide)</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Hidalgo (County wide)</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Luna (County wide)</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Sierra (County wide)</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Socorro (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Chaves (County wide)</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Curry (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>De Baca (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Eddy (County wide)</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lea (County wide)</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lincoln (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lincoln Ruidoso</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Otero (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Roosevelt (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bernalillo (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bernalillo Sandia Crest</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Sandoval (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Valencia (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Colfax (County wide)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Guadalupe (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Harding (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Mora (County wide)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Quay (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>San Miguel (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Union (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Los Alamos (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rio Arriba (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rio Arriba Chama</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rio Arriba Dulce</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rio Arriba El Vado Dam</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rio Arriba Gavián</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rio Arriba Lindrith</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rio Arriba Tres Piedras</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>San Juan (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Santa Fe (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Taos (County wide)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Torrance (County wide)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Catron (County wide)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Cibola (County wide)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>McKinley (County wide)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sandoval (County wide)</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

*Except as otherwise listed*

The minimum allowable air content for mix design submittal purposes is:
1. 6.0% for low-risk zones;
2. 6.5% for medium-risk zones;
3. 7.0% for high-risk zones.

Confirm these contents by the pressure method and the volumetric method in accordance with Section 509.2.8.4.3, “Mix Design Submittal.”

509.2.8.3 PCC Mixture Development

Submit representative samples of all proposed Materials to a PTL that is pre-approved to
Section 509: Portland Cement Concrete Mix Designs

509.2.8.3.1 Combined Gradation

The combined gradation procedure is optional for all concrete mixes except for High Performance Deck (HPD) mixes. HPD mixes must be prepared using the combined gradation procedure. Evaluate aggregates for concrete mixtures prepared for the combined gradation procedures in accordance with the following:

1. **Coarseness Factor.** Determine the Coarseness Factor in accordance with the following equation:

   \[ CF = \frac{Q}{Q + I} \times 100 \]  

   where
   - \( CF \) is the Coarseness Factor
   - \( Q \) is the weight of the aggregate retained on or above the 3/8-inch sieve
   - \( I \) is the weight of the aggregate passing the 3/8 in sieve, but retained on the No. 8 sieve

2. **Workability Factor.** The weight of the aggregate passing the No. 8 sieve divided by the weight of the combined gradation, represented as a percent.

3. **Mortar Factor.** The volume of the cement, fly ash, water, air, other pozzolans, and aggregate passing the No. 8 sieve divided by the volume of the entire concrete mixture, represented as a percent.

4. **Paste Factor.** The volume of the cement, fly ash, water, air, and other pozzolans divided by the volume of the entire concrete mixture, represented as a percent.

Combine aggregates to produce a uniform gradation. Ensure that combined aggregates comply with the required individual physical and chemical properties. Individual gradation requirements will not apply. Use the .45 Power Curve to blend the aggregates to achieve the densest grading possible. Approximate targets for the Coarseness Factor and the Workability Factor are shown in Table 509.2.8.3.1:1, “Recommended Workability Factor and Coarseness Factor Targets,” for concrete mixtures designed using combined gradation.

**Table 509.2.8.3.1:1**

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size</th>
<th>Workability Factor</th>
<th>Coarseness Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 in</td>
<td>31–33</td>
<td>65–80</td>
</tr>
<tr>
<td>1.0 in</td>
<td>33–35</td>
<td>60–70</td>
</tr>
<tr>
<td>3/4 in</td>
<td>38–40</td>
<td>45–55</td>
</tr>
<tr>
<td>1/2 in</td>
<td>40–42</td>
<td>10–20</td>
</tr>
</tbody>
</table>

509.2.8.4 Concrete Mix Design Development

Use fly ash in all concrete mixtures. If fly ash is the only pozzolan used, add at a minimum of 20%, by weight of cement only. Only use Class C or C/F blended fly ash with non-reactive aggregate. When using Class C or C/F blended fly ash instead of the Class F fly ash, use at a minimum dosage rate of 25%, by weight of cement. When using additional pozzolans, such as silica fume, metakaolin, or GGBFS, the minimum amount of fly ash required is 12% for mixtures using Class F fly ash and 15% for mixtures using Class C fly ash. When using multiple pozzolans, ensure that the total pozzolan content is at least 20% with Class F fly ash and 25% with Class C or C/F blend fly ash.

509.2.8.4.1 Concrete Mix Design Documentation

Submit documentation to the State Materials Bureau that verifies:

1. All Materials used comply with Section 510.2, “Materials;”
2. The PTL prepared and tested a proof mix using the designated Materials and batch weights;
3. A complete companion set of compressive strength test cylinders was delivered to the Department District Laboratory for comparison testing.

Section 509: Portland Cement Concrete Mix Designs Page 213
4. The cylinders were cured for at least 48 h after casting, and the cylinders were transported upright in protected and cushioned containers to the Department District Laboratory.

509.2.8.4.2 Concrete Mix Design Designing & Proportion
Design and proportion the concrete mixtures to comply with the following performance requirements:

1. Except for concrete mixtures to be used exclusively in pre-stressed applications, all structural concrete mixtures must demonstrate strength gain characteristics as follows:
   1.1 28-Day strength of at least 130% of the 7-Day strength;
   1.2 56-Day strength at least 108% of the 28-Day test;

2. Structural concrete mixtures must achieve a minimum durability index:
   2.1 Greater than or equal to 85 for Low-Risk Zones;
   2.2 Greater than or equal to 90 for Medium-Risk Zones; and
   2.3 Greater than or equal to 95 for High-Risk Zones;

Determine the durability index from at least one prism tested at 28 Days for 300 cycles, in accordance with ASTM C 666, Method A. Cure prisms tested for durability index by bathing in lime saturated water at a temperature of 73.3 °F ± 3.0 °F for the first 7 Days followed by 21 Days in lime saturated water at a temperature of 100.0 °F ± 3.0 °F. If the specimen cannot be tested immediately after curing, place immediately in a freezer at a maximum temperature of 10.0 °F until testing;

3. Hardened air void system characteristics required of all structural concrete classes, when examined in accordance with the ASTM C 457 linear traverse method include:
   3.1 A minimum air content of 5.0%;
   3.2 A specific surface greater than 600 in-1; and
   3.3 A spacing factor less than 0.008 in;

4. Ensure that concrete complies with Section 509.2.4.4, "Alkali-Silica Reactivity," and Section 509.2.4.5.1, "ASR Mitigation Evaluation Criteria," as determined by the State Materials Bureau;

5. Provide chloride ion permeability at 28 Days for structural concrete tested in accordance with ASTM C 1202 that is:
   5.1 Less than or equal to 3,000 coulombs for Low-Risk Zones; or
   5.2 Less than 2,500 coulombs for Medium-Risk Zones; or
   5.3 Less than 2,000 coulombs for High-Risk Zones;

Cure concrete for chloride ion permeability the same way as the durability index specimens in accordance with #2, above;

6. The maximum shrinkage value for HPD concrete mixtures is 0.05% at 56 Days when tested with 3 in x 4 in x 16 in prism or 3 in x 3 in x 10 in prism and cured in a standard cure for the first 7 Days. Following the 7 Day initial cure, cure in a relative humidity of 50% and test in accordance with AASHTO T 160;

7. For Class G mixtures, provide trial mix and slump loss test results that verify compliance with the concrete slump requirements for Class G.

Only technicians who are currently certified as ACI Concrete Field Technician, Level I shall determine concrete fresh properties in accordance with the appropriate AASHTO procedures. Laboratories approved by the Department’s State Materials Bureau shall determine hardened properties. Technicians performing tests on hardened concrete must be certified as an ACI Level I Laboratory Technician or by TTCP for Compressive Strength Testing of Concrete.

Develop concrete mixtures with compressive strengths as close as possible to the over-design strengths calculated in accordance with Section 509.2.8.1.1, “Details for Table 509.2.8.1.1, ‘Concrete Classes for Laboratory Design of Concrete Mixtures.’” Concrete with strengths substantially in excess of these over-design strengths will be rejected and returned to the submitting Laboratory for the appropriate adjustments.

509.2.8.4.3 Mixture Design Submittal
Submit a completed electronic copy of the NMDOT Concrete Mix Design Submittal Form to the Concrete Unit of the State Materials Bureau. Ensure that the following information is included:

1. Company name of the requestor;
2. Company address, telephone number and e-mail address;
3. PTL’s name and signature; and
4. The New Mexico registration number of the professional engineer who is responsible for the concrete mixture design work;

Ensure that the following information and the required documentation is provided electronically and through back-up documentation:

5. A comprehensive materials list and the properties of each component, including:
   5.1. Aggregates:
      5.1.1. Source names;
      5.1.2. Specific source locations;
      5.1.3. For sources not on the Department approved list, provide a complete ASTM C 295 "Petrographic Examination of Aggregates for Concrete" and an ASTM C 294, "Constituents of Natural Mineral Aggregates" for both the coarse and fine aggregate Material after completing processing and manufacturing procedures and the aggregate is ready for use; include the geologic origin of the Material; perform and certify the analysis using a petrographer previously approved by the Department;
      5.1.4. Soundness loss with calculations;
      5.1.5. Percent of Fractured Faces for the coarse aggregate;
      5.1.6. Gradations, including AASHTO T 11;
      5.1.7 Bulk saturated surface dry specific gravities;
      5.1.8. Los Angeles wear abrasion;
      5.1.9. Fineness modulus;
      5.1.10. Aggregate absorption;
      5.1.11. Aggregate correction factor;
      5.1.12. Sound equivalent of fine aggregate;
      5.1.13. Fineness modulus;
      5.1.14. Fine aggregate clay lumps content; and
      5.1.15. Organic impurity content, including soft fragments, coal and lignite, flat or elongated pieces, and other deleterious substances.
   5.2. Cement:
      5.2.1. ASTM C 150 Analysis;
      5.2.2. Chemical and physical cement properties, including the amount of C3S, C2S, C3A, the amount finer than the No. 325 sieve, and the Blaine Fineness; and
      5.2.3. Cube strengths;
   5.3. Fly Ash:
      5.3.1. ASTM C 618 Analysis;
      5.3.2. Specific gravity;
      5.3.3. Material retained on a No. 325 sieve;
      5.3.4. Moisture content;
      5.3.5. Loss on ignition;
      5.3.6. Magnesium oxide content; and
      5.3.7. Calcium oxide content.
   5.4. Blended Cement:
      5.4.1. ASTM C 595 and ASTM C 1157 analyses;
      5.4.2. Chemical and physical cement properties, including the percent of C3S, C2S, C3A, the amount finer than a No. 325 sieve, and the Blaine Fineness;
      5.4.3. Total alkalis;
      5.4.4. ASTM C 618 Analysis; and
      5.4.5. Percent of fly ash;
   5.5. Admixtures:
      5.5.1. Documentation of compliance with appropriate ASTM requirements; and
      5.5.2. Verification of supply availability;
   5.6. Water:
      6. Concrete mixture proportions; state clearly if submitting request under the combined gradation provisions;
      7. Water/cementitious ratios;
8. Type and amount of admixtures; use admixtures on the Department’s Approved Products List;
9. Water source and location; include pH, available alkalis, and a full chemical analysis, if the water source is not a certified NMED public potable water supply;
10. Plastic Concrete Properties:
   10.1 Air temperature;
   10.2 Concrete temperature;
   10.3 Slump; when using super-plasticizer, document the slump before and after addition of the super-plasticizer;
   10.4 Unit weight; and
   10.5 Air content measured in accordance with AASHTO T 152 or AASHTO T 121;
10.6 When using super-plasticizer, document the measured air content before and after adding the super-plasticizer);
11. Hardened Concrete Properties:
   11.1 New Concrete Mixtures:
      11.1.1 Compressive strength tests (the average of three cylinders tested at 7 Days, 28 Days, and 56 Days, except for Class E and Class F which shall have two cylinders tested at 7, 14, 28 and 56 Days);
      11.1.2 Type of fracture of each cylinder;
      11.1.3 Durability index (for structural mixes only);
      11.1.4 Hardened air void analysis (for structural mixes only);
      11.1.5 Rapid Chloride Permeability (for structural mixes only); and
      11.1.6 Expansion data from AASHTO T 303;
   11.2 Existing Concrete Mixtures:
      11.2.1 Consecutive compressive strength data with individual specimen test results from 7 Days, 28 Days, and 56 Days (at least 15 tests required); Present this data in chronological order;
      11.2.2 Durability index (for structural mixes only);
      11.2.3 Hardened air void analysis (for structural mixes only);
      11.2.4 Rapid Chloride Permeability (for structural mixes only); and
      11.2.5 Expansion data from AASHTO T 303;
   11.3 Incidental Concrete Mixtures (Only for specific Projects) Concrete mixes intended for projects that anticipate less than 300 yd$^3$ of each concrete class, but not more than 750 yd$^3$ for concrete used on the project:
      11.3.1 Compressive strength data (field performance data if using the mix within the previous 12 months, or laboratory mix performance data not using it in the field); and
      11.3.2 Air content, as measured by the pressure method or the volumetric method; when using superplasticizer, show the air content before and after adding superplasticizer.

509.2.8.5 Mixture Design Approval
The Department will require at least 14 Days to review the submittal packages after receipt by the State Materials Bureau of all required information. The Department will approve designs for a period of 1 year from the date of issuance if the documentation verifies compliance with all requirements. At least 30 Days before the 1-year approval expires, the Contractor may request that the mix design be reissued. The Contractor must provide test reports showing that the mix design met specification requirements during the issue period. Mix designs may be re-approved for no more than 4 additional years. The Department will grant each approval period if the documentation verifies the following:
1. Constituent Material sources and the Material’s properties remain the same;
2. The compressive strength performance data verifies compliance with Section 510.3.5.3, “Acceptance of Concrete Based on Cylinders;”
3. Compliance with other fresh and hardened properties is verified where the mixture was used;
4. The coefficient of variation (CV), determined in accordance with ACI 214, is less than 12%; and
5. When field performance data shows the CV exceeds 12%, a “Comprehensive Operations QC/QA Manual” that shows how the Contractor will reduce the variability and improve the consistency of its production process will be required.

At the discretion of the State Concrete Engineer, a mixture can be adjusted without re-
batching by using “cement efficiency” calculations to determine the amount of change to the
cement and the total cementitious content that is necessary to achieve the desired level of
performance. When this procedure is allowed, the ratio of pozzolan to cement ratio will remain
unchanged, the water content will remain unchanged, and the aggregates will be adjusted
without changing the overall gradation to accommodate the changes in volume from changes
made to the cement. All changes made by this method must be approved by the State
Concrete Engineer before being implemented in the field.

If the constituent Materials change, immediately provide documentation to the State
Materials Bureau describing how to resolve the problem. Return the affected Material to an
approved condition or submit a new concrete mixture design package. If the compressive
strengths do not comply with Department requirements, describe the needed adjustments.
Submit a written summary of the adjustments to achieve compressive strength to the State
Materials Bureau for approval. Do not use the concrete mixture on Department projects
before receipt of written approval from the State Materials Bureau.

The Department will not consider the addition of more cement a sufficient explanation or
resolution without additional documentation explaining why other measures are not
appropriate.

509.3 CONSTRUCTION REQUIREMENTS – Vacant

509.4 METHOD OF MEASUREMENT – Vacant

509.5 BASIS OF PAYMENT

The Department will pay for concrete in accordance with the section of these Standard
Specifications for which the concrete is used.
SECTION 510: PORTLAND CEMENT CONCRETE

510.1 DESCRIPTION
This Work consists of placing PCC.

510.2 MATERIALS
Test Materials in accordance with AASHTO and ASTM methods or other test procedures designated by the Department. The State Materials Bureau will decide questions about test procedure interpretation. Correct or remove and dispose of improperly graded or segregated material that fails to meet the requirements as directed by the Project Manager and at no additional cost to the Department.

Use pre-approved Materials in accordance with the current Department’s Approved Products List. The Department will not allow changes in the source or character of the Materials without notifying the State Materials Bureau and obtaining written approval.

510.2.1 PCC Mixture
Use a PCC mixture that has been reviewed and approved in accordance with Section 509 for use the freeze-thaw risk zone in which the project is located.

510.2.2 Aggregate
Use aggregates that are the same as those used on the approved mixture design. Do not use aggregate from a different source or that does not have the same properties.

If the concrete mixture is approved under the conventional stockpile procedures, ensure the gradations comply with Table 509.2.4.2.3.1 “Coarse Aggregate Gradation Requirements” and Table 509.2.4.3.3.1 “Fine Aggregate Gradation Requirements.”

If the concrete mixture is approved under the combined gradation procedures, ensure that the most current gradations have been reviewed, and the Coarseness Factor and the Workability Factor comply with Section 509.2.8.3.1 “Combined Gradations.”

510.2.3 Curing Materials
510.2.3.1 Liquid Membrane Forming Compounds
Use Type 1-D liquid membrane-forming concrete curing compounds that comply with AASHTO M 148.

510.2.3.2 Linseed Oil Emulsion
Do not use linseed oil emulsion-curing agent.

510.2.3.3 Sheet Materials for Curing Concrete
Use concrete curing sheet Materials in accordance with AASHTO M 171. The Department will only allow the white reflective type.

510.2.3.4 Fogging System
Use a fogging system which uniformly applies a constant uniform fog of water comprised of droplets that are too small visually discern any individual droplets, and that does not splash or mark the surface of the concrete.

510.2.4 Water
See Section 509.2.6, “Water.”

510.3 CONSTRUCTION REQUIREMENTS
510.3.1 General Use
510.3.1.1 Freeze-Thaw
Use a concrete mixture which has been approved for use in a freeze-thaw zone of equal or greater risk than the zone in which the project is located.

510.3.1.2 Class Substitution
The Contractor may substitute an approved structural class of concrete with a higher compressive strength than that of the specified class of concrete, as long as the design slump characteristics remain the same (i.e. Class AA for Class A, Class F for Class E). Do not substitute Class A for Class E or Class AA for Class F concrete mixtures.

Perform concrete field-testing with concrete field testing technicians certified by ACI or
510.3.1.3 Alternate Batching Facilities
A request may be made to the State Materials Bureau to allow a currently approved concrete mixture to be batched out of facilities not under the direct control of the Contractor to whom the concrete mixture approval is granted. The Department will permit off-site batching of an approved concrete mixture when the following occur:

1. Use the same Materials off-site as are used at the plant where the mixture is approved;
2. Use the same admixtures off-site as are used at the plant where the mixture is approved;
3. Prepare a written QC plan for the off-site facilities, personnel and operations that adequately addresses how the off-site plant will maintain the plant quality of the mixture;
4. The requestor has demonstrated compliance with the approved QC plan with other mixtures;
5. Provide plant statistics that show the same level of performance is achievable off-site as at the plant.

510.3.1.4 Plastic Properties
The allowable slump range for non-superplasticized Class AA and Class A concrete is 3.5 in ± 1.0 in. The allowable slump range for Class E and Class F slip-formed Concrete is 1.5 in ± 1.0 in. The Department will determine compliance with the specified air content for structural concrete using the air content calculated from the unit weight in accordance with AASHTO T 121 for the following criteria:

1. Low Risk – from 4.5% to 8.0%; or
2. Medium Risk – from 5.0% to 8.0%; or
3. High Risk – from 6.0% to 8.0%.

510.3.1.5 Troubleshooting
If the approved mixture design fails to meet requirements, the Project Manager will contact the PTL who designed the mixture and the State Concrete Engineer immediately. The PTL shall work with the State Concrete Engineer to make the necessary changes to resolve the problems found. Efforts to evaluate problems with the concrete does not relieve the Contractor of the responsibility to provide a concrete mixture that meets project requirements.

510.3.2 Batching
Produce ready-mixed concrete and site-mixed concrete in accordance with AASHTO M 157, Section 9 to 11. Ensure that production facilities are certified in accordance with the National Ready Mix Concrete Association (NRMCA) criteria for concrete production facilities.

510.3.2.1 Batching Plant
The Department will review and approve facilities and Equipment before batching operations begin.

Ensure that batching plants have clearly separated aggregate bins or stockpiles, silos for cement and fly ash, weighing hoppers, and scales. Ensure that the batch plants are equipped to proportion aggregates, bulk cement and fly ash using calibrated weighing devices. Weigh aggregates on separate scales or accumulatively on a single scale. If weighing fly ash in the same hopper as the portland cement, weigh the cement first, and then add the fly ash.

Ensure that the batch plant operator has a direct view or live video of each scale and admixture sight tube while preparing batches of concrete. It is not sufficient to be able to see only the computer measurements. Ensure that the batch plant is capable of:

1. Accurately weighing and batching Materials for portland cement or portland cement/fly ash concrete within the tolerances specified;
2. Providing readily visible scale dials or instrumentation devices for admixture bottles, beam scales and load cells, even if using a computer to prepare the batch;
3. Incorporating weighing hopper or hoppers of sufficient size to contain the Material without loss or spillage; and
4. Properly combining and re-combining various mixture components to obtain the required uniformity and consistency.
Use a weighing hopper or hoppers that efficiently discharge weighed Materials for each batch. Ensure that the Material charging Equipment can deliver the batch to the mixer without loss or spillage. Provide scales for weighing aggregates, cement, water, and fly ash in accordance with Section 109.1, “Measurement of Quantity.”

**510.3.2.2 Portland Cement and Fly Ash**

Use cement and fly ash in bulk or in sacks. Weigh fractions of sacks before using cement or fly ash in a concrete batch. Measure cement and fly ash by weight. Weigh bulk cement and fly ash on an approved scale, except when using continuous proportioning and mixing Equipment.

Ensure that the batching produces cement, and combined cementitious weights are within ± 1% of the required weights. If the weight of cementitious Materials is expected to weigh less than 1,000 lb, ensure that those Materials weigh within 30 lb of the target weight.

If the Material exceeds the target weight by more than ± 1.0%, the Department will immediately notify the Contractor to take corrective action. If the weight is no more than 2.0% above or 1.5% below the target weight, the Department may accept a maximum of 5 loads with these weight discrepancies for each 10 consecutive loads of concrete delivered, regardless of whether the discrepancies are for the same Material or for other weighed Materials. The Department will reject further unacceptable loads. Dispose of rejected loads at no additional cost to the Department.

Equip cement and fly ash scales and hoppers with a device that indicates the complete discharge of cement and fly ash into the mixer. Contain bulk cement and fly ash in weather tight bins and weighing hoppers. Do not suspend discharge chutes from the weighing hoppers. Arrange the discharge chutes so that cement and fly ash do not lodge in or leak from them.

Protect cement and fly ash from moisture. Store different brands or types of cement/fly ash, or cement/fly ash from different production facilities separately. Provide separate, identifiable blended portland-fly ash cement storage at the project or plant site. Store portland cement and portland-fly ash cement separately.

**510.3.2.3 Water**

Mixing water consists of free water, ice added to the batch and surface moisture on the aggregates. Measure the added water by weight or volume to ensure that the amount of water in the mixture design is not exceeded. Measure added ice by weight. For truck mixers, discharge the wash water before loading the next batch of concrete.

**510.3.2.4 Aggregates**

**510.3.2.4.1 Stockpiles**

Ensure the separation of stockpiles of different sizes or from different sources. Stockpile aggregates so that the coarse and fine particles do not separate. Provide stockpiles that can produce enough concrete for the section constructed during a scheduled operation. Ensure that aggregates are not contaminated by contact with the ground, dust, or other Deleterious Materials. Do not use aggregates that become segregated or mixed with Deleterious Material. Do not use frozen lumps of aggregate in concrete batching.

Ensure that a “sacrificial” layer of the same size aggregate at least 6 in deep is maintained below the bottom of the stockpile so that the front-end loader will not pick up non-complying Materials that would contaminate the concrete mixture.

**510.3.2.4.2 Gradations**

The Project Manager may cancel concrete placements that have gradation data that is more than 7 Days old.

1. If the mixture design is approved with the Conventional Stockpile Procedure, ensure that the stockpile gradations comply with the standard gradation requirements for each sieve size shown in Table 509.2.4.2.3.1, “Coarse Aggregate Gradation Requirements,” and Table 509.2.4.3.3.1, “Fine Aggregate Gradation Requirements;”

2. If the mixture design is approved with the combined gradation procedure, it is the Contractor’s responsibility to continuously monitor the gradation of each of the stockpiles. Provide new gradation results to the Project Manager, in one of the following ways:

2.1 If placing 1000 yd$^3$ or more per week, provide new gradation results every 500 yd$^3$.
2.2 If placing less than 1000 yd³ per week, provide new gradation results once per week;

3. The Contractor’s responsibilities to monitor gradations are not related to the QC/QA requirements. The Department considers these responsibilities to be part of the standard operation and maintenance of the batching facilities;

4. Determine if the combined gradation is within the following limits:
   4.1 Coarseness factor is ± 4 percentage points of the value in the approved mixture design;
   4.2 Workability factor is ± 3 percentage points of the value in the approved mixture design;

5. Adjust the aggregate batch weights if the Coarseness Factor or the Workability Factor does not comply with 4.1 or 4.2 above. The Coarseness Factor and Workability Factor can also be adjusted at the Contractor’s request. When adjusting these factors, adjust them to the tolerances in 5.1 and 5.2, below;
   5.1 Coarseness factor is ± 2 percentage points of the value in the approved mixture design;
   5.2 Workability factor is ± 1.5 percentage points of the value in the approved mixture design;

6. If the gradation tolerances in 4.1 and 4.2 can not be met, do not place concrete until the gradations are corrected to meet the designated tolerances.

510.3.2.4.3 Batch Weights
Batch aggregate target weights over 1,000 lb to within ± 2% of the target weight. For target weights less than 1,000 lb, batch to within ± 50 lb of the target weight.

If a fine or coarse aggregate weight differs from the target weight by more than 2%, but no more than ± 3%, the Project Manager may accept or reject the concrete. The Department will allow no more than five loads exceeding the maximum allowable weight tolerances for each 10 consecutive loads of concrete delivered.

510.3.2.4.4 Moisture Control
1. For a manually operated facility, measure the moisture content of the fine and coarse aggregates at least every 4 hours, or as required by changing moisture conditions within the stockpiles;

2. For plants equipped with automatic moisture probes, measure moisture content manually at least once a day. Determine the manual measurement immediately before preparing the first concrete load and compare it to the measurement shown by the moisture sensing Equipment. If the measurements differ by more than 0.5%, re-correlate the moisture probe. Send a certificate showing the moisture correlation to the Project Manager with the first load of concrete;

3. Determine the aggregate moisture content to the nearest 0.5% in accordance with one of the following procedures:
   3.1 AASHTO T 217. The shelf life of the calcium carbide is relatively short. Closely monitor the age of the calcium carbide and replace it in strict accordance with the manufacturer’s recommendations;
   3.2 AASHTO T 255. The Department will allow the hot-plate or microwave methods for this purpose, as long as no Material is lost and the pan is continuously agitated during the drying process;

4. Provide the following information on the moisture certificate to the Project Manager:
   4.1 Pan weight (it is not acceptable to tare out the pan weight on scales equipped to do so);
   4.2 Wet weight of the pan and the sample;
   4.3 First dry weight of the pan and the sample;
   4.4 Second dry weight of the pan and the sample;
   4.5 Third dry weight of the pan and the sample (if necessary);
   4.6 Absolute moisture content of the sample;
   4.7 The moisture probe reading from the tested sample; and
   4.8 The calculated difference between the actual moisture content test and that shown by the moisture sensing Equipment.

Allow washed aggregates to drain before use. The Project Manager may require the aggregates to remain in the stockpile or storage area for longer, if the moisture contents are excessive.
510.3.2.5 Air-Entraining and Chemical Admixtures

Store admixtures in separate containers to avoid contamination, evaporation, and damage. Protect liquid admixtures from freezing and from damaging temperatures. For admixtures used as suspensions in non-stable solutions, provide agitating equipment to ensure the thorough distribution of the ingredients. Measure liquid admixtures within ± 3% of the target amount.

510.3.2.6 Mixing

Ensure that the uniformity of the concrete mixture complies with AASHTO M 157, Section 10.2. If using a central plant mixer it must have a rated mixing capacity of at least 3 yd³. Batch and deliver concrete in accordance with NRMCA standards.

510.3.3 Transporting

Transport mixed concrete in non-agitating trucks only when the slump is less than 2 in. Use revolving-drum mixer trucks to transport concrete with a slump in excess of 2 in. Transport concrete produced in a dry-batched concrete plant in revolving-drum mixer trucks.

510.3.3.1 Non-Agitator Trucks

Use bodies of non-agitating trucks that are smooth, mortar-tight metal containers capable of discharging the concrete at a satisfactory controlled rate without segregation. Provide covers needed for protection.

510.3.3.2 Truck Mixers and Agitators

Equip agitator trucks with a plate directly attached to the truck in a readily visible location, labeled with the specific truck properties, including the designated drum mixing speed.

Keep documentation for review by Department personnel upon request to show that the mixers and agitators have been inspected in accordance with NRMCA guidelines within the last 12 months.

Department personnel will check the water tank site tube when the truck arrives at the project site. If there is water missing from the tank, the Department will reject the truck unless the driver can account for the missing water.

510.3.3.3 Upon Arrival at the Project

Re-mix the concrete that arrives at the project site in agitator trucks as follows:

1. For concrete mixed in a central mix plant: mix at the designated mixing speed for a minimum of 2 min before discharging;
2. For concrete mixed inside an agitator truck: mix at the designated mixing speed for a minimum of 5 min before discharging;
3. If any water, water-reducing admixtures, entrained air, or other ingredients are added to the concrete, mix the additional material at the designated mixing speed for at least 5 min before discharging.

510.3.4 Placing

510.3.4.1 Temperature and Weather Limitations

See Section 511.3.3, “Temperature and Weather Limitations.”

510.3.4.2 Mixing Time

“Mixing time” is the elapsed time from when the Contractor exposes the cement to the aggregates until the Contractor places the concrete into its final location. Do not use concrete mixed less than the minimum specified time. The maximum mixing time for concrete hauled in truck mixers or truck agitators is 90 min. Do not exceed 60 min of mixing time when the concrete temperature is 90 °F or above.

When hauling the concrete in non-agitating trucks, all concrete must be placed into its final location within 45 min of initial mixing. If the concrete temperature is 80 °F or above, place concrete within 30 min from initial mixing.

510.3.4.2.1 Extended Mixing Time

In rural and remote areas of the state where mixing time cannot be met, submit a written request to the District Construction Engineer for additional time. Include the following information:
1. The reason for requesting additional time;
2. The additional time needed in excess of the specified mixing time;
3. The proposed procedures, methods, and type of Materials or admixtures to be used so that the concrete will meet required fresh and hardened properties; and
4. Documentation to prove that the additional time will not damage the quality of the concrete.

This information will be forwarded to the State Concrete Engineer for review. The State Concrete Engineer will issue a written recommendation within 7 Days from receipt of the request.

If the Department allows a mixing time extension, prepare a trial batch consisting of at least one full load of concrete at the designated production facility and haul to the project site. Batch the concrete in the same quantities as anticipated for the project. Place the trial batch in a non-critical application to assess the mixture.

510.3.4.3 Concrete Sampling and Testing

The Contractor shall test for quality control; and the Department will test for acceptance.

1. Measure concrete for specification compliance only by the test methods described in this section. The Department will not accept results from the in-place test methods described in Section 510.3.5.2, “In-Place Concrete Strength Measurements” as an alternative to these requirements. Prepare slump, unit weight, air content tests, and compressive strength test cylinders with concrete obtained from the point of discharge into the Structure being placed. The Department will provide test results to the Contractor after the final compressive strength test for each set of test specimens is complete with a copy to the Supplier, weekly;

2. Mold and cure concrete cylinders for compressive strength tests in accordance with AASHTO T 23, Making and Curing Concrete Test Specimens in the Field using 4 in × 8 in single use plastic cylinder molds with plastic lids. Use cylinder molds that are 6 in × 12 in if the nominal maximum size of the aggregate is equal to or greater than 1.5 in;

3. Use a rod to consolidate the concrete in all slump, air content and unit weight tests and all compressive strength test cylinders cast with normal slump concrete (Class A, Class AA, Class G and Class D). Use a vibrator to consolidate the concrete in all air content and unit weight tests and all test cylinders cast from slip form concrete (Class E and Class F). Do not use a rod to consolidate slip-form concrete;

4. Immediately after molding, begin curing test cylinders by submerging in a water bath with a temperature of 70 °F ± 10 °F. Do not exceed 25 min from the time the concrete was sampled and starting initial curing. Use water that complies with Section 509.2.6, “Water,” for the initial curing;

Unless otherwise approved, locate all cylinder curing containers for testing of the concrete in the same location, and within 50 ft of the site, chosen in advance by Department inspection personnel. Maintain the water-filled containers with the test cylinders undisturbed for a minimum of 21 h, but no more than 48 h, from the time of placement. Ensure that the level of water never drops below the tops of the cylinders;

5. After initial curing, strip the concrete cylinders and place into a standard curing tank (or moist room) in accordance with AASHTO T 23, Section 10.1.3. If the cylinders are to be shipped to an off-site Laboratory for testing, maintain the cylinders in the standard curing environment until they are ready to be transported. Do not ship test cylinders until they are at least 48 h old;

6. The party that prepared the test specimens is responsible for transporting them from the initial curing environment to the final curing environment. Protect the test specimens from being damaged in any way. Specific attention will be paid to protection from sun, wind, rain, vibrations moisture loss and any sudden drops or impacts during transport.

510.3.4.3.1 Testing Frequency

Department personnel will obtain at least one sample from each of the first three concrete loads delivered to the project site. The Department will test for slump, air content, and unit weight. The Department will cast a set of compressive strength test cylinders from one of these three loads. Beginning with the fourth load of concrete delivered to the project, the
Department will randomly select one load from each sub-lot of six trucks (three loads for Bridge deck placements) for testing.

510.3.4.4 Superplasticizers
If using a super-plasticizer, measure the initial slump before adding the superplasticizer, and again immediately after the super-plasticizer has been properly mixed into the load. Do not exceed slump specifications defined on the approved mixture design before introducing the super-plasticizer. Do not exceed a slump of 8 in after adding the super-plasticizer. Check super-plasticized concrete for segregation before and during placement. Do not place segregated concrete.

510.3.5 Acceptance
510.3.5.1 Concrete Strength
Determine the compressive strength by averaging two or more concrete cylinder test results from the same concrete sample and tested at the specified age. Make, handle, and store in accordance with AASHTO T 23 and test in accordance with AASHTO T 22. Consider a single test result only as an indicator. It will not be considered an actual strength measurement.

510.3.5.1.1 Individual Strength Test
Unless otherwise specified, verify compliance with the specifications by determining the concrete strength at the age designated in Table 509.2.8.1.1, “Concrete Classes for Laboratory Design of Concrete Mixtures.” Make at least four cylinders for each set. Test the first cylinder at 7 Days for use as an early concrete compressive strength indicator. Test the second and third cylinders to determine the individual strength test result. Reserve the fourth cylinder for testing if the “Within-Test-Coefficient-of-Variation” exceeds 5%, in accordance with ACI 214.3.4.1. If the fourth cylinder is tested, average all of the cylinders tested at that age to determine the individual strength test, unless any of the following conditions exist:
1. There is a visible cylinder defect or a defect in the capping;
2. A significant irregularity occurred while loading the test specimen to failure, such as a sudden load burst, cyclic or pulsating loads, or a loading rate not in accordance with AASHTO T 22.

510.3.5.2 In-Place Concrete Strength Measurements
If the Contractor requests measurement of in-place concrete strength for construction-related purposes, then the Contractor must provide testing Equipment and perform strength tests at no additional cost to the Department. Field cured test cylinders will be tested by a PTL approved by the State Materials Bureau. Use one of the following procedures to determine the in-place concrete strength:
1. Core Testing. Perform in accordance with AASHTO T 24, and Section 510.3.5.4, “Investigation of Low Strength Cylinder Test Results;”
2. The Maturity Method, ASTM C1074. Integrates the heat of hydration and the time since the concrete was batched, correlated for the specific concrete mixture before use in the field;
3. The Windsor Probe, ASTM C803. Measures the penetration depth of a specially fabricated probe into the concrete, calibrated to the concrete mixture;
4. The Pull-Out Test, ASTM C900. Measures the pull-out resistance of a plug cast into the concrete, calibrated to the concrete mixture;
5. The Match-Cure Method. Places additional cylinders into a specially controlled chamber that maintains the temperature of the cylinders to that of the concrete represented;
6. The Cast-in-Place Cylinder Method, ASTM C873. Tests a cylinder that is actually cast into the concrete being evaluated. The hole remaining after removal of the cast-in-place-cylinder is filled with a non-shrink grout or a Type K cement;
7. Field Curing. Cast cylinders in accordance with AASHTO T 23, and cure in accordance with AASHTO T 23, Section 9.4.1.

Before using the method of measuring in-place concrete strength in the field (with the exception of Method 7 - “Field Curing”), submit complete supporting documentation for the method and intended procedures to be followed to the Project Manager for approval by the State Materials Bureau.

The Department will not consider field cured cylinders appropriate measurements of in-
place strength for any structural applications. The Department will not permit core testing, pull-out test, or cast-in-place cylinder test methods on Bridge decks.

If the in-place compressive strength is at least equal to the strength required for the intended application, the Contractor may strip forms or allow traffic on the Structure or pavement.

510.3.5.3 Acceptance of Concrete Based on Cylinders
The Department will accept concrete based on the compressive strength cylinder tests when both of the following requirements are met:

1. The running average of three consecutive individual strength tests meets or exceeds the specified strength; and,
2. No individual strength test falls below the specified strength by more than 500 psi.

If the Contractor does not meet cylinder-based acceptance requirements, the Department will review the strength tests and notify the Contractor in writing whether the Department will accept the concrete at full price or at a reduced price, or if the Contractor has to replace it.

510.3.5.4 Investigation of Low Strength Cylinder Test Results
Do not use the following test procedures as a substitute for the compliance test program in Section 510.3.4.3, “Concrete Sampling and Testing.” The procedures described below will not be allowed more than twice during the course of the project.

If problems with low strength cylinder tests persist, the Department may suspend the operation at no additional cost to the Department and require the Contractor to comply with Section 510.3.1.5, “Troubleshooting.” If the corrective actions taken are insufficient, the Department may suspend the Contractor to comply with Section 510.3.1.5, “Troubleshooting.” If the corrective actions taken are insufficient, the Department may suspend Work again, at no additional cost to the Department, until the Project Manager determines appropriate action.

The Contractor may use one of the in-place strength-test methods in accordance with Section 510.3.5.4.1, “Testing Cores.”

510.3.5.4.1 Testing Cores
If the Contractor uses cores to determine in-place compressive strength, obtain cores in accordance with AASHTO T 24, and immediately seal each core in an air tight plastic bag. Test cores in accordance with AASHTO T 22.

If the Structure concrete will be dry under normal service conditions, cure the cores inside the plastic bags at a temperature range of from 60 °F to 80 °F for 7 Days before testing. Test the cores dry.

If the Structure concrete will be more than superficially wet under normal service conditions, cure the cores in lime-saturated water for at least 40 h before testing. Test the cores wet.

For non-bridge Structures, take the cores 49 Days after concrete placement (21 Days old for Class E or Class F concrete). Take at least three cores to evaluate the area of concrete that had low strength test results. The Department will approve core locations before the cores are obtained. Test for compressive strength of the concrete cores at 56 Days (28 Days for Class E or Class F concrete).

For Bridge concrete (exclusive of bridge decks) with low strength test results, the Bridge Design Section will develop a coring plan within 38 Days of the initial concrete placement. Obtain, cure and test cores in accordance with the previous paragraph.

The Department will accept the concrete when the average of the cores representing each area of concern equals or exceeds the specified strength.

510.3.5.4.2 Alternate Testing
As an alternative to using cores for testing in-place compressive strength, or to investigate Bridge decks, submit a written request to the Project Manager for permission to use one of the in-place strength-test methods described in Section 510.3.5.4.2, “In-Place Concrete Strength Measurements.” Do not use the methods until receipt of written approval from the State Materials Bureau.

The Department will accept the concrete when the average of the tests is equal to or greater than the 108% of the specified strength.
510.3.5.4.3 State Concrete Engineer Analysis

If the in-place strengths are not adequate for acceptance at full price, the State Concrete Engineer will evaluate the concrete. After reviewing the State Concrete Engineer’s recommendations, the Department will take one of the following actions:

1. Direct the Contractor to remove and replace the failed concrete at no additional cost to the Department; or,
2. Pay the Contractor for the concrete in accordance with Table 510.3.5.5.1.1, “Price Adjustment Percentages for Low Strength Concrete Based on Lab-Cured Cylinders.”

510.3.5.5 Price Adjustments

The Department will make price adjustments for non-compliance with concrete strength specifications based on lab-cured strength tests unless alternate in-place strength tests have been previously approved.

If concrete cores were obtained and tested in accordance with Section 510.3.5.4.1, “Testing Cores,” and were found to be 95% or more of the specified strength at 56 Days, then the Contractor may choose to have a Hardened Air Content Test performed by a Department approved petrographer in accordance with ASTM C-457. If the results of the hardened air void analysis comply with 1, 2 and 3 below, then the concrete represented by the cores will be paid for at full price.

1. A minimum air content of 5.0%;
2. A specific surface greater than 600 in-1; and
3. A spacing factor less than 0.008 in.

510.3.5.5.1 Cylinder Based Price Adjustments

If low strength concrete is accepted based on lab-cured cylinders, the Department will pay for concrete in the lot represented by the low strength tests in accordance with Table 510.3.5.5.1:1, “Price Adjustment Percentages for Low Strength Concrete Based on Lab-Cured Cylinders.” In a case where the Department determines two different pay adjustments, the lowest percentage pay adjustment will apply.

Table 510.3.5.5.1:1
Price Adjustment Percentages for Low Strength Concrete Based on Lab-Cured Cylinders

<table>
<thead>
<tr>
<th>Average of 3 consecutive tests compared to specified strength (%)</th>
<th>OR Amount individual strength is less specified strength (psi)</th>
<th>Price adjustment factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;100</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>97–99</td>
<td>550</td>
<td>96</td>
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<tr>
<td>94–96</td>
<td>600</td>
<td>91</td>
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<tr>
<td>90–93</td>
<td>625</td>
<td>84</td>
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<td>85–89</td>
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<td>75</td>
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<tr>
<td>80–84</td>
<td>675</td>
<td>64</td>
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<tr>
<td>75–79</td>
<td>700</td>
<td>50</td>
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<tr>
<td>&lt;75</td>
<td>&gt;700</td>
<td>a</td>
</tr>
</tbody>
</table>

*Remove this concrete and replace with concrete that meets the specification requirements at no additional cost to the Department. The Department may accept non-structural concrete, but will pay 25% of the Bid Item Unit Price.

510.3.5.5.2 Price Adjustments based on In-Place Strength Tests

1. If the Department accepts low strength concrete based on core tests, the Department will pay for the concrete represented by the cores in accordance with Section 510.3.5.4, “Investigation of Low Strength Cylinder Test Results.”
2. If the concrete strength is based on one of the in-place test methods specified in Section 510.3.5.2, “In-Place Concrete Strength Measurements,” the price adjustment factor will be determined by multiplying the specified strength by 1.08. This value will then be used as the specified strength to determine the percentage of specified strength listed in the “Average of 3 Consecutive Tests compared to specified strength (%),” column of Table 510.3.5.5.1:1, “Price Adjustment Percentages for Low Strength Concrete Based on Lab-Cured Cylinders.” The Department will not allow use of field cured cylinders to determine price.
510.4 METHOD OF MEASUREMENT—Vacant

510.5 BASIS OF PAYMENT
The Department will pay for concrete in accordance with the section of these Standard Specifications for which the concrete is used.
SECTION 511: CONCRETE STRUCTURES

511.1 DESCRIPTION
This Work consists of constructing concrete box Culverts, headwalls, retaining walls, abutments, bents, piers, slabs, girders, and incidental Structures requiring the use of concrete, except pre-stressed members.

511.2 MATERIALS

511.2.1 General
Use concrete mixes that have been approved by the State Materials Bureau for the freeze/thaw risk zone in which the project is located. Use Class A concrete for Bridge Substructures, retaining walls, and other cast-in-place Structures, unless otherwise specified. Use Class AA for all other cast in place applications.

511.2.2 Joint Sealing Materials
Provide premolded expansion joint sealing Material in accordance with the Contract. Provide nonextruding and resilient expansion joint filler in accordance with AASHTO M 153. Provide preformed asphalt expansion joint filler in accordance with AASHTO M 213. Provide elastomeric compression joint seals in accordance with Section 561, “Elastomeric Compression Joint Seals.”

511.2.3 Curing Material
Provide resin-base membrane-forming curing compound in accordance with AASHTO M 148 for Type I-D curing compounds.

511.2.3.1 Curing Materials Sampling
Thoroughly mix each sample and submit it in a sturdy, airtight plastic container. Submit samples to the State Materials Bureau at least 30 Days before the intended use of the Material. Clearly identify the sample containers with the project number, Material enclosed, lot or batch number, and the name of the manufacturer.

511.2.3.2 Certificates of Compliance for Curing Materials
Submit a Certificate of Compliance in accordance with Section 106, “Control of Materials,” with the curing Material samples.

511.2.4 Steel Reinforcement
Provide steel reinforcing bars and epoxy-coated steel reinforcing bars in accordance with Section 540, “Steel Reinforcement.”

511.3 CONSTRUCTION REQUIREMENTS

511.3.1 Falsework and Falsework Foundation
Construct Superstructure in accordance with Section 511, “Concrete Structures,” and Section 512, “Superstructure Concrete.” Design, construct, and maintain falsework and falsework foundation to provide the required strength and rigidity, and to support loads without settlement. Have a professional engineer licensed in the state of New Mexico design the falsework and its foundation in the following cases:
1. If the height of the Structure is greater than 10 ft, (excluding concrete Culverts with bottom slabs);
2. Where the supported span is greater than 20 ft; and
3. Where traffic, other than workmen involved in constructing the Structure, will travel under the falsework.

Place the falsework on an adequate foundation. Provide methods for measuring settlement or movement of falsework and forms under load. If falsework shows settlement, stop the Work and correct the settlement or movement.

If pilings are used for falsework, pull or cut off falsework pilings. Ensure the cut-off elevations are 1 ft below the low water level, natural ground, or bottom of proposed channel.

If required, submit plans for falsework to the State Bridge Engineer for approval. Submit proposed changes to existing Structures required for maintenance of traffic to the Project Manager for approval. The approval process may require up to 38 Days.
511.3.2 Form Construction
Make forms mortar tight and sufficiently rigid to prevent deformation due to the pressure of the concrete and other loads incidental to the construction operations, including vibration. Construct and maintain forms to prevent the joints from opening. Construct and maintain forms used on surfaces in public view with a smooth surface of uniform color and texture. Do not weld reinforcing or structural steel, except as required in the Contract.
Remove loose dirt, laitance and miscellaneous debris from the bottom of the forms before placing concrete.
Fillet forms and chamfer them 3/4 in, unless required otherwise in the Contract, and give them a bevel or draft for easy removal of projections such as girders and copings.

511.3.2.1 Form Lumber
Use lumber that is planed on at least one side and the two edges for exposed concrete surfaces. Place the planed face so that it will be the formed surface for the concrete being placed.

511.3.2.2 Metal Ties
Construct metal ties and anchorages within the forms to permit the removal of a portion of the tie connections without damaging the concrete, and provide at least 1/2 in depth of cover from the concrete surface.

511.3.2.3 Surface Treatment of Forms
Ensure that all forms have been properly treated with an approved form release agent before placing reinforcing steel. Ensure that forms have been properly wetted before placing concrete.
Do not use form oil that adheres to or discolors the concrete.

511.3.2.4 Metal Forms
Provide metal forms thick enough to prevent bending and maintain their shape. Use countersunk bolts and rivet heads. Use clamps, pins, and other connecting devices designed to hold forms rigidly together and for removal without damaging the concrete. Use metal forms that have a smooth surface and line up properly.
The Contractor may use metal forms that remain part of the Structure in accordance with the Contract or as approved by the State Bridge Engineer. Use permanent steel Bridge deck forms in accordance with Section 512.3.4.1, "Permanent Steel Deck Forms."

511.3.2.5 Reuse of Forms
Continuously maintain the shape, strength, rigidity, water tightness, and surface smoothness of reused forms. Resize warped or bulged lumber before reusing it.

511.3.3 Temperature and Weather Limitations
Keep the concrete mixture temperature between 50 °F to 90 °F at the time of placement.

511.3.3.1 Cold Weather Concrete
Do not place concrete directly onto any surface that is less than 40 °F unless otherwise approved by the Project Manager. Do not place concrete on frozen ground.
Place cold weather concrete in accordance with ACI 306, Cold Weather Concreting.
If air temperatures are likely to fall below 35 °F during the placement or curing periods, submit a cold weather concreting and curing plan to the Project Manager for approval by the State Concrete Engineer before concrete placement. Ensure that the plan details the methods and Equipment to maintain the required concrete temperatures.
If placing concrete at or below air temperatures of 35 °F, provide suitable enclosures and heating devices. Vent exhaust from combustion type heating devices outside the placing area so that the exhaust fumes can not come in contact with the freshly placed concrete.
Ensure the concrete surface temperatures never fall below 45 °F during placement and the first three Days after placing. Do not let the surface temperature fall below 40 °F during the next four Days after placing, or until the in-place strength determined by the Maturity Method, as described in Section 510, “Portland Cement Concrete” indicate that 75% of the design strength is achieved.
Monitor the minimum concrete temperatures at various locations including edges and corners of slabs or other Structures, and check immediately before placing insulating material.
over the concrete.

If heating the aggregates or water, use heating methods and equipment that can heat the material uniformly. Do not heat the materials to more than 150 °F. During the heating or mixing process, do not add cement to water and aggregate combinations that are hotter than 100 °F.

511.3.3.2 Hot Weather Concrete

Place hot weather concrete in accordance with ACI 305, Hot Weather Concreting.

511.3.3.3 Rate of Evaporation Limitations

Do not place Bridge deck slab concrete unless the combination of air temperature, temperature of fresh concrete, relative humidity, and wind velocity (Evaporation Potential) at the site is less than 0.20 lb per square foot per hour in accordance with Figure 511.3.3.3:1, “Surface Evaporation from Concrete,” or by using a continuous reading computerized weather station.

If using Figure 511.3.3.3:1, “Surface Evaporation from Concrete,” measure wind speed, relative humidity and ambient air temperature at a height of 5 feet above the deck. Determine and record evaporation potential at intervals not greater than 5 minutes. Continue obtaining and recording the evaporation potential after all of the concrete has been placed until the final curing system has been physically applied.

Do not place concrete during periods of high air temperature, low humidity, or high winds unless one or more of the following measures have been taken upon by the Contractor at his expense and maintained to the satisfaction of the Project Manager to reduce the rate of evaporation to within the specified rate:

1. Erect windbreaks to reduce the wind velocity over the concrete surface;
2. Place concrete during nighttime or early morning hours;
3. Use cool aggregate and mixing water to lower the fresh concrete temperature during hot weather;
4. Increase the relative humidity at the site with a fog spray; or
5. Protect the concrete with temporary wet coverings during an appreciable delay between placing and finishing.

511.3.3.3.1 Wind Break

If a wind break is specified in the Bridge design Plans, the wind break shall be a minimum height of 8 ft-0 in and constructed in a perimeter enclosing the Bridge deck, approach slabs, sleeper footings and/or transition slabs (if applicable). The nature and type of windbreak to be used shall be approved by the Project Manager prior to placement of any Superstructure concrete.

511.3.3.3.2 Fogging System

If a fogging system is specified in the bridge design Plans, a water fog shall be continuously applied over the surface of the freshly placed concrete in such a manner that the entire surface is kept at a relative humidity of 90% or greater and the surface of concrete is kept at an evaporation potential of 0.15 pound/square foot/hour or less, as determined from Figure 511.3.3.3:1. The evaporation potential shall be determined prior to fogging and outside the wind protection, and continuously monitored with evaporation potential measurements taken and recorded at least once every 5 min throughout the entire placement, and continuing until the concrete curing system has been completely installed. If a wind break and/or fogging are being used, obtain these readings from the protected area near the concrete.

The area to be fogged shall be the entire area of the freshly placed concrete, which has not had the finish applied. This fog shall be delivered through a network of nozzles, which are properly spaced to provide a uniform fog at the surface of the concrete. The nozzles used shall be of the type, which atomizes the water so that there are no visually discernible droplets of water. The area of coverage from each nozzle shall overlap all adjacent nozzle coverage by at least 1 ft. It shall be demonstrated prior to the placement of the concrete that the intended system is capable of delivering the required fogging environment for at least twice the anticipated required time.

The intended system must be properly field tested, and approved by the State Materials Bureau before being used on any Superstructure concrete. Fogging shall continue until the surface is covered with an approved curing compound. The wet burlap shall not be applied over the curing compound until the Superstructure concrete can receive the wet burlap and
Do not place concrete until the Project Manager approves the reinforcing steel and forms. Ensure that forms are clean and free of rust, grease, and other Deleterious Material immediately before placing the concrete. Remove wooden form spacers immediately before placing concrete in that area.

Vibrate the concrete during placement to force the coarse aggregate from external surfaces and to bring mortar against the forms to produce a smooth finish significantly free of water, air pockets, and honeycombs.

Place concrete in girders, walls, and other similar Structures in horizontal layers. Ensure that the concrete is not too thick for the vibrator to consolidate and merge it with the previous layer. Do not pour concrete layers deeper than 2 ft.

Do not place concrete faster than the rate used for the design of the forms. Adjust the
511.3.4.1 Chutes and Troughs
Avoid segregation of the Materials and the displacement of the reinforcement when placing the concrete. Use metal or metal-lined open troughs and chutes; do not use aluminum. All tools used for the moving and/or spreading of the concrete shall be square pointed tools. Do not use round nose shovels and spreading tools.

Where the Contract requires steep slopes, equip the chutes with baffle boards or use short lengths that reverse the direction of movement.

Keep chutes, troughs, and pipes clean and free of hardened concrete by thoroughly flushing with water after each pour. Discharge the water used for flushing away from the placed concrete.

Do not allow concrete to free fall for more than 5 ft, unless confined by closed chutes or pipes. For walls equal to or less than 10 in thick, such as Culvert walls, concrete may have a free fall of less than 9 ft.

Fill each part of the form by placing the concrete as close to the final position as possible. Vibrate the concrete during placement to force the coarse aggregate back from the forms and around the reinforcement without displacing the bars. After the concrete’s initial set, do not jar the forms or place strain on the ends of projecting reinforcement.

511.3.4.2 Concrete Pumping

If placing concrete by pumping, install pumping Equipment so that vibrations resulting from the operation do not damage the concrete being placed. Obtain Project Manager approval before using concrete pumping Equipment.

Before placing the concrete, clean the Equipment thoroughly. Operate the Equipment so that it pumps a continuous flow of concrete without air pockets and without an appreciable loss of slump or entrained air.

Control the loss of entrained air by one or more of the following methods:
1. Tie the end of the pump hose so that the discharge end is pointing upward, forming a “J” at the end of the hose;
2. Install a series of four consecutive elbows to form a 360° loop;
3. Reduce the diameter of the end of the pump line; or
4. Limit the enclosed angle of the boom arms to an angle of 135° or more.

Do not use aluminum pipe. Do not add water to the concrete during pumping. If water is added at the pump hopper to clear a clogged pump, dispose of the concrete in the hopper and the line.

511.3.4.3 Conveyers and Belts

The Contractor may use conveyor belts to transport the concrete from the point of delivery to the point of placement. If using multiple belts, ensure that the drop from one belt to the next is no greater than 18 in. At the end of the last belt, do not allow the concrete to free-fall more than 4 ft. Ensure that the concrete coming off the end of any belt is not being segregated. If segregation occurs, slow down the speed of the belt until segregation no longer occurs.

511.3.4.4 Placing Concrete Under Water

If placing concrete under water, submit a mix design and procedure plan to the Project Manager. The Project Manager may require up to 30 Days to approve them. Allow time in the schedule to accommodate this approval process.

511.3.4.5 Vibrating/Consolidation

Unless otherwise directed by the Project Manager, and excluding drilled shafts, compact concrete with suitable mechanical vibrators operating within the concrete. During concrete placement, keep enough personnel, vibrators, and other tools available to assure adequate consolidation. If necessary, supplement vibrating with hand spading with suitable tools to assure proper consolidation. If using vibrators, use procedures in accordance with ACI 309.

Do not use a “jitterbug” or any other flat tool that could cause concrete segregation.

Use approved vibrators that can transmit vibration at frequencies up to 10,000 vpm. Provide vibrators that have each been certified within the last 90 Days to provide 8,000 to 10,000 vpm.

Operate vibrators to consolidate the concrete thoroughly around the reinforcement and rate for the temperature of the concrete being placed.
embedded fixtures and into corners and angles of the forms. Do not use vibrators to make concrete flow or run. Vibrate long enough to accomplish consolidation, but do not vibrate so long to cause segregation or air bubbles. Insert the vibrators vertically into the concrete, and immediately withdraw upward along the same line with the opposite motion. Do not drag the vibrator horizontally across the placing area.

When operating vibrators, avoid contact with reinforcing bars, particularly epoxy coated reinforcing bars or bars that extend into concrete that has taken an initial set. If vibrating concrete in areas reinforced with epoxy-coated bars, cover the vibrators with nonmetallic sleeves to prevent damage to the epoxy coating.

511.3.4.6 Sequence of Placement and Application of Load

Do not place superimposed loads on or against load carrying members, floor slabs, or retaining walls until the concrete reaches a compressive strength of 2,500 psi, as determined by the Maturity Method, in accordance with Section 510.3.5.2, “In-Place Concrete Strength Measurements.”

Submit a concrete placement schedule to the Project Manager upon request. Plan and schedule concrete placement to prevent damage to previously placed concrete or to the curing or protection systems of previously placed concrete.

The following applies to concrete placement scheduling:

1. The Contractor may erect reinforcement and formwork for walls, columns, and pier caps 24 h after placement of footings or floor slab concrete;
2. Unless otherwise provided, the Contractor may concrete columns, walls, and pier caps, 48 h after placement of footing or floor slab concrete;
3. Do not set beams or girders, or place Superstructure concrete until Substructure forms have been stripped sufficiently to determine the quality of the concrete;
4. Do not place the load of the Superstructure on the Substructure until the Substructure concrete has been in place for at least 14 Days or until in-place strength measured by the Maturity Method indicates that the concrete has attained the design strength;
5. Ensure that the concrete has achieved sufficient strength as determined by the Maturity Method in accordance with the form design before placing concrete for integral horizontal members, such as pier caps or roof slabs;
6. Place the vertical members at least 7 Days before mounting friction collars or falsework brackets that will support the weight of horizontal members. Ensure that the vertical members have attained the specified strength before applying loads, unless the Department approves otherwise;
7. Limit monolithic casting of walls and deck slabs of concrete box culverts to culverts that are 6 ft high or less. Construct box culvert walls higher than 6 ft in accordance with this subsection;
8. If the strength gain of the concrete is retarded, the District Construction Engineer may extend the waiting periods. Conduct construction operations in a manner that does not damage the previously placed concrete.

511.3.4.7 Supplementary Lighting

Do not mix, place, or finish concrete when the natural light is insufficient without using an adequate artificial lighting system, approved by the Project Manager. Test the lighting system at least one day before placing the concrete to assure that the system will provide sufficient light, without shadows or dark areas for placing, testing and finishing concrete. Ensure that the lights do not create a hazard for traffic on adjacent Roadways or detours.

511.3.5 Removal of Forms

Do not remove the forms until the concrete is strong enough to avoid damage by removing the forms, and the temperature differential between the concrete surface to be exposed and the core of the concrete Structure is less than 10 °F per inch.

If in-place strength tests in accordance with Section 510.3.5.2, “In-Place Concrete Strength Measurements,” are not used to control field operations remove forms in accordance with Table 511.3.5.1, “Timetable for Removal of Forms,” not counting those days when the temperature is below 40 °F.
Table 511.3.5:1
Timetable for Removal of Forms

<table>
<thead>
<tr>
<th>Structural component</th>
<th>Minimum time for removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom of beams</td>
<td>14 Days</td>
</tr>
<tr>
<td>Bridge decks</td>
<td>7 Days</td>
</tr>
<tr>
<td>Floor slabs</td>
<td>7 Days</td>
</tr>
<tr>
<td>Walls</td>
<td>24 h</td>
</tr>
<tr>
<td>Columns</td>
<td>48 h</td>
</tr>
<tr>
<td>Sides of beams</td>
<td>24 h</td>
</tr>
<tr>
<td>All other parts</td>
<td>24 h</td>
</tr>
</tbody>
</table>

*Additional requirements of Section 512, “Superstructure Concrete,” shall apply.*

If one of the test methods in Section 510.3.5.2, “In-Place Concrete Strength Measurements,” is used to control the field operations, the Contractor may remove forms from the bottom of beams and floor slabs when the concrete reaches 75% of the design compressive strength.

511.3.6 Joints

Make construction joints in concrete Structures in accordance with the Plans, unless otherwise directed or approved by the Project Manager.

If the concrete placement is interrupted and additional construction joints are required, place the additional joints in planes perpendicular to the principal lines of stress, and at points of minimum shear, as approved by the Project Manager.

Roughen the joint surface to increase the bond with future concrete, except in areas near the forms.

511.3.6.1 Keyed Joints

Mechanically bond construction joints with keys formed by beveled strips embedded in the surface of the concrete. Make the keys from 1 3/8 in to 1 1/2 in deep. Place the keys centrally within the thickness of the joint. Ensure that the keys have a width that is one-third of the depth of the smallest dimension of the joint. The keys do not need to exceed the clear distance between reinforcing mats, or be greater than 8 in. Provide raised keys in accordance with the Plans.

511.3.6.2 Bonding New Concrete to Existing

If bonding new and existing concrete, retighten the forms before depositing new concrete on or against the hardened concrete. Roughen the surface of the hardened concrete without loosening the aggregate or damaging the concrete on the surface. Thoroughly clean the surface of foreign matter and laitance.

Have an approved private testing Laboratory measure the water vapor being transmitted through the concrete surface in accordance with ASTM F 1869. Do not place new concrete on existing concrete if the water vapor exceeds 5 lb per 1,000 ft² per 24 h.

Provide a bonding agent at the interface between the hardened and fresh concrete by covering the cleaned and saturated surfaces with a coating of mortar, neat cement grout, or an approved bonding agent. Place the new concrete before the grout reaches an initial set. If using an approved bonding agent, follow the manufacturer's instructions. Do not use a bonding agent that is water soluble or is delivered in a water-based solution. Place the concrete continuously from joint to joint, and finish the face edges of exposed joints in accordance with the Plans.

511.3.6.3 Water Stops and Flashings

Provide and place water stops and flashings. Splice or solder water stops and flashings to form continuous watertight joints.

511.3.6.4 Joint Fillers

Accurately shape the pre-formed joint filler to fit adjacent concrete, and hold the filler firmly in place to prevent formation of concrete fins under and between sections of the Material.
Section 511.3.7 Miscellaneous Construction

511.3.7.1 Setting of Bearings

Ensure the surfaces on which metal masonry plates and elastomeric bearing pads will rest are flat and on level planes. If using elastomeric bearing pads finish the Bridge seats slightly high and grind to the correct elevation.

If it is necessary to adjust the elevation of a bearing upward, make the adjustment by placing full size shim plates. If it is necessary to adjust the elevation of a bearing downward, make the adjustment by grinding to a level plane-bearing surface. Do not use grout to level or adjust elevation.

If placing a bearing surface below the level of adjacent concrete, ensure water drains away from the masonry plate or elastomeric bearing pad.

Finish sections of bridge seats on abutments or piers on both sides of bearing assemblies to drain, with a slope of from 1/16 in to 1/8 in per foot. Correct depressions that retain water.

511.3.7.2 Waterproofing

If required in the Contract, protect the backsides of abutment backwalls and wingwalls by waterproofing. The Contract defines the vertical and horizontal limits of the waterproofing. Select a membrane type waterproofing system from the Department’s Approved Products List.

511.3.8 Finishing

Perform finishing after removing forms in accordance with the Contract.

511.3.8.1 Exposed Surfaces

The Department considers “exposed surfaces” as surfaces that are not buried in the ground or permanently covered by the fill, or against which the fill is not permanently placed. However, the Department does not consider the inside surfaces of concrete box drainage Culverts and concrete box girders, and the bottom side of concrete Bridge decks as “exposed surfaces.”

511.3.8.2 Class 1, Ordinary Surface Finish

Apply a Class 1 finish to exposed surfaces as a final finish or before a Class 2, Rubbed Surface Finish, or a Class 4, Special Surface Finish.

A Class 1 finish includes the removal of rods, bolts, or other form ties to at least 1/2 in deep from the face of the concrete. Fill tie holes and honeycombs with mortar composed of one part cement and two parts sand; use the same brand and type of cement as used in the concrete.

Remove objectionable fins, bulges, and projections by rubbing with carborundum bricks or by other methods approved by the Project Manager. If necessary, clean the entire surface. Keep such surfaces in an acceptable condition until final acceptance of the Work.

Apply a Class 1 finish to surfaces buried in the ground or permanently against the fill, except that form ties may be cut off even with the concrete surface, and fins, minor bulges, projections, stains, and discolorations do not need to be removed.

Unless specified otherwise in the Contract, apply a Class 1 finish to the front faces of backwalls of abutments, the top surfaces of Bridge seats on piers and abutments, and concrete curtain walls between pier pilings.

Apply a Class 1 finish to the inside surfaces of concrete box drainage Culverts, except as noted in Section 511.3.8.3, “Class 2, Rubbed Surface Finish.”

511.3.8.3 Class 2, Rubbed Surface Finish

Apply a Class 2 finish to concrete surfaces generally exposed to public view.

The Contract may specify a Class 4, Special Surface Finish with selected colors, for various components or parts of components. If the Contract specifies a Class 4, Special Surface Finish, apply a Class 2 finish first, unless otherwise approved by the Project Manager.

A Class 2 finish consists of a Class 1 finish, then thoroughly wetting the surface and applying a mortar.

Apply a thin mortar, composed of one part cement and four parts sand, and rub it into holes and pockets; use the same brand and type of cement as used in the concrete. Use sand passing a No. 16 sieve. Allow the mortar to remain until it has set sufficiently to prevent removal by subsequent rubbing operations. Rub the surface with a No. 25 to No. 30 carborundum brick, then, rub with burlap to remove excess mortar. If the completed rubbed
surface does not look uniform, make a final finish by wet rubbing with a No. 30 carborundum brick.

Apply Class 2 finish to the following:
1. Outside vertical surfaces of Bridge decks;
2. Outside surfaces of exterior girders, curb and rail posts seen in elevation view;
3. Curb tops, post tops, inside faces of curbs, and faces of hand rails;
4. Exposed surfaces of pier columns and caps;
5. Abutment wingwalls and Bridge seats 1 ft below final grade;
6. Bridge rehabilitation projects with existing slope paving;
7. Top surface of slope paving (tops of bridge seats require only a Class 1 finish);
8. Exposed surfaces of barrier railings on Bridges or concrete box Culverts;
10. Concrete box Culverts used for drainage, on the soffit and streamside faces of headwalls and wingwalls, and for 6 in down the back side of wingwalls; and
11. The interiors of sidewalls to 1 ft back from the face of the Culvert at the tops of the sidewalls, and extending on a 45° line downward and inward.

511.3.8.4 Class 3, Float Finish
Apply a Class 3 finish to upper surfaces not formed, such as tops of walls, parapets, tops of slabs and bottom slabs of box Culverts, copings and Bridge seats, except tops of bridge decks, Sidewalks, or curbs.
A Class 3 finish consists of placing an excess amount of concrete in the forms and striking off this excess concrete with a template, forcing the coarse aggregate below the surface. After striking off the concrete, thoroughly work the surface with a wooden, cork, or canvas float without adding water or cement. Before the final finish has set, use a fine brush to remove surface film and to produce a fine grain, smooth, sanded texture.

511.3.8.5 Class 4, Special Surface Finish
Apply a Class 4 finish on new Structures over the Class 2 finish, unless directed otherwise by the Project Manager. If applying a Class 4 finish, apply it throughout the Structure and on adjacent Structures for concrete surfaces where the Contract specifies a Class 2 finish.
If repairing existing Structures, apply a Class 4 finish to the entire surface of the repaired components.
For a Class 4 finish use Materials from the Department’s Approved Product List for special surface finish on concrete Structures. Use the same Material and methods for surfaces the Contract requires to receive a Class 4 finish.
Submit sample panels for each type of Class 4 finish, showing colors and texture to the Project Manager at least 30 Days before beginning finishing operations for approval by the Landscape Architect. Unless otherwise shown in the Contract, use sample panels that are at least 1 ft × 1 ft.
If applying a Class 4 finish and penetrating water repellent on a concrete surface, allow the penetrating water repellent to cure for at least 7 Days before applying the Class 4 finish.

511.3.8.6 Penetrating Water Repellent Treatment Solution
Saturate the exposed surfaces of the following concrete Structures with a penetrating water repellent treatment in accordance with Section 532, “Penetrating Water Repellent Treatment;”
1. Bridge wingwalls;
2. Front and side faces of abutment Bridge seats;
3. Front faces of abutment backwalls;
4. Top surfaces of bridge seats on piers and abutments;
5. Pier columns, stem walls and vertical surfaces of pier caps;
6. Top and vertical side surfaces of Bridge decks;
7. Top surfaces of concrete approach slabs;
8. Concrete barrier railings;
9. Concrete wall barriers; and
10. Sidewalks, curbs and gutters on structures.
Extend treatment to at least 1 ft below the final groundline.
Do not treat the underside of pier caps, sides, and end surfaces of concrete approach
511.3.9 Curing

Use curing methods in accordance with Table 511.3.9:1, "Curing of Concrete Structures," unless the Contract specifies otherwise.

For Structures with formed surfaces such as barrier walls, barrier railings on Bridges, wingwalls, or parapets on Bridges or box Culverts, remove the forms, finish the concrete, and resume curing with Method 2. Do not pause curing for more than 2 h. Keep the concrete surface moist throughout the finishing and curing operations.

For other formed vertical surfaces, the Contractor may strip or partially strip forms before the end of the specified 7-Day curing period, if the Contractor immediately resumes curing by Method 2.

Cure construction joints in box Culverts, Bridge Substructures and Superstructures, and other concrete Structures with wet burlap for 7 Days, or until covered with the next lift of concrete. Alternatively, cure these Structures with Method 1, provided that the surfaces are sandblasted and thoroughly cleaned before placing the new concrete.

<table>
<thead>
<tr>
<th>Table 511.3.9:1</th>
<th>Curing of Concrete Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method designation</td>
<td>Curing method description</td>
</tr>
<tr>
<td>Method 1</td>
<td>Water curing</td>
</tr>
<tr>
<td>Method 2</td>
<td>Curing compound</td>
</tr>
<tr>
<td>Method 3</td>
<td>Form curing</td>
</tr>
<tr>
<td>Method 4</td>
<td>Combination of Method 1 and Method 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structure description</th>
<th>Curing methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge decks*</td>
<td>4</td>
</tr>
<tr>
<td>Approach slabs</td>
<td>4</td>
</tr>
<tr>
<td>Concrete curbs, gutters and Sidewalks</td>
<td>1 or 2</td>
</tr>
<tr>
<td>Top surfaces of:</td>
<td></td>
</tr>
<tr>
<td>Pier caps, abutment Bridge seats</td>
<td>1 or 2</td>
</tr>
<tr>
<td>Wingwalls and parapet walls</td>
<td>1 or 2</td>
</tr>
<tr>
<td>Other concrete**</td>
<td>1, 2, or 3</td>
</tr>
</tbody>
</table>

\*See Section 512.3.10.1, "Curing," for additional curing requirements for bridge decks.

\*Unless the Contract specifies otherwise.

The Contractor shall not apply curing compound to surfaces that will receive a Class 2 or Class 4 finish, unless the Contractor sandblasts and thoroughly cleans the surfaces before applying the finish.

If the Department allows the Contractor to choose the curing method, the Contractor shall obtain the approval of the Project Manager before beginning curing operations. During curing operations, keep unsprayed surfaces wet.

511.3.9.1 Method 1, Water Curing

Keep the concrete Structures thoroughly and continuously wet and covered for at least 7 Days. Place and anchor covers, mats, and sheeting to ensure continuous contact with the concrete surfaces.

The Contractor may temporarily remove the cover of surfaces that require a rubbed finish for finishing, but shall restore the cover as soon as possible.

Cover concrete slabs as soon as possible with a double layer of clean, wet burlap or cotton mats, or other moisture retaining Material approved by the Project Manager. Next, cover the concrete slab with white plastic sheeting. The Project Manager will determine the suitability of burlap or cotton mats for reuse, based on the cleanliness and absorptive ability of the Materials.

Soak burlap in a solution of water and a small amount of detergent. Drain the burlap and cotton mats and lay them flat with no wrinkles on the deck surface. Ensure that adjacent strips of burlap and cotton mats overlap at least 12 in. Once in place, lightly fog-spray the burlap and cotton mats with water. Regularly re-wet the burlap or cotton mats so that they are not allowed to become dry.

Completely cover the concrete slab with burlap and cotton mats and the plastic sheeting.
If the slabs are on grade, extend the mats at least twice the slab’s thickness beyond the edges of the slab, and make sure that the entire exposed surface of the concrete is protected. If the slab is a Bridge deck, place the mats and plastic to fully protect exposed edges and unformed surfaces of the concrete.

511.3.9.2 Method 2, Curing Compound
For slabs, Bridge decks and other flatwork, apply the curing compound to the fresh concrete after as soon after finishing as allowed by manufacturer.
Thoroughly mix the membrane forming curing compound within an hour of use, and agitate it during spraying operations. Do not apply the curing compound in rainy conditions.
Apply the curing compound under pressure with an atomizing-type spray nozzle. Uniformly cover the entire surface area at a rate of at least 1 gal per 175 ft². Use spray Equipment with enough pressure to force the curing compound to leave the nozzle as a fine mist. If the nozzle becomes plugged, immediately clear the nozzle before continuing the application. Do not continue to spray curing compound through a nozzle that has become plugged or obstructed.
Apply the curing compound by first spraying back and forth in one direction until a uniform covering has been achieved. Then spray back and forth in a direction perpendicular to the first application until a second, uniform covering has been achieved. Ensure that the entire curing surface has been uniformly covered with two coatings of curing compound. Do not apply the curing compound to exposed reinforcing steel or construction joints.
Protect all surfaces covered with curing compound for 7 Days after application. Provide walkways and mats for workmen, Material, and Equipment.
Do not use a curing compound that exhibits separation, segregation, or skimming.

511.3.9.3 Method 3, Form Curing
Leave forms in place for at least 7 Days. Keep the forms moist during the curing period and replenish the system with water spray to maintain a continuously moist condition. Cure exposed surfaces with Methods 1 or 2.

511.3.9.4 Method 4, Combination of Curing Compound and Water Curing
Apply Method 2 curing first.
When the concrete is hard enough that burlap or cotton mats can be placed without marring the concrete surface, apply Method 1 curing directly over the emulsion coated surface.

511.3.9.5 Equipment and Personnel Readiness
Show the Project Manager that curing Material and Equipment (including backup sprayers and mixers) are in working order, at least one Day before concrete placement.

511.3.9.6 Temperature Requirements for Storage and Application
Store curing compounds in protected areas away from weather and extreme temperatures. Dispose of compounds that have been frozen in storage. Apply curing compounds when the temperature of the compound is between 50 °F and 95 °F.

511.4 METHOD OF MEASUREMENT—VACANT

511.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Concrete, Class ____</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Structural Concrete, Class ____  in</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Substructure Concrete, Class ____</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Special Surface Finish</td>
<td>Square Foot</td>
</tr>
<tr>
<td>Waterproofing</td>
<td>Square Foot</td>
</tr>
</tbody>
</table>

The Department will pay for Class 4, special surface finish only for existing concrete. Payment for the Class 4, special surface finish on new concrete is included in the payment for the new concrete.
511.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: waterstops and flashings, premolded and preformed bituminous joint fillers, concrete required to fill overbreakage in excavation when footings or walls are cast against vertical or horizontal faces of excavation, and installation of drains and weep holes.
SECTION 512: SUPERSTRUCTURE CONCRETE

512.1 DESCRIPTION
This Work consists of constructing concrete bridge decks, reinforced-concrete box-girder Bridges; slab Bridges, slant-leg Bridges, truss Bridges, and other structural configurations requiring the use of Superstructure concrete.

Cast-in-place concrete placed in Bridges above the bearings will be Superstructure concrete with the exception of abutment backwalls and abutment wingwalls, unless otherwise shown in the Contract.

Bridges with integral abutments will have wingwalls, end diaphragms, and concrete above the bearings, constructed of Superstructure concrete.

512.2 MATERIALS
Requirements contained in Section 510, “Portland Cement Concrete,” and Section 511, “Concrete Structures,” will be applicable where appropriate and not expressly modified in this Section.

Provide Superstructure concrete, Class AA.

Provide steel reinforcing bars and epoxy-coated steel reinforcing bars in accordance with Section 540, “Steel Reinforcement.”

512.3 CONSTRUCTION REQUIREMENTS

512.3.1 Deck Placement Preconstruction Conference
The Project Manager will hold a preconstruction conference at least one week before the anticipated deck placement to review the specification requirements and discuss the Contractor’s preparations. Ensure that at a minimum the following attend the conference:

1. Project Superintendent;
2. Bridge deck foreman; and
3. One representative of the concrete Supplier.

The recommended agenda checklist is available from the Bridge Design Section.

512.3.2 Profile Survey of Girders
After placing beams and before setting screeds, take a profile along each line of beams. If actual top of beam elevations differ significantly (more than a nominal haunch dimension) from those shown on the Plans such that excessive haunches or deficient slab thickness would result, make appropriate adjustments as directed by the State Bridge Engineer.

512.3.3 Falsework
The Contractor may not support deck finishing machines with overhang brackets outside of exterior steel beams or girders, unless the Contractor provides adequate bracing for the top and bottom flanges of the beams and girders. If using overhanging supports, use end overhang brackets to adequately support the corners of the deck.

Submit plans for the proposed girder bracing system to the Project Manager for approval at least 30 Days before the anticipated placement date.

512.3.4 Forms
Use deck forms that produce the desired results, unless otherwise specified in the Contract.

512.3.4.1 Permanent Steel Deck Forms
Provide Material and elements for the permanent steel deck form units that are fabricated from steel in accordance with ASTM A 653M (A653) Grades 40 and 50. Provide a Class G 165 coating. Provide form sheets and form supports in accordance with the shop drawings; that are at least 22 gauge and 16 gauge thick, respectively.

Do not use permanent steel forms in panels where longitudinal slab construction joints are located between stringers. Provide proper vibration of the concrete to ensure adequate consolidation of concrete.

512.3.4.1.1 Permanent Ventilated Steel Deck Form Design
Design permanent steel forms to support superimposed dead loads of the form, reinforcement, and plastic concrete, plus a live load of 50 lb per square foot. Use steel ventilated at a minimum rate of 1/2 in2 per square foot.
The Department will not allow the following:

1. Unit working stresses to exceed the lesser of the following:
   1.1. 72.5% of the specified minimum yield strength of the Material, or
   1.2. 36,000 psi.

2. Maximum deflections under the weight of the plastic concrete, reinforcement, and form, to exceed the lesser of the following:
   2.1. 1/240 of the form span, or
   2.2. 3/4 in.

3. A load used to compute the deflection that is less than 120 lb per square foot.

The form span for design and deflection is the clear distance between the flanges of the supporting beams less 2 in, measured parallel to the form flutes.

Limit the increase in dead load due to the use of permanent steel deck forms to 15 lb per square foot. If the increase exceeds this limit, show that the additional load will not be detrimental; or strengthen the Structure to accommodate the extra load, at no additional cost to the Department.

Calculate physical design properties in accordance with the current American Iron and Steel Institute Specification for Design of Cold-Formed Steel Structural Members.

Design the permanent steel deck forms so that the deck slab laterally supports the steel beam or girder top flanges in compression, except where providing shear connectors.

512.3.4.1.2 Permanent Steel Deck Form Installation

Do not rest form sheets directly on the top of the stringer or floor beam flanges. Securely fasten sheets to form supports. Use sheets with a minimum bearing length of 1 in at each end. Place form supports in direct contact with the flange of stringers or support beams. Make attachments with welds, bolts, clips, or other approved means; do not weld to girder or beam flanges.

Place bottom reinforcing bars with a minimum cover of 1 in. Except in cases where reinforcing bars are not parallel to form corrugations, center the bars (approximately) in the bottom layer of the main reinforcement over the valleys of the forms when necessary to achieve the minimum concrete cover. Do not allow the distance from the top of the slab to the bottom layer of main slab reinforcement to be less than the dimension shown in the Contract.

512.3.4.1.3 Inspection and Acceptance of Decks Placed with Permanent Steel Deck Forms

If during the placement of the deck concrete there is adequate evidence to question the consolidation of the concrete, the Department will require the following procedure. Provide suitable facilities to provide safe access to the Work for inspection. Follow one or more of the following inspection procedures a minimum of two Days after placing the deck concrete:

1. Test the forms for soundness of the concrete and bonding to the concrete by striking a sharp blow to the form with a geologist hammer as and when ordered by the Project Manager. Provide the geologist hammer.

2. As a minimum, strike forms at 10-foot intervals parallel to and 6 in from the edge of the steel beam and at 10-foot intervals along the centerline of each bay between the beams in an “X” pattern with those along the beams. Strike forms at random points on a semicircle or circle as applicable on approximately a 2-foot radius from the above points. Strike forms in other places as directed by the Project Manager to define suspicious or defective areas.

3. Sound areas where efflorescence is evident in accordance with item No. 2 of this list. Repair defective areas as directed by the Project Manager at no expense to the Department.

512.3.5 Placing of Reinforcing Bars

Firmly support reinforcing bars in deck slabs with approved devices spaced at intervals not exceeding 3.3 ft. Securely tie down reinforcing bar mats in bridge decks to beams and forms to prevent upward movement during concrete placement.

Do not allow the spacing between adjacent reinforcement bars to vary more than 1/2 in from the dimensions shown in the Contract. Place and maintain reinforcement bars within 1/4 in of the vertical dimensions shown in the Contract. Do not allow the concrete cover over the top layers of reinforcement to be less than 2 in.

For continuous steel Bridges, complete the forming and placing of reinforcing steel and
screed rail settings for the entire length of the Bridge before proceeding with any portion of the
deck placement, unless otherwise authorized by the State Bridge Engineer.

512.3.6 Preparation for Placing Concrete
512.3.6.1 Support of Finishing Machines

Ensure finishing machines travel on steel rails. Provide pipe for rails with 2 3/8 in outside
diameter and 1 15/16 in inside or heavier. Firmly support rails on adjustable steel supports.
Securely fasten supports in place and do not space them more than 30 in apart. The
Department will not allow the Contractor to weld the supports to top flanges of steel beams or
girders, or to the stirrups of concrete beams.

512.3.6.2 Setting of Screed Rails

Set the steel rails for placing and finishing Equipment to finish the deck in accordance
with the Contract or as directed by the Project Manager. Make the accuracy of setting the rails
consistent with the required tolerances for smoothness. Check elevations and straightness of
the rails by survey, straight edging, or string lining, and sight by eye.

If supporting the finishing machine over an outside beam, check edge forms for the deck
for vertical alignment and install in accordance with the Contract tolerances for smoothness.
Provide rails that extend a sufficient distance beyond both ends of the scheduled length of
placement to permit the finishing machine to reach all areas of the concrete placed and to
permit off-deck parking of the machine out of the way of the hand finishers. Check the
finishing machine setup for correct deck cross sections. Check blockouts for expansion joints
for proper depths and widths of openings.

512.3.6.3 Finish Machine Trial Run

At least 24 h before placing concrete, traverse the finish machine the length of the
proposed placement or, if a continuous steel Bridge, for the full length of the Bridge.
Demonstrate that the following performance criteria are met during the trial run:
1. Use of required deck slab thickness, top of deck elevations, and the specified
   reinforcing bar cover; unless otherwise noted on the Plans, provide cover to the top
   of the top reinforcing bars of from 2 in to 2 7/16 in. When checking the deck slab
   thickness, top of deck elevations, and cover, allow for deflections of supports
   resulting from the weight of the concrete;
2. Do not allow screed rails to deflect excessively;
3. The finishing machine is properly adjusted and in good working order; and
4. The finishing machine will properly track over the entire length of the proposed
   placement, particularly for decks that are curved, super-elevated, or that have a high
   skew.

512.3.6.4 Work Bridges

Provide one or two transverse work bridges for floating, straight edging, and curing
operations. Provide work bridges that are structurally sound and do not deflect excessively.
Test the work bridges in place before the deck placement to ensure proper adjustments of
wheels, adequate clearances to safety railings, and compliance with other requirements.

512.3.7 Placing of Concrete

Place Superstructure concrete by pumping or other approved means.

Place concrete close to the final position and to the full thickness of the slab. Place
concrete far enough in front of the finishing machine to ensure proper striking off and finishing,
generally a distance not greater than 12 ft.

Unless otherwise directed by the Project Manager, compact concrete with suitable
mechanical vibrators operating within the concrete. During concrete placement, keep enough
personnel, vibrators, and other tools available to assure adequate consolidation. If necessary,
supplement vibrating with hand spading with suitable tools to assure proper consolidation. If
using vibrators, use procedures in accordance with ACI 309.

Do not use a “jitterbug” or any other flat tool that could cause concrete segregation.

Use approved vibrators that can transmit vibration at frequencies up to 10,000 vpm.
Provide vibrators that have each been certified within the last 90 Days to provide 8,000 to
10,000 vpm.

Operate vibrators to consolidate the concrete thoroughly around the reinforcement and
embedded fixtures and into corners and angles of the forms. Do not use vibrators to make
concrete flow or run. Vibrate long enough to accomplish consolidation, but do not vibrate so long to cause segregation or air bubbles. Insert the vibrators vertically into the concrete, and immediately withdraw upward along the same line with the opposite motion. Do not drag the vibrator horizontally across the placing area.

When operating vibrators, avoid contact with reinforcing bars, particularly epoxy coated reinforcing bars or bars that extend into concrete that has taken an initial set. If vibrating concrete in areas reinforced with epoxy-coated bars, cover the vibrators with nonmetallic sleeves to prevent damage to the epoxy coating.

If hydraulic fluid, motor oil, dirt, or other Deleterious Material leaks or falls onto the deck, remove contaminated concrete from the deck before proceeding.

512.3.7.1 Pumping of Concrete

Before placing concrete, thoroughly clean the Equipment. Operate the pump to produce a continuous stream of concrete without air pockets and no appreciable loss of slump.

If placing concrete by pumping, do not add water at the concrete entrance hopper. If adding water at the pump hopper to clear a clogged pump, remove and dispose of concrete in the hopper and the line.

Obtain the Project Manager's approval of concrete pumping Equipment before use. Provide a backup placement system capable of completing concrete placement to a bulkhead in case of a pump failure. Provide bulkheads that are pre-cut and ready for installation.

Do not use aluminum pipe as a conduit for concrete placement.

The Department will test concrete for acceptance at the discharge end of the pump, and collect samples from concrete placed on the deck.

512.3.7.2 Delays in Deck Placement

Stop placement operations and correct, if one of the following problems occur:

1. A deck-finishing machine fails;
2. Placement operations are not within the specification requirements; or
3. Placement operations are not achieving satisfactory results.

If the concrete placement is delayed, stop all other placement operations until the cause of the delay is corrected.

If the Contractor fails to correct the problem within 45 min (or within 60 min if using a set retardant), erect a bulkhead parallel to the finishing operations and as close as practical to the location that placement originally stopped. Finish concrete to the bulkhead and discontinue placement operations for the day. Before deck placement, cut the bulkhead to length and slot it for reinforcing bars.

For slab Bridges, install the bulkhead as close to one of a span's quarter points as possible.

If deck placement operations have been suspended and bulkheads installed, do not resume deck construction until after 12 h and after taking adequate corrective measures to ensure concrete mixing, placement, finishing, and curing are performed in accordance with the Contract, as approved by the District Construction Engineer.

512.3.7.3 Rate of Progress

Provide a rate of progress of bridge deck placement in accordance with the Contract. If the Contract does not define a rate, the rate of progress will be at least 30 ft per hour over the entire width of the deck, except for slab Bridges, for which the rate will be at least 20 ft per hour.

If the placement includes integral pier or abutment diaphragms, do not include the time required to place the diaphragms in the rate of placement calculations. Include delays in the placement due to other causes in the calculation of the overall rate of pour.

The Department may reject decks placed at rates slower than specified. The Project Manager may decrease the rate of placement by 25%, if the following conditions exist:

1. The rate of evaporation is less than 0.8 lb per square foot per hour;
2. The wind velocity on the deck is less than 10 mph; and
3. The Contractor is producing an acceptable finish.
512.3.7.4 Concrete Placement in Girders

Unless otherwise approved by the District Construction Engineer, uniformly deposit concrete in girders the full length of the girder and bring up evenly in horizontal layers not exceeding 2 ft in depth.

512.3.8 Temperature and Weather Limitations

512.3.8.1 Temperature Requirements

See Section 511.3.3, "Temperature and Weather Limitations."

512.3.8.2 Change in Weather Conditions

The Contractor shall assume the risk of proceeding with deck placement during marginal weather. Repair or remove and replace concrete damaged due to changing weather conditions.

After placement operations have started, if weather conditions change causing evaporation rates to exceed those previously specified or if other adverse weather conditions arise, immediately place an emergency bulkhead, finish concrete to the bulkhead, and discontinue placement operations for the day.

Keep materials available to cover and protect unfinished deck areas and completed deck areas ahead of and behind the finishing machine as the machine moves forward to the bulkhead.

512.3.9 Finishing

Ensure that the rideability, drainage, and surface texture characteristics of finished bridge deck slabs meet the requirements specified.

Provide deck with smooth transitions at ends of Bridges and across expansion and construction joints. Provide deck that is free draining, with no depressions.

Unless otherwise specified in the Contract or approved in writing by the District Construction Engineer, operate finishing machines with the skew of the Structure. Float and broom the plastic concrete parallel to the finishing operation.

Provide a 10-foot long, lightweight, round-bottom, straightedge equipped with a long handle, as approved by the Project Manager.

Do not add water to the surface of the concrete to assist finishing.

512.3.9.1 Finishing Machine

Finish bridge deck slabs and approach slabs with approved power driven finishing machines, unless the use of such machines is impractical and the District Construction Engineer provides a written waiver.

Use finishing machines with one or more rotating rollers, augers, and vibratory pans providing from 2,500 vpm to 4,000 vpm.

512.3.9.2 Finishing of Slab Edges

If an exterior beam or girder supports a finishing machine, the Contractor may hand finish the deck slab between the exterior beam or girder and the edge of the deck slab.

512.3.9.3 Hand Finishing Plan Submittal

The Contractor may finish the concrete deck slabs by hand if the use of a finishing machine is not possible. Submit a hand-finishing plan to the Project Manager for approval before initiating placement operations. The plan will describe the screed arrangement and proposed methods of finishing.

512.3.9.4 Final Finishing Operations

Immediately following the initial finishing operations and while the concrete is still plastic, test the slab surface for trueness in accordance with Section 512.3.10.2, "Acceptance Criteria," by using the straightedge as a float. Advance the straightedge longitudinally along the slab in successive stages not more than 1/2 the length of the straightedge.

Correct variations in the surface of the slab by striking off projections and filling depressions with freshly mixed concrete. Consolidate and refinish the corrected areas with a long handled float at least 3 ft in width.

The Contractor may use small hand floats if approved by the Project Manager. Recheck the surface with a straightedge.

During the floating and straightedging process, check and ensure that the deck has the proper crown, slope, and grade. Construct deck surfaces in the vicinity of deck drains to slope...
gently toward the drains. The Contractor may use a float 3 ft or greater in width to seal the surface behind the finishing machine. Final finishing operations will follow the trailing edge of the finishing machine closely, generally, at a distance of 13 ft or less. Do not allow more than 1 h to elapse between the time of placement of concrete on the deck and the completion of final finishing operations. Unless otherwise specified in the Contract, apply a broomed finish to the plastic concrete parallel to the finishing operation.

512.3.10  Final Operations

512.3.10.1  Curing

Unless otherwise specified in the Contract, cure bridge decks and approach slabs in accordance with Section 511.3.9, “Curing.” Ensure forms supporting bridge decks remain in place for at least 7 Days.

512.3.10.2  Acceptance Criteria

Test the smoothness of the completed Roadway surfaces of bridge decks, approach slabs, and the adjoining 50 ft of approach pavement. After the concrete of bridge decks, approach slabs, and pavement hardens, check the entire surface areas with a 10-foot straightedge. Hold the straightedge in successive positions parallel to the centerline of the Roadway and in contact with the slab. Advance the straightedge longitudinally along the slab in successive stages no greater than half the length of the straightedge. Provide a finished surface plane of bridge decks and approach slabs that do not vary more than 3/16 in, measured from the bottom of the straightedge. Provide a finished surface of concrete or asphalt approaches that does not vary more than 1/4 in, measured from the bottom of the straightedge. Plainly mark variations that exceed the allowable values.

Ensure that vertical steps or discontinuities at the ends of Bridges and approach slabs do not exceed 3/16 in. Place expansion joints below grade, from 1/16 in to 3/16 in. The Department will reject expansion joints installed at elevations above the Roadway grade. Remove smaller discontinuities or high spots greater than 3/16 in by rubbing with carborundum brick and water. Correct larger areas of deck requiring repair by use of power grinders or similar tools approved by the Project Manager. The Department will not allow the use of a bush hammer or similar tools to remove irregularities. When grinding, do not reduce the concrete cover over the reinforcing steel to less than 1 9/16 in. If grinding cannot satisfactorily correct portions of decks, remove and replace them at no additional cost to the Department.

After rubbing and grinding, restore the curing system on the deck as necessary. The District Construction Engineer may direct the Contractor to remove and replace unacceptable areas under the following conditions, at no additional cost to the Department:
1. The finished deck surface is exceedingly rough;
2. Plastic shrinkage cracking or surface tearing is severe; or
3. Serious damage due to any cause occurs over large areas of the deck placement.

512.3.10.3  Grooving of Hardened Concrete

Straightedge and repair the bridge deck before grooving. Do not groove the deck before the end of the concrete curing period.

512.3.10.3.1  Grooving Machine

Groove hardened concrete with diamond blades mounted on a multiblade arbor on a self-propelled machine built for grooving concrete pavements. Provide a grooving machine with the following:
1. A depth control device that detects variations in the concrete surface and adjusts the cutting head height to maintain the specified groove depth; and
2. A device to control alignment.

512.3.10.3.2  Groove Pattern

Groove the bridge decks parallel to the centerline of the Roadway if bridge decks abut concrete pavement that is to receive longitudinal grooving, or as specified in the Contract. Otherwise cut grooves perpendicular to the centerline of the Roadway. Begin grooving 18 in from the gutter line or face of rail and run in a continuous pattern to
18 in from the opposite gutter line or face of rail. The Contractor may increase the 18 in dimension on one side of the deck to as much as 27 in, if the clearance of the grooving machine does not allow a closer approach to the railing.

Provide grooves that begin and end within from 2 in to 4 in of expansion joints, contraction joints, and ends of the slab.

Lay out the grooving accurately before cutting begins. Provide grooves that are 0.125 in ± 0.02 in wide and from 1/8 in to 1/4 in deep.

If using transverse grooving, space grooves in a random pattern from 1/2 in to 7/8 in centers. If using longitudinal grooving, space grooves from 5/8 in to 7/8 in centers.

512.3.10.3.3 Grooving Residue Removal
Continuously remove resulting slurry or residue immediately following grooving operations. Clean the lands and the grooves and leave the surface free of slurry residue and other Deleterious Material.

Remove grooving residue by flushing, vacuuming, or other methods approved by the Project Manager.

512.3.10.4 Penetrating Water Repellent
After finishing, repairing, and machine grooving, apply a penetrating water repellent treatment to bridge decks and approach slabs in accordance with Section 532, “Penetrating Water Repellent Treatment.”

512.3.11 Superstructure Appurtenances

512.3.11.1 Construction Joints
Make construction joints smooth and true to line, and finish them with an edging tool with a radius of approximately 1/8 in. If longitudinal construction joints are located off the crown, provide a finish across the joint that is smooth and of a slope to provide proper drainage of the deck.

512.3.11.2 Sealing of Construction Joints and Surface Cracks
After grooving and applying the penetrating water repellent, fill and seal construction joints and cracks that are visible on a dry deck with a HMWM resin in accordance with Section 535, “Crack Sealing Using Low-Viscosity, Gravity-Fed Sealers.”

Apply HMWM resin to joints and cracks that permit the flow of water through the deck thickness as recognized by leaching along the crack or joint lines when viewed from below the deck, as determined by the Project Manager.

512.3.11.3 Sidewalks, Curbs, and Raised Medians on Structures
Thoroughly tamp the concrete in Sidewalks, curbs, and raised medians on Structures so that a layer of mortar approximately 1/8 in remains on top of the coarse aggregate. Strike off the surface of the concrete with a strike board to a uniformly smooth surface and float it with an acceptable wood or cork float.

Test the surface of Sidewalks and raised medians with a 10-foot straightedge and ensure the surface does not vary more than 1/4 in from the bottom of the straightedge.

Give Sidewalks, curbs, and raised medians a broomed surface finish. After finishing and curing, give the Sidewalks, curbs, and raised medians a penetrating water repellent treatment in accordance with Section 532, “Penetrating Water Repellent Treatment.”

512.3.11.4 Opening of Bridge Deck and Approach Slabs to Traffic
If it is necessary to open a Roadway to traffic at the earliest possible moment, the District Construction Engineer may allow traffic on a bridge deck or on approach slabs after the 7-Day curing period and after cylinders that are field cured in the same environment as the slabs demonstrate a compressive strength greater than 3,000 psi.

The Department will allow traffic on the deck before the application of the penetrating water repellent treatment; however, the Contractor shall perform the specified surface preparation procedures before application.

512.4 METHOD OF MEASUREMENT
The Department will measure Superstructure Concrete using the dimensions shown in the Contract or approved modifications.
512.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>PAY ITEM</th>
<th>PAY UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superstructure Concrete</td>
<td>Cubic Yard</td>
</tr>
</tbody>
</table>

512.5.1 Work Included In Payment

The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

A. Machine grooving; All corrective work; HMWM construction joint sealing; and

B. The pay quantity for superstructure concrete will not be increased for any additional volume of concrete placed because of the use of metal stay-in-place forms.
514.1 DESCRIPTION
This Work consists of constructing concrete barrier railings for Bridges.

514.2 MATERIALS
Provide Material in accordance with the following requirements:
1. Superstructure concrete Class AA for barrier railings concrete on Bridges;
2. Cement, air-entrainment and other admixtures, water, and aggregates in accordance with Section 510, "Portland Cement Concrete;"
3. Curing Materials in accordance with Section 510, "Portland Cement Concrete;"
4. Reinforcing steel in accordance with Section 540, "Steel Reinforcement."

514.3 CONSTRUCTION REQUIREMENTS
514.3.1 General
Perform Work in accordance with Section 511, “Concrete Structures.” The Department will not allow welding to anchor bars and other barrier reinforcement.

514.3.2 Deck Preparation for Barrier Placement
Cure bridge deck tops beneath barrier railings using the water curing method. If another method of curing is used, clean excess curing Materials from that portion of the bridge deck by sandblasting before placing the barriers. Before placing the railings, thoroughly clean dirt, oil, and other Deleterious Materials from the deck surface.

514.3.3 Barrier Placement and Placement Tolerances
Cast concrete barrier railings in place using removable forms. Do not use slip forms for barrier railings, unless otherwise approved by the State Bridge Engineer.
For Bridges set on tangents, set the forms and place the concrete so that a stringline placed along the top inside edge of the finished barrier shows no horizontal deviations from a straight line greater than 3/8 in within 20 ft.
For Bridges set on curves, ensure that the horizontal deviations from the horizontal curve do not exceed 3/4 in within 20 ft.
Ensure that the overall vertical tolerance of the outside surface of the barrier railings is less than 3/8 in within the full height.
Place concrete for barrier railings in accordance with Section 511.3.4, “Placing Concrete.” However, do not allow the depth of layers for placing concrete in the barrier forms to exceed 12 in.

514.3.4 Curing
Perform curing in accordance with Section 511.3.9.1, "Method 1, Water Curing,” or Section 511.3.9.2, “Method 2, Curing Compound.”

514.3.5 Final Treatment of Barrier Railing
After finishing and curing, apply a penetrating water repellent treatment to the exposed surfaces of the barrier railings in accordance with Section 532, “Penetrating Water Repellent Treatment.”

514.3.6 Drilling Holes
Core drill holes for attaching thrie-beam or W-beam terminal connector plates to barrier railings. Do not spall the concrete during the drilling process. Place the holes for attachments at least 6 in away from joints or ends of barrier railing.

514.4 METHOD OF MEASUREMENT
The Department will measure Concrete Barrier Railings along the top of the barrier from end to end, including barriers over wingwalls.

514.5 BASIS OF PAYMENT
<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
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</table>

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514.5.1 Work Included In Payment

The following items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: reinforcing steel, dowels and all embedded steel items; penetrating water repellent treatment.
## 515.1 DESCRIPTION
This Work consists of providing reinforced concrete for minor Structures.

## 515.2 MATERIALS
Provide Class A concrete with a design compressive strength of at least 3,000 psi in accordance with Section 510, “Portland Cement Concrete.”

Provide Grade 40 or 60 reinforcing steel in accordance with Section 540, “Steel Reinforcement.” The Department will allow field bending and cutting. Thread pre-formed hookbolts for the entire depth of embedment, or make hookbolts using reinforcing bar stock.

Provide epoxy grout for anchoring hookbolts in accordance with Section 522, “Concrete Chemical Anchors.”

## 515.3 CONSTRUCTION REQUIREMENTS
Construct reinforced concrete for minor Structures in accordance with Section 510, “Portland Cement Concrete,” Section 511, “Concrete Structures,” and Section 540, “Steel Reinforcement.”

Construct collars to fit tightly for joining pipe-to-pipe or pipe-to-box Structures. Ensure concrete plugs at the ends of existing conduits or box openings fit tightly.

Provide bulkheads at the junction of different sized pipes and conduits to prevent leakage of fresh concrete and mortar into the conduit. Remove concrete or mortar that leaks into the conduit. If required to maintain smooth flow conditions within the conduit, form fillets of fresh concrete to reduce turbulence at conduit junctions.

## 515.4 METHOD OF MEASUREMENT
The Department will measure Reinforced Concrete for Minor Structures using the dimensions shown in the Contract or approved modifications.

## 515.5 BASIS OF PAYMENT
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<tr>
<th>Pay Item</th>
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<td>Reinforced Concrete for Minor Structures</td>
<td>Cubic Yard</td>
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</table>
516.1 DESCRIPTION
This Work consists of providing and placing flowable fill.

516.2 MATERIALS
516.2.1 General
Flowable fill is a flowable mixture of portland cement, fly ash, aggregates, admixtures and water.

516.2.2 Mix Design
The State Materials Bureau is responsible for approving the mix design for flowable fill.

516.2.3 Cement
See Section 509, “Portland Cement Concrete Mix Designs.”

516.2.4 AGGREGATE
Provide a uniform mixture of fine aggregate or coarse and fine aggregate. Provide coarse and fine aggregate with a gradation in accordance with Table 516.2.4:1, “Aggregate Mixture Gradation Requirements.”

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<td>5 – 35</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 – 30</td>
</tr>
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</table>

516.2.5 Water
Provide concrete mix water in accordance with Section 509, “Portland Cement Concrete Mix Designs.”

516.2.6 Air-Entraining Admixture
The Contractor may use an air-entraining admixture to provide air entrainment no greater than 35% in the flowable fill.

516.2.7 Fly Ash
Provide approved Class F, Class C, or Class C/F blended fly ash in accordance with Section 509, “Portland Cement Concrete Mix Designs.”

516.2.8 Water-Reducing Admixture
The Contractor may use a water-reducing admixture.

516.2.9 Proportioning and Physical Property Requirements
Provide a flowable fill mix design in accordance with the following limits:
1. Cement, maximum 50 lbs/yd³.
2. Fly Ash, from 150 lbs/yd³ to 300 lbs/yd³.
3. Air Content, optional.
4. Slump, from 6 in to 11 in.
5. Water/cement ratio, proportioned by weight to produce a slump within the prescribed limits.
6. Consistent aggregate throughout the concrete mixture.
7. Compressive strength will not exceed 150 psi at 28 Days.
516.10 Sampling and Testing
Obtain the State Materials Bureau’s approval of the flowable fill mix properties before
using the mix in the field. Determine the flowable fill mix properties by producing the flowable
fill mixture in the Laboratory and preparing and testing strength test specimens in accordance
with the ASTM C 39, with the following modifications:
1. Cast the test specimens in 4 in × 8 in test cylinders, perforated on the bottom with
four 1/4 in diameter holes for free draining;
2. Keep the test cylinders in a moist environment, but do not cure in a curing tank.
3. Cast six compressive strength test cylinders in the Laboratory. Test two cylinders at
7 Days, two at 28 Days, and two at 56 Days.
For field testing, use a standard (15 lb) T-post fence driver to drive a #6 reinforcing bar
with a flat end into the flowable fill Material 24 h after placement. Lift the driver until the
bottom of the driver is even with a mark located 6 in below the top of the rebar, and then allow
it to fall under its own weight. Remove and replace the flowable fill if fewer than 6 blows or
more than 25 blows are required to drive the rebar exactly 12 in into the fill. The Department
will not require compressive strength test cylinders for field-testing purposes.

516.3 CONSTRUCTION REQUIREMENTS
516.3.1 Batching, Mixing, and Transporting
Perform batching, mixing, and transporting in accordance with Section 510, “Portland
Cement Concrete.”

516.3.2 Placing
Place flowable fill uniformly to prevent voids in or segregation of the bedding and filling
Material. Secure the Culvert or pipe from movement.
Place the flowable fill by direct discharge from a ready mix truck, pumping, or other
method approved by the Project Manager. Place the flowable fill in layers no more than 12 ft
high. Do not place the individual layers until flowable fill in a previously placed layer has been
in place at least 2 h.
Submit a written request and obtain written approval from the District Construction
Engineer before placing the flowable fill in a full depth layer.
Do not place the flowable fill on frozen ground or while it is raining. Protect flowable fill
from flooding for at least 24 h after placement.
If necessary, place flowable fill in standing water that is positioned to keep the outside
water from contaminating or mixing with the flowable fill.
If required, consolidate the flowable fill with internal vibrators in accordance with
Section 511.3.4.5, “Vibrating/Consolidation.”
Do not allow any imbedded items to float or otherwise dislodge. Secure pipe to
compensate for buoyancy.
Fill the areas between the walls of the existing CBC and an inserted CMP thoroughly.
Do not disturb the flowable fill Material for at least 24 h after placement. The Contractor
may reduce this 24-hour period, if the penetration resistance of the Material justifies, as tested
in accordance with Section 516.2.10, “Sampling and Testing.”

516.3.3 Application of Load
The Contractor may cover the flowable fill within 24 h after placement, if a person
weighing at least 150 lb does not sink into the Material more than 1 in, if standing on a
4 in × 4 in wooden block.

516.3.4 Temperature and Weather Limitations
Do not place flowable fill when the air temperature is lower than 35 °F. The Contractor
may begin placement only when weather conditions are favorable and the air temperature is
at least 35 °F and rising. If the air temperature at the time of placement is less than 40 °F, place
flowable fill that has a temperature of at least 50 °F.

516.4 METHOD OF MEASUREMENT
The Department will measure flowable fill using the dimensions shown in the Contract or
as approved by the Project Manager. The Department will consider flowable fill used at the
Contractor's option to be incidental to the associated Bid Item.
516.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>PAY ITEM</th>
<th>PAY UNIT</th>
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<tbody>
<tr>
<td>Flowable Fill</td>
<td>Cubic Yard</td>
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</table>

516.5.1 Work Included in Payment

The following work will be considered as included in the payment for the main item and will not be measured or paid for separately: When called for in the contract, or the Contractor proposes its use and is approved by the Project Manager, flowable fill can be used for backfill in culvert installations. No measurement or payment will be made for work and materials associated with backfilling pipes with flowable fill. This will be included in the contract unit price per linear foot of culvert pipe.
517.1 DESCRIPTION
This Work consists of fabricating and installing precast, non-stressed components composed of PCC.

The Department defines a concrete Structure or component that is cast in a location that is not its final intended in-service location to be precast concrete.

The Department defines non-stressed components as precast concrete members that are not subject to pre-tensioning or post-tensioning.

517.2 MATERIALS
Unless otherwise specified, use Class A concrete in accordance with Section 509, “Portland Cement Concrete Mix Designs.”

Provide PCC for precast concrete components in accordance with Section 510, “Portland Cement Concrete,” unless otherwise specified in this section.

517.2.1 Design and Acceptability Requirements
Before casting, obtain the State Materials Bureau’s approval of the concrete mix design. The Contractor may only make changes to the approved mix design in accordance with Section 509.2.8, “PCC Mixture Design and Approval.”

517.2.2 Testing Requirements
Perform sampling and testing of coarse and fine aggregates for alkali-silica reactivity in accordance with Section 509.2.4, “Aggregate.”

If specified in the Contract or directed by the Project Manager, determine the required compressive strength in accordance with AASHTO T 22, at no additional cost to the Department. Make and cure, or obtain from the manufacturer 4 in × 8 in compressive strength test cylinders in accordance with AASHTO T 23. If the Contractor places more than 10 yd$^3$ of concrete in a day, the Contractor shall make at least three cylinders from the placed concrete. If the Contractor places less than 10 yd$^3$ of concrete in a single day, the Contractor shall cast at least three cylinders from a random sample for each 50 yd$^3$ of placed concrete. The Department may waive this testing requirement if the Contractor places less than 10 yd$^3$ of concrete in a day and no more than 50 yd$^3$ of concrete on the overall project.

A compressive strength test is the average of two or more compressive strength cylinder tests performed at the same age. The Department will determine acceptance of the concrete in accordance with Section 510.3.5.1.1, “Individual Strength Test.” Enter all test results for compressive strength and fresh concrete properties, including slump, air content and unit weight, on the Field Report Form provided to the Contractor at the same time the approved mix was provided.

Allow Department personnel access to obtain test samples and to perform independent testing at the Department’s discretion.

If compressive strength tests fail to comply with the Contract requirements, the Department will allow the manufacturer to perform in-place compressive strength testing on the members in question. The Department will evaluate these tests in accordance with Section 510.3.5.4, “Investigation of Low Strength Cylinder Test Results.”

517.2.3 Steel Products
517.2.3.1 Reinforcing Steel
Provide steel reinforcement in accordance with Section 540, “Steel Reinforcement.”

517.2.3.2 Structural Steel
Provide Structural Steel items in accordance with Section 541, “Steel Structures.”

517.3 CONSTRUCTION REQUIREMENTS
517.3.1 General
Manufacture precast components in one of the following plants:
1. A PCI certified plant regularly engaged in design and construction, or a structural precast member with a minimum of five years experience; or
2. A facility inspected and approved by a precast concrete Inspector.
517.3.2 Quality Control

Ensure that precast concrete manufacturing facilities have a current quality control plan on record that describes the procedures in detail, unless specifically waived by the Project Manager in writing. The plan shall include an organization chart of the overall casting operation, a list of responsible people and a detailed description of their job duties, and the telephone number of the responsible party for contact 24 h per day during placement of precast Structures.

Obtain all batch weights used for each day's production directly from the computer generated production record for each batch, and record each batch weight on the same Field Report form as the test results referenced in 517.2.2. Electronic copies of the report form for each day's production will be kept available for review by the Department Precast Concrete Inspector upon request. In addition to the electronic copy, a printed copy of the summary page and all original computer generated production records will be kept on file for each day's production. Make these copies available to the Precast Concrete Inspector upon his request. For a facility that has no computer or computerized capability, actual batch weights of each ingredient will be recorded before the load is discharged.

Any Precast items cast from concrete batches that can not be verified or with non-complying test results or batch weights can not be used on Department projects, and will be disposed of at no cost to the Department.

517.3.3 Notice of Beginning Work

Give the Project Manager or the Inspector adequate notice before starting work in the plant as follows:
1. Plants in the State of New Mexico: 7 Days;
2. Plants in the Contiguous United States: 21 Days;
3. Plants outside the Contiguous United States: 60 Days.
Do not perform Work before the Project Manager or the Inspector authorizes fabrication.
Request inspections at least 3 Days in advance.

517.3.4 Approval of Plants and Equipment

Obtain approval of the Project Manager or the Inspector for plants and Equipment used in manufacturing precast concrete members before Work begins. The Project Manager or the Inspector may forbid the use of machinery, Equipment, or appurtenances that prove unacceptable.

517.3.5 Shop Drawings

Fabricate precast concrete Structures in accordance with the manufacturer's standard drawings derived from Department's Standard Drawings. For modified or one-of-a-kind precast concrete Structures, submit shop drawings to the Bridge Design Section for review and approval. Provide shop drawings that show sizes, shapes, dimensions, and concrete cover for the reinforcing steel and other items embedded in the concrete.

Allow 30 Days for review and approval of the drawings by the Bridge Design Section.

517.3.5.1 Calculations

Submit design calculations to the Bridge Design Section for modified or unique precast concrete Structures not previously reviewed and approved by the Department. Ensure that a professional engineer registered in the State of New Mexico performs the calculations. Submit the calculations at least 30 Days before the start of fabrication.

517.3.6 Precast Concrete Member Assembly

517.3.6.1 Beds and Forms

Use forms that are smooth, mortar tight, and capable of withstanding forces caused by placement and consolidation of concrete. Accurately fabricate and secure forms in position so that the precast member has true, smooth, and even surfaces. Provide support for casting beds on unyielding foundations. The Department will not allow internal bracing and holding devices in forms if they remain in the finished member.

Provide corners with a chamfer or radius in accordance with the Plans.
Check the grade and alignment of forms each time they are set, and maintain them during concrete placement.
Ensure forms are reasonably free of rust, grease, or other Deleterious Materials.

Thoroughly clean beds and forms after each use and before each casting operation. Do not
allow coatings used for release of members to build up. Maintain beds and forms to produce an acceptable product. Construct the forms to facilitate removal without damage to the concrete. Use care in removing forms to not deface or damage the member. Do not use methods of removal that cause overstressing of the concrete.

517.3.6.2 Forms for Internal Voids
If constructing forms for internal voids, use an approved watertight material that is resistant to breakage and deformation during concrete placement. Provide stay-in-place internal forms that are as light in weight as practical. Securely anchor internal forms in position to prevent flotation or displacement during concrete placement.

Vent and drain stay-in-place void forms through the base of the member. Seal splices and ends of stay-in-place void forms to prevent concrete from entering.

Manufacture internal voids shaped by moving mandrels in accordance with the same dimensional tolerances as formed voids. The timing and rate of mandrel movement will preclude fallout of inner surfaces, tensile cracks, and the separation of concrete from reinforcing.

517.3.6.3 Placement of Reinforcing Bars
Accurately place and secure reinforcing bars in accordance with the Plans, and methods approved by the Project Manager or Inspector. Pay particular attention to concrete cover requirements over reinforcing bars. Provide lap splices in accordance with the approved drawings, and fasten them securely.

517.3.6.4 Placement and Consolidation of Concrete
Place concrete in accordance with Section 511, “Concrete Structures,” unless otherwise specified in this section.

Before placing concrete, correct deficiencies found by the Inspector. Immediately correct deviations in alignment and grade greater than 3/8 in. To ensure that similar deficiencies do not recur, implement quality control procedures satisfactory to the Inspector.

Use internal vibration to eliminate honeycombing. Attach a sufficient number of external vibrators rigidly to the forms so that the vibrations extend throughout the entire length and volume of the member.

The Department will not allow vibrating methods that cause segregation. The Department will reject members with voids or honeycombing that exposes reinforcement.

517.3.6.5 Tolerances
The maximum allowable deviations from the dimension and details shown in the Contract are listed in the Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products, published by the PCI.

517.3.6.6 Curing
Cure precast members in accordance with Section 511, “Concrete Structures.” The Contractor may use steam, in accordance with Section 517.3.6.6.1, “Steam Curing.”

Before placing concrete, submit the proposed curing methods and procedures to the Project Manager or the Inspector for approval. Test elevated-temperature curing facilities for a minimum of 48 h before approval. Make curing Equipment and Materials for curing available before casting.

The Project Manager or Inspector will suspend concrete placement if curing facilities are inadequate or the Contractor is not attending to the proper curing of the concrete. Placement may resume after the Contractor makes the appropriate corrections.

Begin curing before the formation of surface shrinkage cracks. To prevent damage and discoloration of a concrete member, do not allow mats, sheets, or blankets to contact the concrete member.

The Contractor may remove forms after the concrete has reached sufficient strength. Do not interrupt the curing of members for more than 30 min when removing forms.

517.3.6.6.1 Steam Curing
If steam curing, enclose the member entirely within an approved and supported enclosure so that a clear space forms around the sides, ends, and top of the member.

After placement and vibration of the concrete, allow it to attain its initial set before
applying steam. Prevent surface drying during the period between placement of concrete and application of steam by applying coatings, a membrane curing compound, moisture retention covers, or other equivalent methods.

Ensure that the rate of temperature rise and the maximum temperature, in combination with the cement used in the concrete mix, does not promote or initiate delayed ettringite formation.

Equip each enclosure with accurate temperature recording devices spaced at no more than 100-foot intervals to keep continuous hourly records.

If the air temperature is 40 °F or greater, do not admit steam fog to the enclosure for a period of from 2 h to 6 h after final placement of concrete into the forms, to allow the initial set to take place. Maintain the steam fog surrounding the member at a temperature between 120 °F and 165 °F until the member attains the required strength.

If the air temperature is less than 40 °F, admit steam no hotter than 120 °F to the enclosure immediately. Allow the 2-to-6 hour initial setting period to elapse before raising the steam temperature to the specified curing temperature range.

Admit steam into the enclosure at a low pressure and in a saturated condition. Position steam jets so they do not discharge directly onto the concrete, forms, or test cylinders. Carefully check the housing to ensure uniform distribution of steam fog and uniform application of heat and moisture.

When discontinuing the steam, decrease the temperature of the air surrounding the member at a nearly constant rate not to exceed 70 °F per hour until it reaches a temperature 50 °F above the temperature of the surrounding air. At that time, terminate the steam curing. Maintain the temperature of the member above 35 °F for four consecutive days after completion of steam curing.

If, upon completion of steam curing, the member does not attain the 28-day design strength, apply an impervious membrane-curing compound to surfaces of the member in accordance with AASHTO M 148, Type I-D. Apply the compound to the bottom surface of the member immediately after removing it from the casting bed.

Remove side forms from 6 h to 2 Days after completing the pour. Loosen or remove steel side forms as early as practical to prevent damaging the concrete. The Contractor may interrupt curing briefly for this purpose as long as the surrounding air temperature does not drop below 40 °F.

517.3.7 Workmanship

The Department will not reject Work because of fine cracks on the surface of the member that do not extend to the plane of the nearest reinforcement unless they are numerous and extensive. For members with diagonal cracks, which indicate damage from torsion, the Department will perform a structural review before accepting.

Repair cracks that extend into the plane of the reinforcing steel (but are acceptable otherwise) by sealing with an approved epoxy or other approved material.

Repair defective areas or surfaces needing patching using approved methods. Do not plaster over defective areas.

Unless otherwise noted, provide finishes in accordance with Section 511.3.8.2, “Class 1, Ordinary Surface Finish,” or Section 511.3.8.3, “Class 2, Rubbed Surface Finish,” except for temporary Structures which will require a Class 1 finish.

517.3.8 Lifting, Handling, Storing, and Shipping Precast Members

Avoid chipping, cracking, fracturing, and excessive bending stresses when lifting, handling, storing, and shipping members. Support members on firm blocks. During handling and storage, keep the members vertical and the long axis approximately level. Make the points of support and direction of reactions with respect to the member approximately the same as when the member is in its final position in the completed Structure or application. Handle or support the items securely in an upright position.

Use care during lifting, handling, hauling, storing, erecting, and driving to prevent cracking, spalling, or other damage to the member. Replace members damaged by improper handling methods.

Verify lifting devices for capacity in lifting and handling products, taking into account various positions during handling. Do not allow lifting devices to project above the surface of the member after placement unless the lifting devices will:

1. Be embedded in a subsequent concrete pour;
2. Have a concrete cover of at least 2 in; and
3. Not interfere with the placement of reinforcing steel or concrete. Stack members in storage only with approval of the Project Manager or the Inspector. Keep members covered and protected until installed. Do not subject members to heavy loads until the members have attained the specified 28-Day strength.

517.3.9 Installation
Install precast Structures in accordance with the Contract.

517.4 METHOD OF MEASUREMENT
The Department will measure precast concrete members in accordance with the applicable sections of the Specifications.

517.5 BASIS OF PAYMENT
The Department will pay for precast concrete members in accordance with the applicable sections of the specifications.
518.1 DESCRIPTION
This Work consists of manufacturing and erecting pre-stressed concrete bridge piles, beams, other pre-stressed concrete bridge members, or pre-stressed post-tensioned cast-in-place concrete bridge members composed of PCC.

518.1.1 Tensioning Definitions
518.1.1.1 Pre-Tensioning
Tensioning in which the pre-stressing reinforcement is stressed before the Contractor places the concrete. After the concrete attains the required strength, the Contractor releases the pre-stressing force from the external anchorages and transfers that force, by bond, into the concrete.

518.1.1.2 Post-Tensioning
Tensioning in which the Contractor installs the pre-stressed reinforcement in voids or ducts in the concrete and stresses and anchors it against the concrete after the development of the required concrete strength. As a final operation under this method, the Contractor pressure-grouts the voids or ducts.

518.2 MATERIALS
518.2.1 Portland Cement Concrete
Provide an approved State Materials Bureau concrete mix in accordance with the requirements for Special Concrete, as defined in Section 509, “Portland Cement Concrete Mix Designs,” and specified compressive strength in accordance with the Contract.

518.2.1.1 Fly Ash
Provide PCC that contains fly ash in accordance with Section 509, “Portland Cement Concrete Mix Designs.”

518.2.1.2 Coarse Aggregate
Provide coarse aggregate that consists of Material no larger than one-third the size of the smallest clear space into which the Contractor shall place this concrete.

518.2.1.3 Design and Acceptability Requirements
For pre-stressed concrete members, provide the concrete mix design in accordance with Table 509.2.8.1.1, “Concrete Classes for Laboratory Design of Concrete Mixtures.” Obtain the State Materials Bureau’s approval of the concrete mix designs before casting. Once the State Materials Bureau approves a concrete mix design, the Contractor may only make subsequent changes in the mix proportions in accordance with Section 509.2.8, “PCC Mixture Design and Approval.”

518.2.1.4 Testing Requirements
Ensure the compressive strength is in accordance with Section 510, “Portland Cement Concrete.” Make and cure cylinders in accordance with AASHTO T 23 and the following:
1. At least two cylinders per beam or pile from concrete placed in each member;
2. At least three cylinders from concrete placed in a single day; and
3. At least three cylinders from concrete placed on a single casting bed;
Make additional cylinders for strength tests (to determine application of pre-stressing forces) as follows:
4. At least four cylinders from concrete placed in a single day; and
5. At least four cylinders from concrete placed on each casting bed.
Test at least three cylinders as designated in this section. The test results shall yield at least the release strength requirement shown in the Contract.

518.2.1.5 Acceptance Requirements
Test at least one cylinder per beam or pile and at least three cylinders per casting bed or day’s production, as selected by the Department’s Inspector.

Ensure the average strength of the tested cylinders is in accordance with the required 28-Day compressive strength. The Department will not allow cylinders test results less than 90% of the 28-Day required strength.
When cylinders do not meet the compressive strength requirement, the Department may allow the use of one or more of the in-place strength testing methods in accordance with Section 510.3.5.2, "In-Place Concrete Strength Measurements," to determine the actual strength of the concrete in the affected members. Obtain approval of the intended testing method from the State Materials Bureau before beginning the evaluation. If the Contractor uses cores, the Contractor may cut one core from each suspect member. The Department will reject the member if the core does not meet the 28-Day compressive strength requirement.

518.2.2 Steel Products
518.2.2.1 Reinforcing Steel

Provide steel reinforcement in accordance with Section 540, "Steel Reinforcement."

518.2.2.2 Pre-Stressing Reinforcement

Pre-stressing reinforcement consists of high strength steel wire, high strength seven-wire steel strands, or uncoated high strength steel bars, in accordance with the Contract or as approved by the State Bridge Engineer.

Provide pre-stressing reinforcement that is uncoated, clean, and free of dirt, loose rust, oil, grease, or other Deleterious Material when placed in the member.

518.2.2.2.1 High-Strength Wire

Provide high-strength steel wire in accordance with AASHTO M 204.

518.2.2.2.2 High-Strength Multiple-Wire Steel Strand

Provide high-strength multiple-wire steel strands in accordance with AASHTO M 203M, Supplement S1 (low-relaxation), unless otherwise specified.

518.2.2.2.3 Uncoated High-Strength Steel Bars

Provide uncoated high-strength steel bars in accordance with AASHTO M 275. If the Department allows bars with a greater minimum ultimate strength, produce and test them in accordance with AASHTO M 275.

518.2.2.2.4 Identification of Pre-Stressing Reinforcement

Assign pre-stressing reinforcement and anchorage assemblies with a lot number and tag for identification purposes. The Department will reject high-strength materials lacking identification.

518.2.2.2.5 Sampling of Pre-Stressing Reinforcement

Provide samples to the Department’s Inspector for testing. Provide certification with the samples that states the samples were taken from and are representative of the lot numbers provided. Provide load elongation curves and mechanical properties representative of the strands or bars to the Department’s Inspector. Sample and test in accordance with AASHTO 203/M 203. If the Department requests provide the following:

1. Enough wire to make up one parallel lay strand at least 8 ft long, consisting of the same number of wires required for the strand in which they are to be assembled. Cut wires requiring heading for anchoring to length and headed on both ends;
2. At least 8 ft of wire strand of each diameter, measured between near ends of fittings. Provide the sample with fittings attached
3. One completely fabricated pre-stressing tendon 10 ft long for each size tendon, including anchorage assemblies;
4. At least 8 ft of high-tensile strength bars of each diameter, measured between threads at ends of bars if furnished with threaded ends and nuts, or between anchorage devices;
5. At least two anchorage assemblies, complete with distribution plates of each size or type, unless such anchorage assemblies are attached to the samples of pre-stressing reinforcement;

Provide Material samples for testing 6 weeks in advance of the anticipated time for use, to allow testing.
Protection of Pre-Stressing Steel

Protect pre-stressing steel against physical damage, rust or other results of corrosion, from manufacture to grouting. The Department will reject pre-stressing steel that is physically damaged.

Package pre-stressing steel in containers or other shipping forms to protect the steel against physical damage and corrosion during shipping and storage. Place a corrosion inhibitor that prevents rust or other results of corrosion in the package or form, or apply directly to the steel if the State Bridge Engineer allows. Ensure the corrosion inhibitor has no damaging effect on the steel or concrete, or bond strength of steel to concrete.

Immediately replace or restore damaged packaging or forms. If using a corrosion-inhibiting carrier-type packaging material, provide the material in accordance with Military Specification MIL-P3420. Clearly mark the shipping package or form with the following:

1. A statement that the package contains high-strength pre-stressing steel;
2. The care in handling;
3. The type, kind, and amount of corrosion inhibitor used, including the date placed or applied;
4. Safety orders; and
5. Instructions for use.

If directed by the State Bridge Engineer or the Department's Inspector, submit the following for the corrosion inhibitor:

6. A sample, a list of chemicals and their proportions, and instruction for use;
7. Evidence that the pre-stressing steel will be protected from rust and other results of corrosion; and

After the Contractor installs the pre-stressing, the Department will not allow the Contractor to weld or have ground welding Equipment on the forms or on the steel in the member.

Structural Steel

Provide Structural Steel items in accordance with Section 541, "Steel Structures."

Ducts

Use duct enclosures for pre-stressing steel that are of ferrous metal and mortar tight. Place duct enclosures in accordance with the Plans, or as directed by the State Bridge Engineer. Provide ducts or anchorage assemblies with pipes or other suitable connections for the injection of grout after pre-stressing. Securely fasten ducts for pre-stressing steel in place to prevent movement.

After installation in the forms, cover the ends of ducts as necessary to prevent water or debris from entering. Vent ducts for continuous Structures over each intermediate support and at additional locations. Vents are standard pipe with a diameter of at least 1/2 in. Connect ducts with positive metallic structural fasteners. Ensure the vents are mortar tight, taped as necessary, and provide means for injecting grout through the vents and sealing the vents. Remove the ends of vents 2 in below the Roadway surface after completing grouting.

Provide ducts for continuous Structures (except ducts in bents or pier caps) that consist of rigid galvanized ferrous metal. The Department will not require the Contractor to galvanize transition couplings connecting rigid ducts to anchoring devices. The Contractor may use rigid ducts in simple span pre-stressed members.

Fabricate rigid ducts with either welded or interlocked seams. The Department will not require the Contractor to galvanize welded seams. Provide rigid ducts strong enough to maintain the correct alignment during concrete placement. The Department will not allow angle changes at the joints. Use waterproof tape at the connections.

Anchorage Devices

Secure post-tensioned pre-stressing steel at the ends by means of approved permanent anchoring devices. Design anchorage devices for post-tensioning to hold the pre-stressing steel at a load producing a stress of at least 95% of the pre-stressing steel's guaranteed minimum tensile strength. Distribute the load from the anchoring device to the concrete with approved devices.

Provide anchorage devices in accordance with the following requirements:

1. Do not allow the average bearing stresses on the concrete created by the anchorage distribution plates to exceed the values specified in the current AASHTO
2. Do not allow bending stresses in the plates or assemblies induced by the pull of the pre-stressing to exceed the material yield point, or cause visible distortion in the anchorage plate when 100% of the ultimate load is applied.

The Contractor may omit the steel distribution plates or assemblies if the compressive stresses to the concrete are effectively distributed with anchoring devices in conjunction with a steel grillage embedded in the concrete.

518.2.3 Grout
Provide grout for filling conduits in accordance with Section 520, “Non-Shrink Grout for Post-Tensioned Bridge Members.”

518.2.4 Mortar
Provide non-shrink mortar used to grout keyways in precast box girders in accordance with Section 521, “Non-Shrink Mortar.”

518.3 CONSTRUCTION REQUIREMENTS
518.3.1 General
Use members manufactured in an approved established commercial pre-stressing facility, unless the Contract specifies that members may be cast-in-place.

The State Bridge Engineer or the Department’s Inspector must approve the method of pre-stressing, pre-tensioning, or post-tensioning of concrete before incorporating it into the Work.

For post-tensioned construction, have a skilled representative provide aid and instruction in the use of the pre-stressing Equipment and the installation of Materials. The Contract will specify the required jacking force, anchor set, and coefficient of initial pre-stress.

518.3.1.1 Approval of Post-Tensioning Procedures
For post-tensioned construction, provide complete details and calculations supporting the methods, sequence of stressing, Materials, and Equipment to use in the pre-stressing operations. Submit this to the State Bridge Engineer at least 30 Days before incorporating it into the Work.

Ensure the details completely describe the proposed pre-stressing system, including the following:
1. Type and arrangement of pre-stressing reinforcement;
2. Complete specifications and details of pre-stressing steel;
3. Anchorage devices;
4. Forms for cored holes and voids;
5. Ducts for the enclosure of pre-stressing reinforcement;
6. Any additions or rearrangement of reinforcing steel from that shown in the Contract; and
7. Other data pertaining to the pre-stressing operations.

518.3.1.2 Approval of Plants and Equipment
The State Bridge Engineer or the Department’s Inspector must approve plants and Equipment for manufacturing pre-stressed concrete members before the Contractor starts the pre-stressed concrete work. The State Bridge Engineer or the Department’s Inspector may forbid unsatisfactory machinery, Equipment, or appurtenances.

518.3.1.3 Forms
Use forms that are smooth, mortar tight, and capable of withstanding the action of form vibrators. Accurately fabricate and secure the forms in position so that the cast member will present true, smooth, and even surfaces.

Construct forms for interior cellular spaces with an approved material that is watertight, resistant to breakage and deformation, and as lightweight as possible. Anchor interior forms to resist flotation or displacement during concrete placement. The design of interior and exterior forms shall not restrict the longitudinal movement of the member when the Contractor transfers the pre-stressing force to the casting.

518.3.1.4 Placement of Reinforcing Bars, Pre-stressing Ducts, and Appurtenances
Place and secure reinforcing bars, ducts for enclosing pre-stressing reinforcement, forms
for cored holes, and cellular spaces with methods approved by the State Bridge Engineer. Pay particular attention to concrete cover requirements over reinforcing bars near and at ends of beams.

518.3.1.5 Placement and Consolidation of Concrete

Place concrete in accordance with Section 511, “Concrete Structures,” and Section 512, “Superstructure Concrete.”

Do not place concrete until the inspector has inspected and approved the placement of the items to be embedded in the concrete. Correct deviations from approved dimensions and details larger than 3/8 in. Place and secure shoe plates on beams in the exact position in accordance with the Plans.

The Department will allow the placement of concrete in the bottom flange of precast box girders before placement of the interior form and reinforcing bars in the upper portion of the members, if concrete placement is continuous for longer than 30 min.

Use external vibration for precast box girders or to eliminate internal honeycombing. Rigidly attach external vibrators to the forms in sufficient quantity so that the vibration extends throughout the entire length of the member.

Do not use vibrating methods that cause segregation. The Department may reject members with voids in piles or in the bottoms of beams and girders or over bearing points, or honeycombing sufficient to expose pre-stressing tendons or reinforcement.

The maximum allowable deviations from the dimensions and details shown in the Contract will be the dimensional tolerances listed in the Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products published by PCI, except as follows:

1. The tolerance on camber within 1/8 in per 10 ft of the beam length from the predicted camber called for on the Plans;
2. The tolerance on sweep within 1/8 in per 10 ft of the beam length from the straight line; and
3. The tolerance on tipping and flushness of shoe plates within 1/16 in.

518.3.1.6 Finishing Concrete Surfaces

Finish the top surface of beams after initial set thoroughly with a wire brush to remove laitance and to provide a rough surface.

Finish the top surface of precast box girders and piles by over filling the forms, vibrating, and striking off with a metal plated strike board. On the final forward movement of the strike board, carry excess mortar ahead to completely fill the form. After striking off the concrete, finish the surface to a true plane. Ensure that surface irregularities do not exceed 9/16 in per 10 ft. Unless otherwise shown in the Contract, give the top surface of the precast box girders a final broomed finish to produce transverse corrugations.

If the Contract requires the Contractor to embed the ends of pre-stressed concrete girders in concrete diaphragms, the ends of the girders do not require hand finishing after removal of forms. If the Contract does not require the Contractor to extend strands for field or shop bending to provide continuity reinforcement, the Contractor shall cut the strands to extend 3 in beyond the girder ends.

Finish girder ends that will not be embedded in concrete and other surfaces of pre-stressed bridge members in accordance with Section 511.3.8, “Finishing.”

518.3.1.7 Curing

Steam cure or water cure precast, pre-stressed members.

Perform steam curing in accordance with Section 517, “Precast Concrete Structures.”

Perform water curing in accordance with Section 511, “Concrete Structures.”

Cure post-tensioned cast-in-place bridge members in accordance with Section 511, “Concrete Structures.”

518.3.1.8 Lifting, Handling, and Storing Precast Members

Do not handle members until after applying the pre-stressing force.

During handling and storage, keep webs of pre-stressed beams vertical and keep the long axis approximately level. Keep the points of support and direction of reactions with respect to the member approximately the same as when the member is in its final position in the completed Structure.

Do not crack, spall, or otherwise damage members during lifting, handling, hauling,
storing, erecting, or driving. Replace members damaged by improper handling.

Do not subject members to heavy imposed loading until the results of cylinder tests indicate that the concrete in the members has attained the required 28-Day compressive strength.

518.3.2 Tensioning

Apply tension to pre-stressing steel with hydraulic jacks to produce forces in accordance with the approved Working Drawings.

During strand stressing, the State Bridge Engineer or the Inspector may accept individual wire failures, if no more than one wire in any strand is broken and the area of broken wires does not exceed 2% of the total area of the pre-stressing steel in the member.

Stress the members in a sequence that produces a minimum of eccentric forces.

518.3.2.1 Tensioning Equipment

Apply stress to tendons using hydraulic jacks that can provide and sustain the necessary forces and have either a pressure gauge or a load cell for determining jacking stresses.

If necessary, use a pressure gauge with at least a 6 in diameter dial accompanied with a certified calibration chart. Calibrate each jack and its gauge as a unit with the cylinder extension in the approximate position that it will be at final jacking force.

If necessary, calibrate a load cell and provide it with an indicator to determine the pre-stressing force in the tendon. Use a load cell range that does not include the lower 10% of the Fabricator's rated capacity to determine the jacking stress.

Use a testing Laboratory approved by the State Bridge Engineer to calibrate the Equipment. Ensure that the Equipment has been calibrated within a year of the Work. The Inspector may check certified calibration charts for the hydraulic jacks, pressure gauges, or load cells used for tensioning pre-stressing steel before and during tensioning operations.

518.3.2.2 Measurement of Stress

Provide a record of gauge pressures and tendon elongations for each tendon, for review and approval by the Department’s Inspector. Measure elongations to an accuracy of within 1/16 in. Do not cut off stressing tails of post-tensioned tendons until the Department's Inspector approves the stressing records.

Use the gauge or load cell readings to determine the stress in the tendons during tensioning and verify with the measured elongations.

Use the modulus of elasticity to calculate anticipated elongations of and base calculations for the nominal area (provided by the Fabricator per lot of tensioned steel), or as determined by a bench test of strands used in the Work.

Before starting elongation readings, tension the tendons to a preliminary force to eliminate take-up in the tensioning system. Ensure this preliminary force is between 5 and 25% of the final jacking force. Measure the initial force with a dynamometer or with other approved methods. Mark each strand before the final stressing to permit measurement of elongation and to ensure that anchor wedges are set properly.

Address a discrepancy in indicated stress between jack gauge pressure and elongation. If this occurs, the load used, as indicated by the gauge pressure, will produce a slight overstress rather than understress. Check the entire operation to determine the source of errors, if a discrepancy occurs between gauge pressure and elongation; more than 5% for tendons longer than 50 ft, or 7% for tendons shorter than 50 ft. Correct errors before proceeding.

518.3.2.3 Tensioning Post-Tensioned Members

Do not pre-stress cast-in-place concrete until at least 10 Days after placing the last concrete in the member and until the compressive strength of the concrete has reached the specified strength. Use one of the in-place strength tests in accordance with Section 510.3.5.2, “In-Place Concrete Strength Measurements,” (except do not use field cured cylinders for this application) to determine the actual in-place compressive strength of the concrete. Obtain approval of the method from the State Materials Bureau before using.

Perform the tensioning of pre-stressing reinforcement in the members so that the Department’s Inspector may continuously observe the tension applied and the elongation of the pre-stressing reinforcement.

Apply tensioning forces to pre-stressing reinforcement in the sequence and amount approved by the State Bridge Engineer to avoid excessive eccentric loads about the vertical
The Department will not allow the maximum temporary stress (jacking stress) and the stress in the steel before losses due to creep and shrinkage to exceed the values in accordance with Section 5 of the AASHTO’s LRFD Bridge Design Specification. Take safety measures to prevent accidents due to breaking pre-stressing steel or slipping grips during the tensioning operation.

518.3.2.4 Tensioning Pre-tensioned Members

The Contractor may cast several members in a continuous line on the casting bed. Spools of pre-stressing strand are allowed 2 splices within the entire spool. Do not use strand within each pre-stressed concrete member that have splices.

Accurately locate and hold strands in positions in accordance with the Plans for each individual member. Modify the strand, if the State Bridge Engineer approves, to ensure that the total pre-stressing force and location of its center of application is not changed.

The Contractor may anchor straight pre-tensioning strands at one end of the casting bed and stress the other end with hydraulic jacks. Tension each individual strand to the required stress. Adopt a method for stressing draped strands that prevents significant stress loss between the jacking and anchor ends of the casting bed. If required to avoid significant stress loss, stress draped strands from both ends of the casting bed.

Stress or check pre-stressed strands for required stress within 24 h before placing concrete in the member.

Do not release or cut pre-tensioned strands until cylinder tests indicate that the concrete in the member has reached the initial unit compressive strength. Remove side forms before releasing the strands. Strands may be flame cut to release stress. Release or cut the strands in accordance with a previously approved sequence to avoid unbalanced forces in excess of that applied by one strand. Trim strands in piles flush with the top and bottom of the piles.

518.3.2.5 Grouting Pre-stressing Reinforcement in Post-Tensioned Members

Bond the pre-stressing reinforcement to the ducts 24 h after completing tensioning and anchoring of the pre-stressing reinforcement. Flush ducts with water containing either quicklime (calcium oxide) or slaked lime (calcium hydroxide) in the amount of 0.1 lb per gallon. Ensure the ducts are free of Deleterious Materials that would impair bonding of the grout or interfere with the grouting procedures. Thoroughly clean each duct with oil-free compressed air immediately before grouting.

Fit grout injection pipes with positive mechanical shutoff valves. Fit vents and ejection pipes with valves, caps, or other devices capable of withstanding the pumping pressures. Ensure that the pumping pressure at the tendon inlet does not exceed 250 psi.

Equip grouting Equipment with a pressure gauge with a maximum full-scale reading of 300 psi. Provide standby flushing Equipment that can develop and maintain a pumping pressure of 250 psi, with enough capacity to flush out partially grouted ducts. Pump grout through the duct applying at least 100 psi until no visible slugs of water or air are ejected and the elapsed time of the ejected grout is at least 11 s. Then close the outlet pipe and hold the pumping pressure. Then close the valve at the inlet while maintaining this pressure. Do not remove or open valves and caps until the grout has set. If the Contractor completes stressing and grouting within 10 Days of installation of the pre-stressing steel, the Department will not reject the steel if rust forms in that time. The Contractor shall protect pre-stressing steel the Contractor has installed and tensioned but not grouted within 10 Days in accordance with Section 518.2.2.2.6, “Protection of Pre-Stressing Steel.”

If the end of a post-tensioned assembly will not be covered by concrete, recess the anchoring devices so that the ends of the pre-stressing steel and the anchoring devices are at least 2 in inside of the end surface of the members, unless the Contract requires a greater embedment.

The Contractor shall clean, with an abrasive blast, the surfaces of concrete against which the Contractor shall place concrete encasement after completing the grouting of the ducts. Encase the end anchorages on the member.

518.3.3 Bracing for Beams and Girders

Tie and brace the beams and girders immediately after erection to prevent overturning. Leave ties and bracing in place until the beams or girders are permanently secure for lateral stability.
518.3.4 Grouting Keyways in Precast Box Girders

Use jute, hemp, or other material satisfactory to the Project Manager, to caulk spaces between adjacent precast box girders and below the keyways that are wide enough to permit passage of mortar. Place the caulking material so that it retains mortar but does not intrude into the keyway openings.

Inspect keyway joints in precast box girders immediately before placing mortar. Keep the keyways clear of material, and keep interior surfaces clean and moist. Place and consolidate the no shrink mortar into the joint so that it fills the keyway to the deck surface. Strike off the mortar at the deck surface.

Keep mortared keyways covered with wet burlap until after final set of the mortar, and cure in accordance with Section 511, “Concrete Structures.”

518.4 METHOD OF MEASUREMENT

The Department will measure concrete for post-tensioned members in accordance with Section 511, “Concrete Structures,” or Section 512, “Superstructure Concrete.”

The Department will measure reinforcing steel for post-tensioned members in accordance with Section 540, “Steel Reinforcement.”

518.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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</thead>
<tbody>
<tr>
<td>Pre-stressed Concrete Member Type</td>
<td>Foot</td>
</tr>
<tr>
<td>Pre-stressing Post-tensioned Concrete</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>

518.5.1 Work Included In Payment

The following items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

A. Prestressing reinforcement in post-tensioned members;
B. Ducts, anchorage devices, distribution plates or assemblies, grouting recesses and ducts, and all other incidental parts and processes required for post-tensioned members; and
C. Prestressing steel, reinforcing steel and embedded steel items for precast prestressed concrete bridge members.
519.1 DESCRIPTION
This Work consists of constructing a pneumatically applied shotcrete onto rock, soil or formed surfaces in accordance with the Contract and as directed by the project manager. These specifications refer to premixed cement and aggregate pneumatically applied by suitable Equipment and competent operators.

519.2 MATERIALS
Use a shotcrete mix composed of portland cement, fine and coarse aggregate, fly ash, and water that has been reviewed and approved by the State Concrete Engineer. Shotcrete may also include other pozzolans and fiber reinforcement. Use either wet-mix or dry-mix shotcrete. Reinforce shotcrete in accordance with the Contract.

Provide Materials and perform construction requirements in accordance with the specification sections listed in Table 519.2:1, “Applicable Specification Sections.”

Table 519.2:1

<table>
<thead>
<tr>
<th>Material/construction requirements</th>
<th>Section</th>
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<tbody>
<tr>
<td>Portland cement</td>
<td>Section 509, “Portland Cement Concrete Mix Designs”</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>Section 509, “Portland Cement Concrete Mix Designs”</td>
</tr>
<tr>
<td>Pozzolans</td>
<td>Section 509, “Portland Cement Concrete Mix Designs”</td>
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<tr>
<td>Curing Materials and admixtures</td>
<td>Section 509, “Portland Cement Concrete Mix Designs”</td>
</tr>
<tr>
<td>Water</td>
<td>Section 509, “Portland Cement Concrete Mix Designs”</td>
</tr>
<tr>
<td>Fine aggregate</td>
<td>Section 509, “Portland Cement Concrete Mix Designs”</td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>Section 509, “Portland Cement Concrete Mix Designs”</td>
</tr>
<tr>
<td>Neat cement grout</td>
<td>Section 521, “Non-Shrink Mortar”</td>
</tr>
<tr>
<td>Bar reinforcement</td>
<td>Section 540, “Steel Reinforcement”</td>
</tr>
<tr>
<td>Welded wire fabric</td>
<td>Section 540, “Steel Reinforcement”</td>
</tr>
<tr>
<td>Surface evaporation</td>
<td>Section 512, “Superstructure Concrete”</td>
</tr>
</tbody>
</table>

519.2.1 Water
Use water in the shotcrete mix that is free of elements that could stain the mix and in accordance with Section 509.2.6, “Water.”

519.2.2 Anchor Bars
Provide anchors of appropriate size to hold reinforcement in place. The Department will allow maximum anchor spacing of 24 in on a grid pattern over the entire area for structural applications.

If using “L”-shaped anchors, use those that consist of No. 5 reinforcement bars or larger, bent into an “L” shape. The short leg of the “L” will be at least 6 in long and the long leg at least 2 ft long.

519.2.3 Welded Wire Mesh
Provide non-galvanized 8-gauge steel with a 4 in × 4 in mesh (4 × 4-W2.1 × W2.1) in accordance with Section 540, “Steel Reinforcement” for welded wire mesh. For structural applications, use welded wire mesh in accordance with the Contract and as approved by the State Bridge Engineer. Ensure that all wire mesh has been rigidly fixed in place to prevent rebound when struck by the shotcrete.

519.2.4 Steel Fiber Reinforcement
Provide steel fiber reinforcement with the following characteristics:

1. A length between 1/2 in and 1 3/8 in;
2. A length-to-diameter ratio of less than 80;
3. Blunt or hooked ends; and
4. Cold drawn carbon steel with a minimum tensile strength of 160,000 psi.

Provide steel fibers manufactured specifically for use in concrete applications. The Department will not allow the steel fiber content to be less than 100 lb per cubic yard.

519.2.5 Prepackaged Product

Provide a pre-mixed and prepackaged concrete product, with or without steel fibers, specifically manufactured as a shotcrete product for on-site mixed shotcrete, if approved by the State Materials Bureau.

519.2.6 Mix Design Acceptance Sampling and Testing

Apply shotcrete to approved test panels. Orient the spray nozzle to the test panel in the same position as that used on the actual project. Provide test panels constructed in accordance with the requirements of ASTM C 1140. Use test panels with the following characteristics:
1. Minimum dimensions of 30 in² × 8 in deep;
2. Constructed from wood and sealed plywood; and
3. 45° sloped sides to allow rebound to escape.

Use at least one pre-construction trial to do the following:
4. Obtain test cores to confirm compliance with the hardened properties of Section 510, “Portland Cement Concrete.”
5. Pre-qualify the proposed nozzle operator and strike-off persons. The Department will not allow nozzle operators and strike-off persons who have not been pre-qualified to apply shotcrete on the project. Each nozzle operator and strike-off person shall shoot pre-construction test panels in the presence of the Project Manager or designated representative. Each nozzle operator shall have a minimum of the following qualifications:
   1. Supervisor, at least one year of experience as a shotcrete nozzle operator and at least two years of experience on shotcrete projects.
   2. Nozzle operator and delivery Equipment operators, at least one year of apprenticeship on similar applications with the same type of Equipment.

Perform curing, coring, and testing of the shotcrete test panels and specimens at a private testing Laboratory approved by the State Materials Bureau for concrete mix designs. Provide one half of the test panels with reinforcement and anchors representative of the same size and spacing required in the Contract for the actual Work. Provide the remaining panels with no reinforcement to allow for extraction of shotcrete test cores for compliance testing.

Each nozzle operator proposed for use on the project will shoot at least one test panel at each orientation.

Obtain the required number of test cores in accordance with Section 510, “Portland Cement Concrete,” from these test panels for testing at the designated ages for the specified performance parameters. Extract a minimum of three 4 in diameter cores from locations of intersecting reinforcing steel and mesh to check the adequacy of consolidation of shotcrete around and behind the reinforcement. Take at least one core at an anchor location.

The State Materials Bureau will evaluate the quality of the extracted cores and test panels. If the Department rejects a prequalification test panel, have the nozzle operator shoot a second test panel. If the Department rejects the second test panel, do not allow the nozzle operator to shoot on the project until the operator completes an appropriate training program and prepares an acceptable test panel.

Transport test panels in the wooden forms with care to not crack or damage the specimens.

Place the test panels in a moist room in the Laboratory that is maintained at a temperature of 73 °F ± 3 °F, and a relative humidity of 98 ± 2%. After 3 Days, remove the test panels from the wooden forms and return them to the moist room until testing time.

519.2.6.1 Production Testing

Shoot two construction test panels for each nozzle orientation and for each nozzle operator each day of shotcrete production in the presence of the Project Manager. Shoot one set of panels for each nozzle operator in the morning and one set of panels for each nozzle operator in the afternoon for a full day’s production.

Section 519: Shotcrete
Produce test panels in accordance with ASTM C 1140, a minimum 12 in² × 8 in deep. Use test panels constructed of wood and sealed plywood with 45° sloped sides to permit escape of rebound. Provide construction test panels that contain no reinforcement or embedments.

Store, handle, and cure construction test panels the same as specified for pre-construction test panels. Prepare test specimens the same as specified for pre-construction test specimens.

Use compressive strength test specimens that are 4 in × 8 in cores (length/diameter ratio of 2:1).

The mean compressive strength is acceptable if the average of three cores tested at the specified age is equal to or greater than 85% of the specified strength, with no individual strength test being less than 75% of the specified strength.

Correct unacceptable shotcrete sections at no additional cost to the Department.

519.3 CONSTRUCTION REQUIREMENTS

519.3.1 Equipment

519.3.1.1 Shotcrete Placing Equipment

Apply wet mix shotcrete with one of the following methods:

1. The “thick-stream” method, which involves the use of a regular concrete pump with air addition at the discharge nozzle to pneumatically apply the shotcrete on the receiving surface. The “thick-stream” method usually uses a 2-inch to 2 1/2 in internal diameter delivery hose.

2. The “thin-stream” method, which normally involves the use of a pressurized chamber to pneumatically send the shotcrete down the delivery hose to the receiving surface. The “thin-stream” method normally uses a hose with a maximum 1 1/2 in internal diameter.

Only use the “thin-stream” method if pre-construction testing confirms the capability to properly consolidate shotcrete, fully encase reinforcing steel, and produce a material that meets the required hardened properties.

Use shotcrete delivery equipment in accordance with ACI 506R and that is capable of delivering a steady stream of uniformly mixed material to the discharge nozzle at the proper velocity and rate of discharge.

The preferred type of the wet-mix shotcrete delivery system uses positive displacement pumps equipped with hydraulic or mechanically powered pistons (similar to conventional concrete piston pumps), surge-reduction devices, and compressed air added at the discharge nozzle. The Contractor may use pneumatic-feed guns, rotary-type feed guns (similar to dry-mix guns), and peristaltic squeeze-type pumps if the Contractor demonstrates that the guns can produce shotcrete in accordance with the performance requirements and the Project Manager approves.

Carefully monitor the air ring at the nozzle for signs of blockage of individual air holes. If non-uniform discharge of shotcrete becomes apparent, stop shooting and clean the air ring or take other appropriate corrective actions.

Thoroughly clean the delivery equipment at the end of each shift. Remove build-up of coatings in the delivery hose and nozzle liner. Regularly inspect the air ring and nozzle and replace as necessary.

519.3.1.2 Auxiliary Shotcrete Equipment

Supply a clean, dry air supply capable of maintaining sufficient nozzle velocity and simultaneous operation of a blow pipe.

Use an air supply system with a moisture and oil trap.

Provide auxiliary shotcrete equipment, such as air delivery hoses, blow pipes, couplings, admixture dispensers, and fiber feeders, in accordance with the recommendations of ACI 506R.

519.3.2 Batching and Mixing Shotcrete

519.3.2.1 Wet Mix Process

Batch, mix, and supply wet mix shotcrete using one of the following systems:

1. Central Mixing with transit delivery; or

2. Transit mixing and delivery.

519.3.2.1 Central Mixing and Supply

Batch and mix ingredients in accordance with ASTM C 94 and ACI 304R. Volumetrically
batch water and chemical admixtures.

Add shotcrete Materials in a sequence that provides uniform mixing and dispersion.

Provide inspected transit mixers in accordance with Section 510, “Portland Cement Concrete.”

The Contractor may only re-temper the shotcrete once with superplasticizer added directly to the transit mixer during the period of discharge to maintain workability (slump) of shotcrete. Mix the shotcrete for a minimum period of 5 min at the rated mixing speed after adding the superplasticizer to the transit mixer.

Shoot shotcrete within 90 min of adding mix water to the batch. Use appropriate shotcrete batch sizes per load to meet this requirement.

519.3.2.1.2 Transit Mixing and Supply

Apply central mixing requirements to transit mixing, except add ingredients directly to the transit mixer, not the central mixer. Do not charge transit mixers to more than 70% of their rated capacity.

519.3.2 Dry Mix Process

Batch the cement and aggregate by weight directly at the project site.

Pre-dampen the dry mix before flow into the main hopper and immediately after flow out of the packaging to ensure uniform shotcrete free of dry pockets.

Do not use pre-dampened cement/aggregate mixtures that are more than 90 min old or that are unable to produce the specified hardened properties.

519.3.2.3 Batching and Mixing Steel Fibers

Submit the procedure used for adding steel fibers to the shotcrete to the Project Manager for approval. Demonstrate the procedure in the field to the satisfaction of the Project Manager before starting production operations.

If fiber addition takes place at the nozzle, uniformly distribute fibers throughout the mortar matrix without isolated concentrations (clumping or bailing).

If adding fibers to the dry or wet mix during the batching and mixing process, use a screen with a mesh of from 1 1/2 in to 2 1/2 in to prevent fiber balls from entering the shotcrete line. The Department will not require batching through a screen if the Contractor demonstrates that fiber balls are not forming.

Do not add fibers to the dry or wet mix too quickly (so they can be blended with the other ingredients without forming balls or clumps). Use a vibrating screen or sift to pass bulk fibers (that have a tendency to stick) into the mix as individual elements and not as clumps.

519.3.2.4 Preparation and Hardware

519.3.2.4.1 Subsurface Preparation

Locate and remove loose, spalled, deteriorated, and delaminated concrete, stone, or other substrate. Use hammer sounding to locate specific de-laminated areas of concrete or rock. Do not damage areas of sound concrete or reinforcing steel during concrete removal operations.

Remove concrete using one or more of the following methods:

1. Chip with light duty pneumatic, or electric, chipping hammers (not to exceed 15 lb);
2. Scarifiers, scabblers or other suitable mechanical means;
3. High-pressure (15,000 psi to 40,000 psi) water jetting. (If using water jetting, do not allow water to collect so that surrounding areas are not contaminated or damaged.)

If the Contractor exposes corroded reinforcing steel, the Contractor shall continue concrete removal until there is a minimum 3/4 in clearance around the exposed, corroded reinforcing bar. Do not damage the bond to adjacent non-exposed reinforcing steel during concrete removal.

Taper the perimeter of removed concrete areas at approximately 45° angles. Sawcut the outer edges of chipped areas to a minimum depth of 3/4 in to avoid feather edging.

Use abrasive blast cleaning to remove fractured surface concrete and traces of unsound material or contaminants, such as oil, grease, dirt, slurry or materials that could interfere with the bond of the freshly placed shotcrete. Apply shotcrete to abrasive blast cleaned areas within 48 h or re-blast them.

The Project Manager may waive the requirement for abrasive blast cleaning where the Contractor performed concrete removal with high-pressure water blasting and the prepared surface is free of residual slurry or other material detrimental to an acceptable shotcrete bond.
Install reinforcement in slope blankets that do not contain steel reinforcement. Unless otherwise specified, the reinforcement will consist of No. 4 steel reinforcement bars placed with maximum spacing of 12 in for vertical and horizontal bars. Rigidly attach this reinforcement to the underlying forms or concrete structure. Remove dust, debris, or laitance generated by this process in accordance with these abrasive blast cleaning procedures.

519.3.2.4.2 Repair or Replacement of Steel Reinforcement

If the Contractor exposes corroded reinforcing steel during concrete removal, remove corrosion using abrasive grit blasting.

If pitting is isolated, reinforce the steel by adding appropriately placed reinforcing bars of suitable length (the existing reinforcing steel need not be cut).

519.3.2.4.3 Steel Reinforcement

Use a minimum lap splice length of reinforcing steel that is in accordance with the AASHTO LRFD Bridge Design Specification. Place these bars in accordance with ACI 506R, Sections 5.4 and 5.5. In particular, do not bundle bars in lapped splices; place them so the minimum spacing around each bar is three times the maximum aggregate size to allow for proper shotcrete encapsulation.

Tightly secure intersecting reinforcing steel bars to each other using 12 gauge or heavier tie wire and adequately support them to minimize vibration during shotcrete placement.

Place welded wire mesh fabric in accordance with the Contract. Lap sheets of adjoining mesh by at least two spaces in both directions at intersections, and securely fasten.

The Department will not allow pre-drilled holes with diameters larger than 3 in. Install the slotted drainpipe before placing shotcrete. During placement of shotcrete, protect weep holes and drainpipes against contamination.
519.3.2.4.7 Alignment Control and Cover
Implement alignment control (to establish control over line and grade), and maintain the minimum specified shotcrete thickness and cover of reinforcing steel.

Perform alignment control with shooting wires (also called ground wires), guide strips, depth gauges, or forms. Submit the proposed means of alignment control to the Project Manager for review and approval.

Use shooting wires that are at least “piano wire”-sized high-strength steel wire combined with a turnbuckle and spring coil. Remove shooting wires after completion of shotcreting and screeding operations.

Do not let guide strips and forms impede the ability of the nozzle operator to produce uniform, dense, properly consolidated shotcrete. Do not use alignment control material that causes the formation of sand-pockets and voids.

If using depth gauges for alignment control, space no greater than 4 ft in a grid pattern. Cut back metal depth gauges to 1/4 in below the finished surface.

Cover reinforcing steel in accordance with Section 540, “Steel Reinforcement.”

519.3.3 Quality Assurance And Quality Control Testing
519.3.3.1 Quality Assurance
The Department will implement a Quality Assurance Program for the shotcrete work. The program will include the following:

1. Review of Contractor submittals;
2. Review of the approval of Contractor-proposed Materials, supply, Equipment, and crew. In particular, evaluation in the preconstruction testing program of shotcrete nozzle operator and strike-off person proposed for use on the project; the Department will allow only nozzle operators and strike-off persons approved in writing by the State Materials Bureau to perform Work;
3. Examination and approval (before application of any shotcrete) of areas prepared for shotcreting, including installation of anchors, reinforcement, and alignment control devices;
4. Provision of Inspectors to monitor shotcrete installation and authority to require removal and replacement of defective shotcrete while still plastic;
5. Regular monitoring of quality control testing results;
6. Implementation of a program for in-place evaluation and acceptance or rejection, if test results indicate shotcrete is unacceptable; and
7. Implementation of a program of remedial work, if the Quality Assurance Program deems it necessary.

519.3.3.2 Quality Control Testing
Provide an independent testing Laboratory to establish and maintain a quality control program for the shotcrete work to ensure compliance with Section 519, “Shotcrete.” Such a program will include, but not be limited to, the following:

1. Maintenance of test records for quality control operations;
2. Physical testing in accordance with Section 519.2.6.1, “Production Testing” for the confirmation of compliance with the specified hardened shotcrete properties.

519.3.3.3 Safety and Cleanup
519.3.3.3.1 Preparation
Implement a safety program during preparation for shotcreting to do the following:

1. Protect the structural integrity of structural elements (by shoring or other suitable means) during concrete and reinforcing steel removal operations.
2. Protect personnel from falling debris, blasting grit, and high-pressure water jets during concrete removal processes.

Dispose of debris, blasting grit, and hydro-demolition and water-jetting slurry in accordance with Section 107, “Legal Relations, Environmental Requirements, and Responsibility to the Public.”

519.3.3.3.2 Shotcrete Operations
Implement a safety program using hoarding, shrouds, screens, or other appropriate measures to protect personnel and surrounding property from pneumatically applied shotcrete over-spray and rebound materials during the shotcreting application process.

Personnel working near the shotcreting operation, including nozzle operator, strike-off
persons, nozzle operator’s helpers, supervisors, and Inspectors, shall wear appropriate protective equipment. Such equipment includes, but is not limited to, safety helmet, safety boots, gloves, appropriate clothing, safety glasses with side enclosures, and dust masks.

Nozzle operator’s helpers shall keep a supply of water, cloth or towel, and backup safety glasses available for the nozzle operator so satisfactory vision can be maintained during shooting operations. Provide sufficient lighting so the nozzle operator has a clear view of the Work.

Provide readily available eyebaths and wash facilities in the immediate vicinity of the shotcrete application. The shotcrete crew shall apply appropriate skin protection and adopt work hygiene to protect against cement or accelerator alkali burn.

Install sufficient lighting and ventilation to provide the nozzle operator and helpers with clear, unhindered view of the shooting area. Terminate Work and adopt corrective measures if, in the opinion of the Project Manager, visibility is unsuitable for the safe application of quality shotcrete.

**519.3.4 Shotcrete Application and Finishing**

**519.3.4.1 Shotcrete Application**

The Project Manager will review and approve areas prepared for shotcrete application before application of shotcrete.

Flush surfaces with water at least one hour before application of shotcrete. Allow flushed surfaces to dry back to saturated surface-dry condition before application of shotcrete. If necessary, use a blowpipe with oil-free compressed air to facilitate removal of surface water. For very porous and dry substrates, saturate the substrate the day before shotcreting and then re-wet before shooting as described above.

The Contractor shall apply shotcrete in accordance with ACI 506R, except that if using silica-fume modified shotcrete, the Contractor may apply the full thickness of shotcrete in a single layer. Use the minimum number of layers required to build up the full thickness of shotcrete without sagging, separation, or sloughing. Wherever possible, apply shotcrete to the full thickness in a single layer.

If using multiple-layer shotcrete construction, prepare the first layer with one of the following methods before applying a subsequent layer:

1. Broom the stiffening layer with a stiff bristle broom to remove loose material, rebound, over-spray, or glaze, before the shotcrete attains initial set.
2. If the shotcrete has set, delay surface preparation at least 24 h, then prepare the surface by sandblasting or high-pressure water blasting to remove loose material, rebound, hardened over-spray, glaze, or other material detrimental to good bond.

When successive layers of shotcrete are necessary to build up full shotcrete thickness, prevent the first layer from drying out with fogging or wetting. Only use curing compound with the approval of the Project Manager. If using a curing compound, remove it by abrasive blast cleaning or high-pressure water blasting, before application of the next layer of shotcrete. Clean the first layer of shotcrete of surface water and ensure it is in a saturated surface-dry condition when applying the next shotcrete layer.

Exercise care to protect adjacent surfaces from buildup of rebound and over-spray. The Department will not allow rebound and over-spray on the completed Work. Remove rebound and over-spray from surfaces to receive shotcrete while the Material is still plastic, using blowpipes, scrapers, wire brushes, or other suitable tools. Remove hardened rebound and overspray with abrasive blast cleaning, chipping hammers, high-pressure water blasting or other suitable techniques before applying additional shotcrete.

Provide scaffolding or other devices so the nozzle operator and helpers have free, unhindered access to the work area.

Apply shotcrete from the nozzle in accordance with ACI 506R.

Do not apply shotcrete during periods of rain or high wind, unless suitable protection is provided.

Apply shotcrete in accordance with the Contract using shooting wires, depth gauges, guide strips, forms, or other suitable devices. Apply the minimum cover of shotcrete to reinforcing steel in accordance with the Plans. Cut back metal depth gauges to within 1/4 in of the shotcrete surface, to prevent corrosion staining of the surface.

When applying a 3/8 in maximum aggregate size shotcrete, the Department will allow a final flash coat layer (1/4 in to 3/8 in thick) using 1/4 in aggregate shotcrete.
519.3.4.2 Shotcrete Finishing

Leave shotcrete in the natural gun finish unless otherwise specified in the Contract. If the Contract requires finishing, cut back shotcrete to line and grade using cutting rods, screeds, or other suitable devices. Allow shotcrete to stiffen sufficiently before cutting and trimming, to prevent the formation of tears, cracks, and delaminations. Remove shooting wires on completion of cutting and trimming.

Apply one or more of the following finishes if required:

1. Wood float finish, either as a preliminary finish for other surface treatments, or as a granular texture finish;
2. Rubber float finish, applied to either a flash coat or wood float finish, to produce a finer textured granular finish;
3. Brush finish, a fine hairbrush float finish that leaves a finely textured, sandy finish;
4. Steel trowel finish that leaves a dense, smooth hard finish.

Trim back shotcrete and over-spray from adjacent non-prepared concrete surfaces.

Provide the edges of shotcrete repairs with a minimum square saw-cut edge 3/4 in deep; finish shotcrete up to this edge. Do not featheredge shotcrete (including flash coats).

519.3.4.3 Curing and Protection

On completion of finishing, immediately prevent shotcrete from drying out by fogging or wetting.

If the Contract requires leaving shotcrete with a natural gun finish, apply curing compounds at twice the application rate normally specified for smooth concrete finishes. Completely remove curing compounds by abrasive blasting or water blasting (with a pressure of 3,000 psi) before application of subsequent sealers.

Once the shotcrete achieves its final set, keep it continuously moist for at least 7 Days.

Perform moist curing using one or both of the following procedures:

1. Wrap the elements in wet burlap presoaked in water for 24 h before installation; wrap the wet burlap in plastic sheet to slow the drying rate of the burlap;
2. Install sprinklers, soaker hoses, or other devices that keep the shotcrete continuously wet. Do not use intermittent wetting procedures that allow the shotcrete to undergo cycles of wetting and drying during the curing period.

519.3.4.4 Hot and Cold Weather Protection

Apply shotcrete during periods of hot and cold weather in accordance with ACI 305R and ACI 306R.

Do not proceed with shotcrete application if the rate of surface evaporation of the shotcrete exceeds 0.2 lb per square foot per hour, in accordance with Section 512, “Superstructure Concrete.” If the prevailing ambient conditions (relative humidity, wind speed, air temperature, and direct exposure to sunlight) are such that the shotcrete develops either plastic shrinkage or early drying shrinkage cracking, terminate the application and take one or more of the following steps:

1. Reschedule the Work to a time when more favorable ambient conditions prevail;
2. Adopt corrective measures, such as installation of sunscreens, windbreaks, or fogging devices to protect the Work; or

During periods of cold weather, shotcreting may only proceed if the substrate to which the shotcrete is applied and the air temperature in contact with the shotcrete surfaces are both above 50 °F.

Maintain the air temperature in contact with the shotcrete surfaces at 60 °F or greater for at least 4 Days after application of shotcrete. Submit the means of maintaining the air temperature to the Project Manager for approval. Do not use unvented heaters.

Apply shotcrete at a temperature of between 50 °F and 90 °F. Use cooler mix temperatures during hot-weather shotcrete operations and warmer mix temperatures during cold-weather shotcrete operations.

519.3.4.5 Inspection and Remedial Work

Sound the surface of the cured shotcrete with a hammer to locate unsound areas. Provide equipment, hardware, and means necessary to perform the inspection operations. The inspection accommodations are subject to the approval of the Project Manager.

Cut out and replace sags or other defects with another layer. If welded wire mesh reinforcement is damaged or destroyed by such repairs, repair the damaged area by
overlapping and tying additional wire mesh in accordance with Section 519.3.2.4.3, “Steel Reinforcement.”

519.4 METHOD OF MEASUREMENT—Vacant

519.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shotcrete</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

519.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for shotcrete and will not be measured or paid for separately: reinforcement, anchors, perforated pipe, ties, test molds, test samples, submittals, boring, cores, and grouting.
520.1 DESCRIPTION
This Work consists of providing and placing pre-packaged non-shrink grout for bonding post-tensioned pre-stressing reinforcement in pre-stressed concrete bridge members. Bond post-tensioned steel to the concrete by filling the entire void space between the duct and the prestressing reinforcement with grout in accordance with Section 518, “Pre-Stressed Concrete Members.”

520.2 MATERIALS
Provide prepackaged non-shrink grout (referred to as “grout” in this section) that consists of portland cement, water, and a non-shrink admixture. Select the grout from the Department’s Approved Products List. Provide grout with expansion properties that will produce an expansion of the mortar not to exceed 0.4% in its fully cured state; shrink will be 0.0%.

520.2.1 Portland Cement
Provide Type II portland low-alkali cement in accordance with ASTM C 150. The Contractor may use specialty cement if approved by the State Materials Bureau.

520.2.2 Water
Provide water that is free of oil, salt, vegetable matter, or other Deleterious Material, and has a pH value of from 4.5 to 8.5, in accordance with AASHTO T 26. Ensure the sulfate content as sulfur trioxide does not exceed 1,000 ppm. For flushing ducts, provide water with either quick lime (calcium oxide) or slaked lime (calcium hydroxide) in the amount of 0.1 lb per gallon.

520.2.3 Admixtures
Provide admixtures in accordance with Section 509.2.5, “Admixtures.”

520.3 CONSTRUCTION REQUIREMENTS
520.3.1 Ducts
520.3.1.1 Forming
520.3.1.1.1 Formed Ducts
Provide ducts, formed by a sheath left in place, that allow the entrances of grout. Use a sheath that will transfer bond stresses as required and will retain its shape under the weight of the concrete. Provide galvanized, ferrous metal sheaths.

520.3.1.1.2 Cored Ducts
Form cored ducts without constrictions that would block passage of the grout. Remove coring materials.

520.3.1.2 Grout Opening or Vents
Provide ducts with grout openings at both ends. For draped cables, provide high points with a grout vent except where cable curvature is small, such as in continuous slabs. The Contractor shall provide grout vents or drain holes at low points if the Contractor is to place, stress, and grout the tendon in freezing climate. Provide grout openings or vents with provisions for preventing grout leakage.

520.3.1.3 Duct Size
For tendons consisting of multiple wires, bars, or strands, use duct with a cross-sectional area at least twice that of the stressing steel. For tendons consisting of a single wire, bar, or strand, use duct with a diameter at least 1/4 in larger than the nominal diameter of the wire, bar, or strand.

520.3.1.4 Placement of Ducts
After placing the ducts and completing reinforcement and forming, inspect the Work for possible duct damage. Securely fasten ducts at close intervals to avoid displacement during concrete placement. Repair unintentional holes or openings in the duct before concrete placement.

Securely anchor grout openings and vents to the duct and to the forms or reinforcing...
Section 520: Non-Shrink Grout for Post-Tensioned Bridge Members

520.3.2 Personnel Certification
Grout tendon ducts under the direction of a person who has verifiable documentation of experience in performing grouting of post-tension operations. Ensure the person has completed training in a grouting technician certification program like the American Segmental Bridge Institute’s Grouting Certification Program.

520.3.3 Grouting Equipment
Use grouting Equipment that includes a mixer capable of continuous mechanical mixing that produces grout free of lumps or undispersed cement. Use Equipment that pumps the mixed grout in a manner that complies with provisions of this specification. Do not use commercially available plaster and concrete mixers for mixing grout.

Use accessory Equipment that provides accurate solid and liquid measures to batch Materials.

Use a positive displacement type pump that provides an outlet pressure of at least 150 psi. Use a pump with seals adequate to prevent the introduction of oil, air, or other foreign substance into the grout, and to prevent the loss of grout or water.

Place a pressure gauge that has a full-scale reading of 300 psi or less in the grout line between the pump outlet and the duct inlet.

Make standby water flushing Equipment available where difficult grouting conditions exist. Use this Equipment in addition to the grouting Equipment. Provide the standby water flushing Equipment with a different power source than the grouting Equipment. Use standby water flushing Equipment that has sufficient capacity to flush out any partially grouted enclosures, and is capable of developing a pressure of at least 300 psi.

Use grouting Equipment that contains a screen with maximum clear openings of 1/8 in to filter the grout before its introduction into the grout pump. If using a grout with a thixotropic additive, a screen opening of 3/16 in is satisfactory. Make this screen easily accessible for inspection and cleaning.

Use grouting Equipment that uses gravity feed to the pump inlet from a hopper attached to and directly above it. Keep enough Material in the hopper during the pumping operation to prevent air from being drawn into the post-tensioning duct.

Under normal conditions, use grouting Equipment capable of continuously grouting the largest tendon on the project in 20 min or less.

520.3.4 Mixing of Grout
Prepare the grout in accordance with the manufacturer’s recommendations. The Project Manager will determine the pumpability of the grout in accordance with ASTM C 939. Ensure the outflow time of grout samples, immediately after mixing, reaches or exceeds 11 s.

520.3.5 Duct Preparation
Conduct a pre-grouting air pressure test of ducts and take measures to eliminate or reduce the consequences of identified leakage. Clean ducts of water and Deleterious Materials that would impair bonding of the grout or interfere with grouting procedures. Use oil-free compressed air to blow out ducts.

Flush ducts with concrete walls (cored ducts) with water to ensure that the concrete is thoroughly wetted. Water for flushing ducts may contain slack lime (calcium hydroxide) or quicklime (calcium oxide) in the amount of 0.1 lb per gallon.

520.3.6 Grout Injection Requirements
Bond post-tensioned steel to the concrete by filling the entire void space between the duct and the prestressing reinforcement with non-shrink grout in accordance with Section 518, “Pre-Stressed Concrete Members.” Fit grout injection pipes with positive mechanical shutoff valves. Fit vents and ejection pipes with valves capable of withstanding the pumping pressures. Do not remove or open valves until the grout has set. Prevent leakage of grout through the anchorage assembly by positive mechanical means. Pump grout from the low point of the duct through the duct with vents provided at the high point of the duct when possible. Continuously waste grout at the outlet until no visible slugs, water, or air are ejected and until the efflux time of ejected grout is at least 11 s. Allow grout to flow from the first vent after the inlet pipe until residual flushing water or entrapped air disappears, then cap or otherwise close the vent. Close the remaining vents in sequence in the same manner. Then
close the outlet valve and hold the pumping pressure momentarily. While maintaining this pressure, close the inlet valve.

Do not allow the pumping pressure at the tendon inlet to exceed 250 psi.

If the actual grouting pressure exceeds 250 psi, the Contractor may inject grout at any capped vent, as long as the Contractor maintains a one-way flow of grout. If the Contractor uses this procedure, the Contractor shall fit the vent, at which it plans to inject, with a positive shutoff.

520.3.7 Temperature Considerations
Do not allow the temperature of the grout to exceed 90 °F or fall below 45 °F during mixing and pumping. If necessary, cool or heat the mixing water. Maintain the concrete at a temperature of 35 °F or higher until site-cured mortar cubes reach a compressive strength of 800 psi.

520.3.8 Grouting Inspection
Physically probe or visually inspect anchorages 48 h after grouting until the Project Manager is assured that there is no bleed water or subsidence voids. The Project Manager may require subsequent spot inspections of one or more selected anchorages per span to verify the absence of voids. Immediately fill discovered voids with grout.

520.3.9 Finishing of Anchorage Zones
The Contractor shall thoroughly blast clean (with abrasives) the surfaces of concrete against which the Contractor shall place concrete encasement over anchorage assemblies after completing grouting of the ducts.

520.4 METHOD OF MEASUREMENT—Vacant

520.5 BASIS OF PAYMENT
The Department considers providing and placing non-shrink grout incidental to the completion of the Work and will not pay for it separately.
521.1 DESCRIPTION
This Work consists of providing and placing non-shrink mortar for use in concrete Structures. Uses of mortar include the following:
1. Filling under masonry plates, keyways between precast members, and voids in reinforced concrete Bridge members;
2. Repairing surface defects;
3. Bonding reinforcing bars in preformed recesses; and
4. Other uses as required.

521.2 MATERIALS
Provide non-shrink mortar that is a sand/cement mixture containing an approved non-shrink admixture or a preblended, commercial product listed on the Department's Approved Products List.

Provide non-shrink mortar that is a nonmetallic, water-based compound containing portland cement, silica sand, and other agents (water reducers, plasticizers, nonshrink admixtures, filters, etc.). The Department will not allow chlorides, fluorides, sulfites, nitrates, or gas-forming agents.

The 28-Day compressive strength of sand/cement non-shrink mortar cubes will be at least 4,000 psi when cured and tested in accordance with AASHTO T 106, except confining cover plates, which are to be clamped on the molds immediately after filling and left on the molds for at least 20 h. Ensure the 28-Day compressive strength of pre-blended commercial mortars reaches at least 5,000 psi.

Manufacturer’s certified strength tests for the pre-blended non-shrink mortars may be accepted instead of field tests or tests by the State Materials Bureau.

521.2.1 Portland Cement
Provide Type II low-alkali portland cement in accordance with Section 509, “Portland Cement Concrete Mix Designs.”

521.2.2 Water
Provide water in accordance with Section 520, “Non-Shrink Grout for Post-Tensioned Bridge Members.”

521.2.3 Fine Aggregate
Provide fine aggregate for sand/cement non-shrink mortar in accordance with Section 509.2.4.3, “Fine Aggregate,” except that fine aggregate will be well graded from coarse to fine in accordance with Table 521.2.3:1, “Fine Aggregate Gradation Requirements.”

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>% Passing</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 in</td>
<td>100</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td>90</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>No. 8</td>
<td>65</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>No. 16</td>
<td>45</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>No. 30</td>
<td>35</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>No. 50</td>
<td>10</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>No. 100</td>
<td>2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>No. 200</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Note: Sand shall pass the No. 8 sieve for mortar used to fill voids with width or depth less than 3/4 in.

Provide sand for use in mortar that does not exceed half the size of the recess, hole, or space to be filled.

521.2.4 Non-Shrink Admixture
Provide non-shrink admixture in accordance with Section 520, “Non-Shrink Grout for Post-Tensioned Bridge Members.”
521.3 CONSTRUCTION REQUIREMENTS
Use non-shrink mortar in accordance with the manufacturer’s recommendations and instructions regarding proportioning, mixing, maximum water content, application, curing temperatures, and curing conditions.

521.3.1 Placing, Finishing, and Curing
Clean concrete areas of loose or Deleterious Material that would prevent a bond between the mortar and the base concrete surfaces. Flush areas with water and let dry to a surface dry condition immediately before placing the mortar.

Provide a mortar-tight seal at the following locations before placing mortar:
1. Keyways;
2. Spaces between structural members;
3. Holes;
4. Spaces under structural members; and
5. Other locations where mortar could escape.

Tightly pack mortar and completely fill recesses and holes, and place on surfaces, under structural members, and at other specified locations. Screed the Material to the specified level, and finish the surface to the specified texture.

521.3.2 Curing
After placing, cure surfaces of mortar by the water method or another approved method in accordance with the manufacturer’s recommendation. If the manufacturer recommends no specific period, cure for at least 3 Days.

521.3.2.1 Temperature Requirements
Place mortar when the air temperature is at least 50 °F, but less than 95 °F. Do not allow the mortar temperature to rise above 86 °F during mixing and placing.

Maintain the temperature of the mortar and grout at or above 50 °F during the curing period.

521.3.3 Elapsed Time Before Loading
Do not allow loads on mortar that has been in place less than 72 h, or as recommended by the manufacturer, unless otherwise directed by the Project Manager.

521.3.4 Mortar Defects
Remove and replace improperly cured or otherwise defective mortar.

521.4 METHOD OF MEASUREMENT—Vacant

521.5 BASIS OF PAYMENT
The Department considers providing, placing, and curing of non-shrink mortar incidental to the completion of the Work and will not measure or pay for it separately.
522.1 DESCRIPTION
This Work consists of providing chemical anchorage systems.

522.2 MATERIALS
Use either chemical anchorage or cementitious systems for the installation of steel anchors in concrete Structures, unless otherwise specified in the Contract.

522.2.1 Chemical Anchor Devices
Select chemical anchor devices from the Department’s Approved Products List. Notify the Project Manager of the selection at least 15 Days before using the devices on a project.

Provide devices in accordance with Table 522.2.1:1, “Chemical Anchor System Ultimate Tension Load Requirements.” Use adhesives of an epoxy or polyester resin base.

<table>
<thead>
<tr>
<th>Anchorage bolt diameter (inch) or bar size</th>
<th>Minimum ultimate tension load (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in</td>
<td>37,700</td>
</tr>
<tr>
<td>7/8 in</td>
<td>28,900</td>
</tr>
<tr>
<td>3/4 in</td>
<td>21,200</td>
</tr>
<tr>
<td>5/8 in</td>
<td>14,700</td>
</tr>
<tr>
<td>1/2 in</td>
<td>9,400</td>
</tr>
<tr>
<td>3/8 in</td>
<td>5,300</td>
</tr>
<tr>
<td>1/4 in</td>
<td>2,400</td>
</tr>
<tr>
<td>No. 6</td>
<td>21,200</td>
</tr>
<tr>
<td>No. 5</td>
<td>14,700</td>
</tr>
<tr>
<td>No. 4</td>
<td>9,400</td>
</tr>
</tbody>
</table>

522.2.1.1 Hardware
Provide high-tensile strength bolts, nuts, and washers in accordance with AASHTO M 164, Type 3, and Section 542.2, “Materials.” Provide high-tensile strength studs (rods) in accordance with AASHTO M 164, Type 3. Provide Grade 60 deformed steel bar reinforcements in accordance with AASHTO M 31.

The Department will not accept metal wedge expansion-type anchors as substitutes for chemical anchors.

522.2.1.2 Bonding Agent
Provide a bonding agent that is:
1. Prepackaged or pre-measured with the mixing instructions, cure time, and expiration date on the package;
2. Free of corrosion promoting agents; and
3. Resistant to chemicals and solvents, including salts, acids, and hydrocarbons.

Store original unopened containers at temperatures between 32 °F and 100 °F. Do not use bonding agents past the expiration date certified by the manufacturer.

522.2.1.3 Materials Certification
Submit a sample of the concrete chemical anchor device along with the manufacturer’s installation instructions to the Project Manager.

Submit independent certified testing results, in accordance with ASTM E 488, to the Project Manager. Use ASTM A 307 Grade A steel for anchor bolts (rods) and Grade 60 steel reinforcing bars for these independent certified tests.

Test capsulated concrete chemical anchor device systems to a depth equal to one capsule length. Use a method of drilling and provide drill hole diameters in accordance with the manufacturer’s recommendations.

Test non-capsulated concrete chemical anchor device systems in accordance with the manufacturer’s recommendations.

Use Class A concrete for independent certified testing results in accordance with Section 510, “Portland Cement Concrete.”
Provide independent test results to certify that the average ultimate tension load strength and method of installation of the proposed concrete anchorage system are in accordance with Table 522.2.1:1, “Chemical Anchor System Ultimate Tension Load Requirements.”

522.3 CONSTRUCTION REQUIREMENTS

Prepare holes and installation of the chemical anchors in accordance with the manufacturer’s recommendations and instructions, including weather and temperature limitations. Do not install chemical anchor systems before concrete attains its design strength.

522.3.1 Drilling of Holes

Use drilling methods that do not cause concrete spalling or cracking, or damage to the main reinforcing steel members. Drill the diameter of the holes in accordance with the chemical anchor manufacturer’s instructions.

Repair spalled or damaged concrete as directed by the Project Manager.

Do not drill with a lubricant; water is not a lubricant.

Maintain a distance of at least 2 in from the bottom of the structural slab to the bottom of drill holes. Only use anchor systems that can maintain this minimum surface-to-drill-hole distance requirement and still meet certified strength requirements.

522.3.2 Hole Preparation

Before installing the chemical anchors, thoroughly clean holes with water or air blasting.

Before placing the chemical anchors, remove Deleterious Material from dry drilled holes.

522.3.3 Finishing

After the Contractor inserts the anchor bolt or rod the full depth into the hole, the Contractor shall strike flush the excess bonding agent with the concrete surface. After placing the anchors, do not move the bolts or anchors and do not load the anchors until adhesives are fully cured.

522.3.4 Field Pullout Tests

Submit the testing method to the State Materials Bureau before beginning the field pullout tests. Use an applied test load for the concrete chemical anchors field pullout tests in accordance with Table 522.3.5:1, “Concrete Chemical Anchor Design Loads.”

Perform pullout tests only if the Contract requires. If the Contract requires pullout tests, use nondestructive loading and stop the tests when the tensile forces are equal to the design loads specified.

Use anchor bolts or rods that attain the specified test loads without permanently displacing the anchor bolts or damaging the concrete. Replace anchor devices that fail the load test. Test replaced anchors.

Repair spalled or damaged concrete from load tests as directed by the Project Manager.

522.3.4.1 Acceptance

The Department will accept anchor bolts if the specified test load is attained without permanently displacing the anchor bolt or damaging the concrete.

522.3.4.2 Field Test Procedure

If the Contract requires pullout tests, the Project Manager will designate a random portion of not less than 5% of each lot of the installed concrete chemical anchors for load testing. Perform load tests in accordance with ASTM E 488 for static testing. If any individual test fails, test the entire lot for compliance with Table 522.3.5:1, “Concrete Chemical Anchor Design Loads.”

522.3.5 Design Loads

Ensure chemical anchors systems are in accordance with Table 522.3.5:1, “Concrete Chemical Anchor Design Loads.”
### Table 522.3.5:1
Concrete Chemical Anchor Design Loads

<table>
<thead>
<tr>
<th>Anchorage bolt diameter (inch) or bar size</th>
<th>Design load and tensile test load (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in</td>
<td>9,425</td>
</tr>
<tr>
<td>⅝ in</td>
<td>7,225</td>
</tr>
<tr>
<td>3/4 in</td>
<td>5,300</td>
</tr>
<tr>
<td>5/8 in</td>
<td>3,675</td>
</tr>
<tr>
<td>1/2 in</td>
<td>2,350</td>
</tr>
<tr>
<td>3/8 in</td>
<td>1,325</td>
</tr>
<tr>
<td>1/4 in</td>
<td>600</td>
</tr>
<tr>
<td>No. 6</td>
<td>5,300</td>
</tr>
<tr>
<td>No. 5</td>
<td>3,675</td>
</tr>
<tr>
<td>No. 4</td>
<td>2,350</td>
</tr>
</tbody>
</table>

#### 522.4 METHOD OF MEASUREMENT—Vacant

#### 522.5 BASIS OF PAYMENT
The Department will make no separate payment for this Work, unless otherwise specified in the Contract.
523.1 DESCRIPTION
This Work consists of providing and placing cementitious-grouted dowels and anchors for concrete Structures.

523.2 MATERIALS
Unless specified in the Contract, use either chemical anchorage or cementitious systems for the installation of steel anchors in concrete Structures.

523.2.1 Mortar
Provide mortar (grout) in accordance with Section 521, “Non-Shrink Mortar.”
Provide premixed mortar (grout), in accordance with the manufacturer’s recommendations and instructions regarding proportioning, mixing, maximum water content, application, and curing temperatures and conditions.
Use cementitious mortar for grouting bearing anchor bolts for Bridges and other required or approved uses.

523.2.2 Neat Cement Grout
Make neat cement grout from a cement paste of portland cement and water. Provide grout Materials in accordance with Section 509, “Portland Cement Concrete Mix Designs.”
Do not re-temper grout.
Use neat cement grout for attaching new barrier walls to existing bridge decks or for attaching new concrete to old concrete in modifying or rehabilitating existing Structures.

523.2.2.1 Portland Cement
Use Type II or Type III low-alkali portland cement.

523.2.2.2 Water
Do not use more than 4 gal of water per 94-pound sack of cement.

523.2.3 Threaded Rods or Deformed Anchor Bars
Unless otherwise specified in the Contract, fabricate dowels and anchors from full length threaded steel rods in accordance with ASTM A 307 or better, or deformed steel reinforcing bars in accordance with AASHTO M 31, Grade 60.

523.3 CONSTRUCTION REQUIREMENTS
523.3.1 Design Loads
Unless otherwise shown in the Contract, provide design tensile (pullout) loads for anchors or dowels fabricated from full length threaded steel bars or Grade 60 reinforcing bars in accordance with Table 523.3.1.1, Design Tensile (Pullout) Loads for Anchors and Dowels.

<table>
<thead>
<tr>
<th>Reinforcing bar size or threaded rod diameter</th>
<th>Design tensile load for neat cement grout (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>15,700</td>
</tr>
<tr>
<td>No. 7</td>
<td>12,000</td>
</tr>
<tr>
<td>No. 6</td>
<td>8,800</td>
</tr>
<tr>
<td>No. 5</td>
<td>6,100</td>
</tr>
<tr>
<td>No. 4</td>
<td>3,900</td>
</tr>
<tr>
<td>1 in</td>
<td>14,100</td>
</tr>
<tr>
<td>¾ in</td>
<td>10,800</td>
</tr>
<tr>
<td>3/4 in</td>
<td>7,900</td>
</tr>
<tr>
<td>5/8 in</td>
<td>5,500</td>
</tr>
<tr>
<td>1/2 in</td>
<td>3,500</td>
</tr>
</tbody>
</table>

523.3.1.1 Field Pullout Tests
Submit the testing method to the State Materials Bureau before beginning the field pullout tests. Use an applied test load for the cementitious anchors field pullout tests in accordance
Perform pullout tests only if the Contract requires.

If the Contract specifies field-testing, terminate the test when the tensile force is equal to the specified design load and has held for 3 minutes. Use anchors that attain the specified test loads without permanently displacing the anchor bolts or damaging the concrete.

Repair spalled or damaged concrete as directed by the Project Manager. Replace anchors that fail the load tests. Test replaced anchors.

523.3.2 Embedment Depth

Unless otherwise specified in the Contract, provide embedment depths for horizontal or vertical dowels and anchors equal to or greater than the depth calculated to develop the full bond strength of the reinforcing bars. Provide embedment depths of 6 in for new barrier wall anchors to existing bridge decks.

Maintain a distance of 1 1/2 in or greater from the bottom of structural deck slabs and 2 in or greater from the face of Structures in other installations.

Only use anchor systems that can maintain this minimum surface to drill hole distance requirement and still meet certified strength requirements.

523.3.3 Hole Preparation

Use impact drills equipped with carbide tipped bits, or core drill. Do not spall or damage concrete adjacent to the holes.

If the Contract specifies cementitious mortar, provide a drilled hole diameter 3/4 in greater than the diameter of steel anchors and dowels. If the Contract specifies neat cement grout, provide a drilled-hole diameter 1/4 in greater than the nominal diameter of the anchors and dowels.

Clean holes of dust, drilling debris, and other Deleterious Materials, saturate holes with water, remove free water, and dry to a surface dry condition before placing the dowels or anchors.

Do not drill with a lubricant; water is not a lubricant.

523.3.4 Placing of Anchors and Grout

Use sufficient grout so no voids remain between the anchors and the sides of the holes after the dowels or anchors are fully inserted. During and after placing of the dowels and anchors, maintain a tight bond between the grout and hole and between the grout and anchor or dowel.

523.3.5 Curing

Cure mortar and grout for a period of at least 3 Days, or until the dowels and anchors are encased in concrete, whichever occurs first. The Contractor may use Method 2 or Method 3 to cure cementitious mortar and neat cement grout in accordance with Section 511.3.9, “Curing.”

523.3.6 Temperature Limitations

Place and cure mortar and neat cement grout, mixed and blended on site. Ensure substrate temperature is above 45 °F.

523.3.7 Damaged or Unbonded Dowels and Anchors

Remove and replace dowels and anchors that fail to bond or are damaged before placing new concrete or completing the Structure.

523.4 METHOD OF MEASUREMENT—Vacant

523.4 BASIS OF PAYMENT

The Department considers the preparation of holes and grouting of dowels and anchors incidental to the completion of the Work and will not make separate payment.

The Department will pay for threaded rods as structural steel. The Department will pay for deformed reinforcing bars associated with the grouting as reinforcing bars, Grade 420, except that the Department will pay for dowels and anchors for concrete barrier railing for Bridges as barrier railings.
SECTION 529: PIER AND ABUTMENT BEARING MODIFICATION

529.1 DESCRIPTION
This Work consists of raising Superstructure members and modifying bearing units.

529.2 MATERIALS—Vacant

529.3 CONSTRUCTION REQUIREMENTS
Submit to the Project Manager the methods for temporarily raising and supporting the
load-carrying Superstructure members to allow for modifications to the designated bearing
units, and proposed steel cutting and weld removal methods for approval by the State Bridge
Engineer. Unless the existing concrete deck has been removed, simultaneously raise and
support the beams or girders in a span.
Do not damage retained structural members while performing bearing modifications.
Clean and repaint painted areas damaged by the Work in accordance with Section 546,
“Recoating Structures,” at no additional cost to the Department.

529.4 METHOD OF MEASUREMENT—Vacant

529.5 BASIS OF PAYMENT
Pay Item Pay Unit
Pier and Abutment Bearing Modifications Lump sum
SECTION 530: REPAIR AND OVERLAY OF BRIDGE DECKS WITH LATEX-MODIFIED CONCRETE

530.1 DESCRIPTION
This Work consists of repair and overlay of concrete bridge decks with latex-modified concrete.

The Work includes the following:
1. Scarifying the existing deck surface;
2. Removing loose and unsound concrete, including concrete patching material;
3. Removing and replacing corroded reinforcing bars;
4. Providing, placing, finishing, and curing latex-modified concrete for overlay and at repair areas;
5. Providing, placing, finishing, and curing Superstructure concrete Class AA for full depth repairs;
6. Other operations necessary to complete the Work to the satisfaction of the Project Manager.

530.1.1 Personnel Requirements
Provide skilled supervisory personnel on the project at all times who can prove their technical expertise with latex concrete or who have received formal technical training in latex-modified concrete applications from the latex manufacturer.

530.2 MATERIALS
Provide Material in accordance with section 509, “Portland Cement Concrete Mix Designs,” except as modified in this Section.

530.2.1 Cement
Use one brand of cement during each individual placement. Use Type I or Type II cement. The Contract will not require fly ash in the mix.

530.2.2 Aggregate
Provide coarse aggregate in accordance with Table 530.2.2:1, “Coarse Aggregate Gradation Requirements.”

Mix aggregates as necessary to obtain a uniform moisture content and store in stockpiles containing the approximate volume of Material scheduled for one day’s production.

Not more than 18 h before the start of a day’s operations, the Project Manager will check and accept the aggregate stockpiles for a scheduled operation for uniformity of moisture content in accordance with Section 509.2.4, “Aggregate.”

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 in</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>1/2 in</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>3/8 in</td>
<td>40</td>
<td>70</td>
</tr>
<tr>
<td>No. 4</td>
<td>—</td>
<td>15</td>
</tr>
<tr>
<td>No. 8</td>
<td>—</td>
<td>5</td>
</tr>
<tr>
<td>No. 200</td>
<td>—</td>
<td>1</td>
</tr>
</tbody>
</table>

If measurable precipitation occurs after stockpile acceptance and before the Work starts, the Project Manager will recheck aggregate stockpiles as soon as is practical before concrete placement begins. Aggregate moisture content will be periodically checked during concrete placement to ensure the maintenance of acceptable variations in moisture content.

530.2.3 Water
Provide concrete mix water and water for cleaning and soaking the deck surface in accordance with Section 509.2.6, “Water.”
530.2.4 Latex Emulsion Admixture

Use a formulated latex admixture that is a non-hazardous, film-forming, polymeric emulsion in water to which stabilizers have been added at the point of manufacture and that is homogeneous and uniform in composition.

530.2.4.1 Physical Characteristics

Provide an admixture in accordance with Table 530.2.4.1:1, “Latex Emulsion Admixture Requirements.”

<table>
<thead>
<tr>
<th>Property</th>
<th>Specific value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>White</td>
</tr>
<tr>
<td>Polymer type</td>
<td>Styrene-Butadiene</td>
</tr>
<tr>
<td>Percent solids</td>
<td>46.0–53.0</td>
</tr>
<tr>
<td>pH</td>
<td>8.5–12.0</td>
</tr>
<tr>
<td>Percent coagulum by weight, maximum</td>
<td>0.10</td>
</tr>
<tr>
<td>Surface tension, maximum</td>
<td>50.0 dynes/cm</td>
</tr>
<tr>
<td>Percent butadiene by weight</td>
<td>30–40</td>
</tr>
<tr>
<td>Weight per gallon @ 77 °F</td>
<td>30.7 lb–32.2 lb</td>
</tr>
<tr>
<td>Freeze-thaw stability</td>
<td></td>
</tr>
<tr>
<td>percent coagulum by weight, maximum, after two freeze/thaw cycles</td>
<td>0.10</td>
</tr>
</tbody>
</table>


530.2.4.2 Storage

Protect latex admixture from direct sunlight and insulate with suitable material to protect it from freezing and from exposure to temperatures above 86 °F. During prolonged periods of passive storage, turn over containers of admixture at least once a week. Do not use latex that has been frozen.

530.2.4.3 Submittals

Submit three copies of the latex admixture manufacturer’s test report for each batch used to the Project Manager for approval. Ensure that test reports show batch identification and contain specific test results of the properties specified. The manufacturer’s representative responsible for performing the tests shall prepare, date, and sign the test reports.

At least 20 Days before the intended date of use, submit to the Project Manager a 1 pt sample of latex admixture from the batch for the State Materials Bureau for testing.

Batches of latex admixture accepted for use on one Department project do not need retesting for use on subsequent Department projects.

530.2.5 Latex-modified Concrete

Design the latex-modified concrete mix and submit the proposed mix design to the Project Manager 15 Days before use. Use latex-modified concrete mix in conformance with Table 530.2.5:1, “Latex-Modified Concrete Mix Design Requirements.”
Table 530.2.5:1
Latex-Modified Concrete Mix Design Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement, sacks(^a) per cubic yard</td>
<td>7.0</td>
</tr>
<tr>
<td>Latex admixture, gallons per sack cement (94 lb)</td>
<td>3.5</td>
</tr>
<tr>
<td>Air content, % of plastic mix</td>
<td>As recommended by manufacturer</td>
</tr>
<tr>
<td>Water/cement ratio, by weight</td>
<td>0.30–0.40</td>
</tr>
<tr>
<td>Slump (inch)</td>
<td>4–7</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Specific gravity (of latex admixture)</td>
<td>1.05–1.2</td>
</tr>
<tr>
<td>Ratio of coarse aggregate to total aggregate, % by weight</td>
<td>45</td>
</tr>
</tbody>
</table>

Vary water amount to produce slump within the prescribed limits. The total water considered in calculating the water/cement ratio will include the non-solid portion of the latex admixture in addition to the mix water and free moisture on the aggregates.

Measure slump of the plastic concrete five minutes after discharge of the concrete from the mobile mixer. Deposit the concrete sample in a container and do not disturb.

If air content or slump test results do not comply with requirements, remove concrete represented by those tests and concrete in the mixer chute and make necessary adjustments in the mix design.

Do not use the concrete sampled for slump and air content testing in the Work.

### 530.2.6 Sampling and Testing

At random intervals during placement, perform slump, air, unit weight, and strength tests (using cylinders) will be performed on latex-modified concrete, obtained at the discharge end of the bucket, chute, or pump.

### 530.3 CONSTRUCTION REQUIREMENTS

#### 530.3.1 General

Provide a riding surface with smooth transitions at ends of Bridges and across expansion and construction joints in accordance with Section 512.3.10.2, “Acceptance Criteria.” Construct the deck free of depressions to prevent water collection or other drainage problems.

Do not allow traffic on the overlay surface until the required curing is complete.

#### 530.3.2 Equipment

Use Equipment approved by the Project Manager.

##### 530.3.2.1 Surface Preparation Equipment

Use Equipment that is mechanical or hydraulic in nature and that is able to remove surface concrete or unsound subsurface concrete without damage to sound Material remaining part of the Structure. Operate removal Equipment in a manner satisfactory to the Project Manager.

1. **Sawing Equipment**

   Use sawing Equipment capable of sawing concrete to the required depth.

2. **Mechanical Concrete Removal Equipment**

   Use mechanical Equipment for scarification and removal of deteriorated concrete capable of uniformly scarfifying or removing existing concrete to the required depth.

3. **Sandblasting and Shotblasting Equipment**

   Use sandblasting or shot blasting Equipment capable of removing rust and old concrete from exposed reinforcement. The Contractor may use high-pressure water blasting, if effective in removing unsound Material.

4. **Power-Driven Hand Tools**

   Use power-driven hand tools for removal of concrete in conformance with the following limitations and having flat edged cutting points at least 3/4 in wide.
Use concrete chippers or breakers up to a nominal 60 lb class in full depth removal areas and for initial removal of deteriorated concrete located above the top mat of reinforcing steel. If, in the opinion of the Project Manager, the use of such devices is detrimental to the integrity of the adjacent concrete deck slab, discontinue their use and use removal devices up to a nominal 30 lb class.

For chipping around reinforcement, use removal devices up to a nominal 30 lb class. Use smaller chippers or breakers if the Project Manager believes the 30-pound tools are detrimental to the adjacent remaining Material.

Do not operate tools at an angle greater than 60° measured from the surface of the slab.

530.3.2.1.2.3 Hand Tools
Use hand tools, such as hammers and chisels, as necessary, for removal of final particles of unsound concrete.

530.3.2.1.3 Hydro-demolition Equipment
Use hydro-demolition Equipment capable of uniformly scarifying the deck and selectively removing defective and deteriorated concrete. Provide Equipment that includes filtering and pumping units operating in conjunction with a remote controlled robotic device. Employ qualified personnel to operate the Equipment.

530.3.2.1.3.1 Calibration and Testing of Hydro-demolition Equipment
For calibration purposes and to demonstrate that operators and Equipment are capable of producing satisfactory results, the Project Manager will, on each Bridge, designate two trial test areas of approximately 30 ft² each. One test area will contain predominately sound concrete and the other test area will contain predominately deteriorated or defective concrete. Sound concrete is defined as concrete being free from chemical defects, delamination, spalling or cracks, and having a residual strength close to its originally specified strength.

In the area of sound concrete, establish the Equipment calibration and the operating procedures to remove the sound concrete and uniformly scarify the deck as specified.

In the area of deteriorated or defective concrete, establish the Equipment calibration and the operating procedures to remove the delaminated or unsound concrete and prepare the deck as specified.

After establishing the parameters to satisfactorily scarify the deck and remove defective and deteriorated concrete, use them as the basis for production work.

530.3.2.2 Proportioning and Mixing Equipment
Use self-propelled or trailer mounted mixers sufficient to carry enough unmixed Materials to produce at least 6 yd³ of concrete on the site. Use at least two mixers on individual placements requiring an estimated quantity of concrete greater than the capacity of a single mixer. Recharge mixers close to the concrete placement location to not interrupt the operation. Do not overload mixers with bulk Materials beyond their rated capacity. Provide a mixer that discharges mixed concrete through a conventional chute.

530.3.2.2.1 Proportioning and Indicating Devices
Use a mixer capable of automatically proportioning and blending components on a continuous or intermittent basis, as required by the finishing operations. Ensure that the Equipment includes indicating devices for proportioning and mixing the concrete in full view of the operator. Provide convenient operator access to the controls. Individually check the proportioning and indicating devices by following the Equipment manufacturer’s recommendations as related to each individual concrete batching and mixing unit. Make adequate standard volume measures, scales and weights available for checking the accuracy of the proportioning mechanism.

530.3.2.2.1.1 Cement Measurement
The Contractor shall equip the mixer with a visible recording meter with a ticket printout to measure the cement quantities that the Contractor puts into the mix. Print a ticket and give it to the Project Manager at the completion of each day’s placement. Record beginning and ending cement meter readings when the mixer is discharging concrete that is wasted and not incorporated into the Work.
530.3.2.2 Water and Latex Admixture Measurement
The Contractor shall equip the mixer to control the flow of water and latex admixture into the mixing chamber using accurate flow meters to adjust for minor variations in aggregate moisture. Stock mixers with each ingredient in proportion to the mix design. Do not allow the maximum batch to exceed 90% of the stocked capacity of the mixer.

Provide accurate quantity meters on both water and latex admixture systems. Locate quantity meters on the latex and water delivery systems so that they measure only the quantity of Material actually introduced into the concrete mix. Record beginning and ending quantity meter readings of water and latex admixture on each cement ticket printout.

530.3.2.2.2 Calibration and Accuracy of Measurement
Calibrate mobile continuous mixers to accurately proportion the specified mix. Accurately measure Materials in accordance with Section 510, “Portland Cement Concrete.” Measure the latex admixture for batching within an accuracy of 2%.

Provide a true yield within a tolerance of 1% according to the following test:
1. With the cement meter count observed and recorded, activate the mixer to discharge concrete into a 0.25 yd³ container 36 in × 36 in × 9 in.
2. When the container is full and struck level, making provisions for settling the concrete into corners, record the cement meter count again.
3. The difference in readings will show an equivalent cement discharge of 1.75 sacks (7.0 sacks per cubic yard).

The Contractor may make minor changes in mix proportions by adjusting aggregate gate settings to keep the yield within tolerance. Adjustments greater than 5% will require mixer recalibration. Perform yield tests at least once during each individual placement and when directed by the Project Manager.

530.3.2.3 Placing and Finishing Equipment
530.3.2.3.1 Hand Tools
Provide placing and finishing Equipment, including hand tools for placement and brushing in freshly mixed concrete and for distributing it within the placement area. Use approved hand operated vibrators and screeds to place and finish small areas of work.

530.3.2.3.2 Finishing Machine
Use an approved finishing machine for finishing large areas of work that has the following properties:
1. Self propelled and capable of forward and reverse movement under positive control;
2. One or more rotating augers and rollers;
3. Equipped with a 3,000+ vpm vibratory pan; and
4. Operated normal to the longitudinal Bridge centerline.

530.3.2.3.3 Water Spraying Equipment
Provide a water supply unit capable of spraying water over the entire deck placement width.

530.3.3 Preparation of Surface
530.3.3.1 Scarification
Uniformly scarify the top surfaces of existing decks to a depth of at least 1/4 in. Provide a scarified surface with a rough texture to promote bond to the overlay concrete. Scaryfi deck areas not accessible to the scarification machinery using approved chipping hammers or hand tools. The Department will not require scarification of new concrete. Blast clean new concrete and existing concrete to remove non-cementitious or Deleterious Material. The Contractor may choose the type of blast cleaning.

530.3.3.2 Deck Sounding
After scarification, sound the deck under the direction of the Project Manager and mark areas of unacceptable concrete, including full depth areas. Limit sounding to a maximum of three times. Make a concerted effort to remove delaminated material after the initial sounding and before the second sounding. Blast clean only after the Project Manager approves the concrete deck area.
530.3.3.3 Deck Preparation

- Remove unsound and deteriorated concrete in the marked areas. Remove complete thickness of deck concrete at locations where less than 50% of the original deck thickness remain, except in very isolated random locations as determined by the Project Manager.

- At locations where the bond between existing concrete and reinforcing bars has been broken, remove the remaining concrete adjacent to the bar to a depth that will provide a 3/4 in minimum clearance around the bar, except where made impractical by the presence of other reinforcing bars.

- Exercise care to prevent cutting, stretching, or otherwise damaging reinforcing bars and to prevent damage to sound concrete around reinforcement. The Department will not allow loads (other than construction Equipment) on deck portions that have undergone concrete removal. Provide supports for the delivery trucks so the trucks do not drive directly on reinforcing bars in areas of partial or full depth repair.

- Securely fasten loose reinforcing bars to adjacent fixed bars with tie wire.

- If the Contractor uses hydro-demolition Equipment, the Contractor shall take care to avoid the removal of sound concrete below the necessary depth.

530.3.3.4 Replacement of Reinforcing Bars

- Replace existing reinforcing bars that are corroded or damaged to the extent that their structural integrity is in question.

- Provide and install new bars of the same original size and remove the existing corroded or damaged bars.

- Blast clean corroded bars left in place to gray metal. Carefully flame cut or saw bars to be removed with minimal damage to adjacent Material.

- Newly installed bars will have a 3/4 in minimum clearance around their circumference. Lap reinforcing bars on each side of the damaged or removed area. Lap No. 5 or smaller reinforcing bars at least 12 in. The Project Manager will determine the length of lap for larger reinforcing bars.

- The Contractor shall replace reinforcing bars damaged by the Contractor at no additional cost to the Department.

530.3.3.5 Cleaning of Prepared Deck Surface

- Clean deck surfaces to which the concrete overlay is to bond using abrasive blasting or high pressure water blasting. Blast cleaning is sufficient to remove dirt, oil, concrete loosened by scarification, and other Deleterious Material.

- Clean exposed reinforcing bars to gray metal and remove loose products of corrosion. The Contractor may leave tight “flash” rust occurring after blast cleaning. Clean surfaces with high-pressure air blasting after blast cleaning.

- Wet deck surfaces and keep continuously wet but free of standing water for at least 2 hours before and during placement of the overlay.

- If it is necessary for the Contractor to operate mechanized Equipment on the cleaned surface before or during concrete placement, the Contractor shall temporarily cover the cleaned, wetted deck surface with a layer of polyethylene film, 4 mil or thicker.

530.3.3.6 Forms for Full Depth Repair

- Provide forms to support concrete placed in the full depth repair areas. The Contractor may use wires from the reinforcing steel to suspend forms for areas up to 5 ft². For larger areas, the Contractor may use the primary members of the Superstructure to support the forms or shore them from below. Clean the concrete faces and reinforcing steel in areas of full depth repair as described previously.

530.3.3.7 Hydro-demolition Requirements

- Provide for the disposal of runoff water generated by the hydrodemolition process. Obtain required permits and comply with applicable regulations concerning such water disposal.

- Make provisions for the safe handling of runoff water. Exercise care to protect existing berm slopes from scouring by water jet or runoff water.

- Remove concrete debris directly following the hydrodemolition process to prevent the debris from re-settling or re-adhering to the surface or to remaining sound concrete. Carefully remove debris that does re-settle or re-adhere and exercise care to avoid damage to the remaining sound concrete.
530.3.4 Preplacement Requirements

530.3.4.1 Support Rails
Submit plans for anchoring support rails to the Project Manager for approval at least
15 Days before placing concrete.

Place support rails that the finishing machine travels on outside the area to be concreted.
Anchor support rails to provide horizontal and vertical stability.

The Department will not allow a hold down device shot into concrete unless the
Contractor subsequently resurfaces the concrete. The Department will allow hold down
devices of other types that leave holes in exposed areas if the Contractor fully grouts the holes
and no metal remains within 1 in of the finished surface.

530.3.4.2 Setting of Gradelines
Obtain the Project Manager’s approval of grade lines before beginning the overlay
placement.

Set forms and rails to a grade that will produce at least the required minimum thickness
overlay above the prepared deck surface, and that will provide a smooth riding overlay.

The Department will not allow a hold down device shot into concrete unless the
Contractor subsequently resurfaces the concrete. The Department will allow hold down
devices of other types that leave holes in exposed areas if the Contractor fully grouts the holes
and no metal remains within 1 in of the finished surface.

530.3.4.3 Bulkheads and Deck Joint Members
Install required bulkheads or deck joint members at the specified grade and profile before
placing the overlay.

Temporarily cover final exposed surfaces of joint members more than 0.6 in wide with
tape to prevent the bonding of concrete.

530.3.4.4 Longitudinal Joints
When placements require installation of longitudinal joints, the Project Manager must
approve their locations before placement of the overlay based on the Contractor minimizing
the placement of joints in wheel paths.

Place overlays longitudinally, at least 12 ft wide, unless deck geometries or traffic control
factors require narrower placements.

530.3.4.5 Preplacement Conference
The Project Manager will conduct a preplacement conference. During the conference,
the Contractor and the Project Manager will review the following, among other pertinent items:

1. Equipment;
2. Construction and inspection procedures;
3. Specification requirements;
4. Personnel qualifications; and
5. The Contractor’s previous experience.

530.3.5 Placing and Finishing
Provide a latex-modified concrete overlay that is at least the minimum thickness in
accordance with the Contract.

Fill partial-depth repair areas by placing latex-modified concrete monolithically with the
overlay concrete.

The Contractor may place full-depth repair areas separately from the overlay concrete, or
fill with latex-modified concrete and place monolithically with the overlay concrete.

Keep the entire surface continually wet for at least 2 h before placement of concrete.

Immediately before overlay placement, cover the entire surface with a bonding mortar in
accordance with Section 530.3.5.3, “Mortar for Bonding.”

Deposit the concrete directly in front of the finishing machine with mobile buggies,
approved concrete pumps, or through a conventional chute. In general, do not deposit
cement at a distance greater than 10 ft ahead of the finishing machine.

Mix concrete at the site. Provide concrete, as discharged from the mixers, which is
uniform in composition and consistency. Provide mixing capabilities that allow finishing
operations to proceed at a steady pace without un-due interruption.

Place and finish the modified concrete in a continuous operation. If operations are interrupted for more than 20 min, install a bulkhead and stop overlay placement for at least 12 h. During delays of 20 min or less, protect the end of the placement from drying with several layers of wet burlap.

Immediately following the brushing of the bonding mortar, place latex-modified concrete and distribute it ahead of the finishing machine to approximately 1/4 in above the final grade. Then consolidate and finish the overlay at final grade with the finishing machine and necessary hand finishing operations.

Use hand vibrators to repair areas deeper than 3 in occurring along edges and adjacent to joint bulkheads.

Provide suitable work bridges that do not contact the finished surface.

**530.3.5.1 Temperature and Weather Limitations**

Place concrete in accordance with Section 511.3.3, “Temperature and Weather Limitations,” except as modified here.

Unless otherwise approved by the District Construction Engineer, place latex-modified concrete overlays between 3:00 a.m. and 10:00 a.m. during periods of hot weather. Consider hot weather to mean periods when the daytime highs generally exceed 80 °F.

If poor lighting conditions exist, provide lighting in accordance with Section 511.3.4.7, “Supplementary Lighting.”

Do not place overlays when surface evaporation rates exceed 15 lb per square foot per hour (as calculated in accordance with Section 511.3.3.3, “Rate of Evaporation Limitations,”) or when weather conditions make a satisfactory finish impossible to achieve.

Do not place latex-modified concrete when the air temperature is lower than 45 °F. The Contractor may place concrete at 45 °F when the Contractor expects temperatures to remain at or above 45 °F for the full time required to complete the placement.

The Department will reject latex-modified concrete overlay that has frozen during placement or curing operations.

Take adequate precautions to protect freshly placed concrete from damage and from sudden or unexpected rain. The Department may reject concrete damaged by rainfall or other causes.

**530.3.5.2 Full-Depth Repairs**

The Contractor shall provide Superstructure concrete, Class AA, for full-depth repairs, except the Contractor may use latex-modified concrete for full-depth repair areas.

Place and adequately vibrate full-depth Class AA repair concrete after the existing concrete bordering the area receives a coat of mortar or neat cement grout in accordance with Section 511.3.6.2, “Bonding New Concrete to Existing.” If the Contractor uses latex-modified concrete for the full-depth repair, provide grout in accordance with Section 530.3.5.3, “Mortar for Bonding.”

Place in the lower boundary of the overlay, unless using the optional monolithic placement of latex-modified concrete. Give top surfaces of separate full-depth placements a rough finish and a 48-hour, minimum, wet burlap cure. The Contractor may overlay full-depth repairs that do not exceed 2.7 ft² with latex-modified concrete before the 48-hour cure period, as long as the Contractor maintains the wet burlap cure until just before overlay with latex-modified concrete.

After curing, surface dry and blast clean full-depth repair concrete before placing the latex-modified concrete overlay. Remove forms after curing is complete.

**530.3.5.3 Mortar for Bonding**

Thoroughly brush a limited amount of the latex-modified concrete mixture onto the wetted prepared surface immediately ahead of the placement. Surfaces shall receive a thorough coating of mortar from the brushed concrete.

Dispose of coarser particles of the mixture that cannot be scrubbed into intimate contact with the deck surfaces as approved by the Project Manager.

Control the rate of progress of the mortar brushing operation so that the mortar does not become dry before it is covered with concrete required for the overlay and deck repair.

If more effective grout application to large areas of exposed reinforcing steel if necessary, use slurry composed of cement, fine sand, latex admixture, and water. Provide slurry with equal parts (by weight) of cement and sand, and use 3 1/2 gal of latex per 94 lb sack of
cement with enough water to produce a smooth cream consistency.

530.3.4 Treatment at Edge Forms and Construction Bulkheads

Do not treat forms and bulkheads with bondbreaking compounds.

Unless the Contractor has separated the edge forms and construction bulkheads from the newly placed concrete by passing a pointing trowel along the inside faces, sawcut and chip back edge joints before adjacent placement operations as follows:

1. Make trowel cuts for the entire depth and length of edge forms and bulkheads. Do not trowel cut until the concrete has stiffened sufficiently to maintain the separation;
2. Remove edge forms and bulkheads after the latex-modified concrete has taken an initial set. Take adequate precautions during the removal to protect the edge of the new surface from damage.

530.3.6 Curing

Cover the surface of the overlay with a double layer of clean, new or used wet burlap within 30 min after placement is complete. If the curing method cannot be applied within 30 min, shut down the operation.

The Project Manager will determine the suitability of the burlap for reuse, based on the cleanliness and absorptive ability of the burlap. For proper absorption, soak new burlap in water that contains a small amount of detergent, if necessary.

Drain the burlap well and lay the burlap flat with no wrinkles on the deck surface. Overlap adjacent strips of burlap at least 6 in.

Once in place, the Contractor may lightly fog spray the burlap with water. Immediately place a separate layer of white reflective sheeting in accordance with AASHTO M 171, over the wet burlap. Keep the concrete continuously wet by keeping the burlap wet for a minimum of 48 h.

After the wet cure, provide a dry cure to the latex-modified concrete. Apply the dry cure by removing the wet curing material and exposing the deck to air for an additional 48 h.

530.3.6.1 Cold-Weather Curing

During cold weather, continue the wet curing period until the concrete attains a compressive strength of at least 2,000 psi. After the concrete has reached a compressive strength of 2,000 psi, remove the wet burlap and white plastic sheeting and proceed with the dry cure.

The Department defines “cold weather” as any day when the minimum temperature is equal to or less than 32 °F, or any day when the average of the maximum and minimum temperatures is less than or equal to 40 °F.

For determining cessation of wet curing, use one of the test methods in accordance with Section 510, “Portland Cement Concrete.” Cure the cylinders in the same conditions as the overlay.

After 48 h of wet curing, test two of the cylinders for compressive strength in accordance with the following:

1. If the average strength of the cylinders is less than 1,500 psi, continue the wet cure for an additional 48 h, unless the Project Manager approves otherwise;
2. If the average strength of the cylinders is at least 1,500 psi, but less than 2,000 psi, continue the wet cure for an additional 24 h.

After any additional curing period, test two more cylinders. If their average strength is less than 2,000 psi, repeat 1 and 2.

During the wet and dry curing periods, or for at least 7 Days, maintain concrete temperatures in accordance with Section 511.3.3.1, “Cold-Weather Concrete.” During the dry curing period, remove blankets and artificial heat in the daytime when the temperatures are above the required minimums.

530.3.7 Post-Placement Inspection

Following the completion of the curing period, thoroughly test the latex-modified concrete for delamination and proper bonding. Remove and replace areas where the Contractor has not accomplished a positive and complete bond between the overlay and the deck slab, or where the Contractor has failed to meet other specification requirements, at no additional cost to the Department.
530.3.8 Texturing
Broom the plastic concrete and then machine groove the hardened concrete to produce
the specified surface texture. Groove in accordance with Section 512.3.10.3, “Grooving of
Hardened Concrete.”
Broom parallel to the finishing operation. Do not groove the concrete until after the wet
cure period is complete. Groove perpendicular to the Roadway centerline.

530.3.9 Sealing of Construction Joints and Surface Cracks
After grooving and before opening the bridge deck to traffic, fill joints and visible cracks,
and seal with a high molecular weight methacrylate resin in accordance with Section 535,
“Crack Sealing Using Low-Viscosity, Gravity-Fed Sealers.”

530.4 METHOD OF MEASUREMENT

530.4.1 Measurement of Latex-modified Concrete
Determine the quantity of latex-modified concrete by computing the volume of Material
placed in the bridge deck overlay (including partial depth repair sections) from the net weight
of cement (as evidenced from the cement ticket printouts) with the following equation:

\[ V = \frac{C}{658 \text{ lb} / \text{yd}^3} \]  

where
\( V \) is the volume of concrete
\( C \) is the net weight of cement

The Department will adjust the volume of concrete for wasted material outside of the
placement area and for latex-modified concrete used for full depth repair.

530.4.2 Concrete for Full-Depth Repair
The Department will measure the depth of full-depth repair from the bottom of the deck
slab to the bottom of the latex-modified overlay.

530.5 BASIS OF PAYMENT
The Department will pay for Full Depth Repair in addition to the Deck Preparation
quantity.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latex-Modified Concrete</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Deck Scarification</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Deck Preparation</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Replacement Reinforcing Bars Grade 420</td>
<td>Pound</td>
</tr>
<tr>
<td>Full Depth Repair</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

530.52 Work Included in Payment
The following work and items will be considered as included in the payment for the main
items and will not be measured or paid for separately:
A. Texturing concrete;
B. Removal of concrete;
C. Disposal of old concrete and debris;
D. Placement and removal of forms; and
E. Removing old bars.
SECTION 531: LAYERED BRIDGE DECK SEALING

531.1 DESCRIPTION
This Work consists of providing and placing multiple layers of HMA pavement and one layer of waterproof membrane over a bridge deck.

531.2 MATERIALS
531.2.1 Bridge Deck Sealant
531.2.1.1 Sealant
Provide a sealant as follows:
1. Membrane,
   1.1 A laminate of plasticized coal tar reinforced with non-woven synthetic fibers or glass fibers;
   1.2 Supplied in rolls, having a minimum width of 30 in, unless otherwise approved by the Project Manager; and
   1.3 In accordance with Table 531.2.1.1:1, “Membrane Requirements.”

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness (mil)</td>
<td>—</td>
<td>70–75</td>
</tr>
<tr>
<td>Pliability</td>
<td>ASTM D 146, Modified*</td>
<td>No cracking</td>
</tr>
<tr>
<td>Softening Point</td>
<td>ASTM D 36</td>
<td>≥230 °F</td>
</tr>
</tbody>
</table>

2. Mastic. Cold applied, compatible with the membrane in accordance with the membrane manufacturer's recommendations.

531.2.1.2 Material Prequalification
The Department requires Material prequalification for bridge-deck sealant membrane. Submit a notarized certificate from the manufacturer to the Project Manager, stating that the Materials meet the applicable requirements. Include a test report from a certified Laboratory. Provide test reports in accordance with Section 531.2.1, “Bridge Deck Sealant.” Include a sample of the proposed Materials. Department approval will remain in effect until the Department requires prequalification. In that event, repeat the entire qualifying procedure.

1. Lot or batch number;
2. Quantity of Material shipped; and
3. Previously qualified lot or batch number of identical Material.

The Department may require Material samples for quality control testing.

531.2.2 Asphalt Concrete
Provide HMA Materials in accordance with Section 423, “Hot Mix Asphalt—Superpave.” Provide SP-IV, unless otherwise specified in the Contract.

531.2.3 Tack Coat
Provide tack coat Materials in accordance with Section 407, “Tack Coat.”

531.3 CONSTRUCTION REQUIREMENTS
531.3.1 General
Ensure that new concrete attains design compressive strength, and is at least 56 Days old before sealing.

Provide a tack coat between the concrete Bridge deck and the HMA pavement.

531.3.1.1 Traffic Limitations
The Department will allow only the persons and Equipment necessary to perform the Work on the area to which the Contractor is applying the membrane. Maintain other traffic on other portions of the Structure.

Keep traffic off the membrane and protect the membrane from damage. Repair damaged bridge deck sealant by patching.
531.3.2 Temperature and Weather Limitations

Place bridge deck sealant under the following conditions:
1. Surface is dry;
2. Surface is at least 50 °F;
3. Air temperature is at least 50 °F; and
4. Humidity, per manufacturer's recommendations.

531.3.3 Application of Membrane

Store, handle, and place the membrane in accordance with the manufacturer’s instructions. Provide three copies of the manufacturer’s instructions to the Project Manager at least two weeks before starting the bridge-deck sealant operations.

Apply the waterproofing membrane to the top of the first lift of HMA overlay after compacting the first lift.

The Department will not require a primer to adhere the membrane to the new asphalt surface.

Install the waterproofing membrane so that water will run over and not against the laps. Overlap each strip longitudinally and transversely at least 4 in.

Turn the membrane upward at curb faces or barrier railings. At expansion joints at the ends of deck slabs, turn the membrane up to the level of the final Surface Course.

At locations where the Contract does not require expansion joints, extend the membrane at least 2 ft beyond the edge of the deck.

Heat the membrane at joints with a wide-tipped torch or use an adhesive as necessary to provide a good seal at the joints.

Use hand rollers or other pressure devices on the applied membrane to ensure firm and uniform contact with the first HMA overlay. If rollers are used, direct the rolling operations in the direction of the laps of the membrane.

Apply a primer as recommended by the manufacturer between the membrane and the face of the curbs, Sidewalks, expansion joints, and barriers. The membrane shall uniformly adhere to the concrete or steel at these surfaces.

After waterproofing is complete, cut the membrane with two right angle cuts at deck drainpipes. Make the cuts to the inside diameter of the drainpipes. Turn the membrane corners down into the drains and coat them with mastic.

Ensure that the membrane is free of placement defects. Make repairs in accordance with the manufacturer's instructions. Extend patches at least 6 in beyond defects in all directions.

531.3.4 Final Operations

Seal joints between asphalt concrete and PCC or steel surfaces in accordance with Section 411, “Hot-Poured Crack Sealant,” unless otherwise specified in the Contract.

531.4 METHOD OF MEASUREMENT

The Department will measure Bridge Deck Sealant Membrane as the area of the sealed paving surface.

531.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Deck Sealant Membrane</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

531.52 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately: sealing of joints as described in subsection 531.3.4 Final Operations.
532.1 DESCRIPTION
This Work consists of providing and applying a penetrating water repellent treatment to concrete surfaces.

532.2 MATERIALS
Use a penetrating water repellent solution that is from 40% to 100% solution by weight of monomeric alkyltrialkoxy silane.
Use a solution that does not stain, discolor, alter the texture of, or form a coating on the concrete surface. Use a solution that is compatible with surface finishes applied in accordance with Section 511.3.8.5, “Class 4, Special Surface Finish.” Use Material that will dry in 30 min.
Provide a treatment solution that is on the Department’s Approved Products List.

532.2.1 Physical Requirements
Provide concrete samples treated with the penetrating water repellent solution in accordance with Table 532.2.1.1, “Penetrating Water Repellent Treatment Requirements.”

Table 532.2.1.1
Penetrating Water Repellent Treatment Requirements

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Requirement</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in absorption of water</td>
<td>80% minimum</td>
<td>NCHRP #244 Series II</td>
</tr>
<tr>
<td>Reduction in chloride ion content</td>
<td>80% minimum</td>
<td>NCHRP #244 Series II</td>
</tr>
<tr>
<td>Penetration</td>
<td>0.15 in minimum</td>
<td>NM L-34*</td>
</tr>
<tr>
<td>Vapor permeability</td>
<td>99.5%</td>
<td>NM L-35*</td>
</tr>
</tbody>
</table>

*These tests are available from the State Materials Bureau.

532.2.2 Submittals
Submit a manufacturer’s notarized certificate to the Project Manager for each Material lot or shipment.
Provide a 1-pint sample from each lot in a glass container with a nonreactive plastic screw-on lid. Do not allow the sample to contact the metal. Do not expose the sample to moisture.
The Project Manager may take samples of the Materials from the shipping containers at the job site.
Provide documentation showing the manufacturer’s recommended coverage rate and application instructions.

532.3 CONSTRUCTION REQUIREMENTS
532.3.1 Surface Preparation
Before applying the treatment solution, remove curing compounds, laitance, dirt, dust, salt, oil, asphalt, and other Deleterious Materials from the concrete surface.
Obtain written approval for surface preparation Equipment from the Project Manager.
Ensure that the cleaning process:
1. Does not damage the concrete surface;
2. Does not remove or substantially alter the existing surface finish;
3. Does not expose coarse aggregate in the existing concrete; and
4. Provides a reasonably uniform surface color and texture.
Apply the treatment solution only after obtaining written approval of the cleaned surfaces from the Project Manager.

532.3.2 Application of Treatment Solution
532.3.2.1 Temperature and Weather Limitations
Apply the treatment solution only when the air and concrete surface temperatures are between 40 °F and 100 °F, unless otherwise recommended by the manufacturer. Do not spray the treatment solution in windy conditions.
Do not apply the solution to concrete surfaces when the rate of evaporation exceeds 0.20 lb per square foot per hour, calculated in accordance with Section 511.3.3.3, “Rate of Evaporation Limitations.”
Section 532: Penetrating Water Repellent Treatment

532.3.2.2 Application Equipment
Use a low-pressure airless type sprayer with a maximum application pressure of 15 psi. Use horticulture type spray bar units for treatment of Bridge decks or other large horizontal surfaces. Use hand-held sprayers for treating vertical surfaces or small horizontal surfaces. Obtain written approval of the spraying Equipment from the Project Manager before starting application work.

532.3.2.3 Application
Do not treat new concrete until it attains the specified design strength, verified by field-cured cylinders. The Project Manager will determine when concrete surfaces are dry enough for application of the treatment solution. Do not dilute or alter the treatment solution as supplied by the manufacturer. Follow the manufacturer’s recommended rate of coverage when spraying the solution. Lightly apply water to treated surfaces between 12 h and 24 h after treatment. If the Contract specifies both a water repellent treatment and a special surface finish, apply the penetrating water repellent first. Wait 7 Days before applying the special surface finish.

532.3.3 Traffic Limitations
The Project Manager will determine when traffic is allowed on treated surfaces.

532.4 METHOD OF MEASUREMENT
The Department will not measure Penetrating Water Repellent Treatment the Contractor applies to new concrete Structures.

532.5 BASIS OF PAYMENT
Pay Item | Pay Unit
--- | ---
Penetrating Water Repellent Treatment | Square Yard
533.1 DESCRIPTION
This Work consists of the following:
1. Removal of loose, unsound, and deteriorated concrete;
2. Removal and replacement of corroded reinforcing bars;
3. Furnishing, placing, finishing, and curing concrete repair Materials;
4. Applying penetrating water repellent treatment and a special surface finish over exposed surfaces; and
5. Other operations necessary to restore concrete and to satisfactorily complete the concrete work.

533.2 MATERIALS
533.2.1 Concrete
Use a pre-packaged, pre-blended; concrete that is combined with water at the site. Select repair Material from the Department’s Approved Products List.

533.2.1.1 Product Data Sheets
Submit manufacturer’s product data sheets at least 15 Days before the start of concrete repair work that describe the product’s intended for use in Structure repair to the Project Manager. Include mixing, application, and curing instructions.

533.2.2 Enriched Mortar
Provide enriched mortar that consists of a blended patching Material and water. Provide enriched mortar with physical properties in accordance with Table 533.2.2:1, “Enriched Mortar Physical Property Requirements.”

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength, minimum</td>
<td>C-109</td>
<td>1 Day: 2,500 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 Days: 3,000 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28 Days: 4,000 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Day: 2,500 psi</td>
</tr>
<tr>
<td>Bond strength, minimum</td>
<td>C-882</td>
<td>7 Days: 3,000 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28 Days: 4,000 psi</td>
</tr>
</tbody>
</table>
| Linear length change, maximum  | C-157     | 28 Days wet: +0.05 %
|                                |           | 28 Days dry: -0.05 %
| Coefficient of thermal expansion (in/in/°F) | C-531 | 3.9 x 10^{-6} to 7.1 x 10^{-6} |
| Freeze/thaw resistance @ 300 cycles, minimum | C-666 | 85% durability |

Table 533.2.2:1 Enriched Mortar Physical Property Requirements

"The maximum allowable expansion is 0.4% if the locations where enriched mortar is used can tolerate such expansions without exceeding the elastic limit.

533.2.3 Enriched Concrete
Provide enriched concrete consisting of enriched mortar extended with recommended amounts of coarse aggregate. Provide enriched concrete with physical properties in accordance with Table 533.2.3:1, “Enriched Concrete Physical Property Requirements.”
### Table 533.2.3:1
<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength, minimum</td>
<td>C-39</td>
<td>1 Day: 2,300 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 Days: 2,800 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28 Days: 3,500 psi</td>
</tr>
<tr>
<td>Bond strength, minimum</td>
<td>C-882</td>
<td>1 Day: 900 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 Days: 1,800 psi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28 Days: 2,200 psi</td>
</tr>
<tr>
<td>Linear length change (%), maximum</td>
<td>C-157</td>
<td>28 Days wet: +0.04 %a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28 Days dry: -0.04 %</td>
</tr>
<tr>
<td>Coefficient of thermal expansion (in/in/°F)</td>
<td>C-531</td>
<td>3.9 x 10^-6 to 7.1 x 10^-6</td>
</tr>
<tr>
<td>Freeze/thaw resistance @ 300 cycles, minimum</td>
<td>C-666</td>
<td>85% durability</td>
</tr>
</tbody>
</table>

*The maximum allowable expansion can be 0.4% as long as the locations where enriched concrete is used can tolerate such expansions without exceeding the elastic limit.

### 533.2.4 Aggregates
Unless otherwise directed by the manufacturer of the preblended patching Material or bonding agent, use fine aggregates in accordance with Section 509.2.4.3, “Fine Aggregate,” and coarse aggregate in accordance with Table 533.2.4:1, “Coarse Aggregate Gradations.”

### Table 533.2.4:1
Coarse Aggregate Gradations

<table>
<thead>
<tr>
<th>% passing</th>
<th>Sieve size</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/4 in</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1/2 in</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>3/8 in</td>
<td>40</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>No. 4</td>
<td>0</td>
<td>15</td>
</tr>
</tbody>
</table>

### 533.2.5 Water
Provide water in accordance with Section 509.2.6, “Water.”

### 533.2.6 Test Cylinders
At least 30 Days before the start of concrete Structure repair, prepare at least three 4 in x 8 in concrete cylinders for testing in the presence of Department personnel and submit to the Project Manager. Prepare cylinder concrete with the same Materials mixed in the same proportions as the concrete proposed for the Work. Use the proposed Equipment to prepare the cylinder concrete. Use the maximum recommended water ratio. The Department will use the cylinders to determine if the repair Material meets the 7-Day and 28-Day compressive strength requirements.

### 533.3 CONSTRUCTION REQUIREMENTS
#### 533.3.1 Preparation of Repair Areas
The Contract will specify approximate repair areas. The Project Manager will locate and mark the areas with 3/4 in-deep sawcuts. Remove unsound material within the repair limits using chipping hammers or other approved hand-operated devices.
533.3.1.1 Concrete Removal

Saw cut all boundaries to 0.75 in depth, remove concrete with pavement breakers and chipping hammers. Use hand tools only for final removal of concrete from reinforcing bars and faces of remaining concrete. Use Department-approved removal Equipment.

The following restrictions apply to concrete removal tools:
1. Do not use pavement breakers heavier than the 30 lb class;
2. Do not use chipping hammers heavier than the 15 lb class;
3. Operate pavement breakers or mechanical chipping tools only at a 90° angle;
4. Use only hand-powered tools such as hammers and chisels to remove the final concrete particles from reinforcing bars.

533.3.1.2 Concrete Surface Preparation and Cleaning

Ensure the surface substrate is clean, sound, and dry. Remove substances that may prevent a bond between existing and new concrete. If using acid etchers, concrete cleaners, or degreasers to clean the existing surface, remove completely after cleaning.

Mechanically roughen the existing surface using Equipment such as chipping hammers. Remove loose and excess material from repair areas. Place a 4-inch piece of duct tape every square yard to test for cleanliness. The Department will not allow more than 25% of the tape surface to show dust coverage.

Before placing mortar or concrete, clean repair areas with oil-free compressed air or pressurized water. Moisten the substrate and remove excess water.

533.3.1.3 Preparation of Exposed Reinforcing Bars

Preserve existing reinforcing steel exposed during concrete removal. If the bond between exposed bars and adjacent concrete breaks, chip at least 3/4 in deep into the adjacent concrete around the entire bar.

Sandblast exposed reinforcing steel before placing new mortar or concrete.

Strengthen corroded or damaged existing bars by splicing an equal sized bar at least 2 ft longer than the corroded or damaged length. The minimum splice length shall be 1 ft on each end.

533.3.1.4 Application of Bonding Agents

Use diluted bonding admixture or other manufacturer-recommended priming systems as bonding agents. Apply the bonding agents to the contact surfaces of the repair areas immediately before concrete or mortar placement.

533.3.2 Depth of Repair

Use enriched mortar where the repair depth is less than 1 in, and use enriched concrete where the repair depth is 1 in or greater. If the repair depth is 4 in or greater, use the appropriate class concrete.

533.3.3 Placing, Finishing, and Curing

Do not mix mortar and concrete in repair areas. Use forms if necessary.

533.3.3.1 Temperature and Weather Limitations

Make repairs when the air temperature is between 50 °F and 95 °F. Maintain the temperature of the mortar and concrete at or above 50 °F during the curing period. Use a set retardant if recommended by the manufacturer.

533.3.3.2 Placement

Place mortar or concrete in a continuous operation for each repair area. For vertical surfaces, start the Work at the bottom of the patch and continue upwards, and from one edge to the other to prevent the entrapment of air pockets.

If the repair area abuts or crosses a working joint, place a temporary strip of waxed wood or pre-molded filler in the joint before placing repair Material. Remove the strips before the concrete sets.

The Contractor may also repair areas that occur on both sides of a joint by patching the entire cavity and restoring the joint by saw cutting immediately after the repair Material has set, instead of using a temporary vertical insert strip.
533.3.3.3 Curing
Cure in accordance with the manufacturer’s recommendations. If the manufacturer does not specify a cure method, use Method 2 or Method 4 in accordance with Section 511.3.9, “Curing.”

533.3.4 Inspection
The Project Manager will examine repaired areas after the curing period is completed to ensure soundness of the repairs and complete bonding with the existing members. Remove and replace unacceptable areas at no additional cost to the Department.

533.3.5 Penetrating Water Repellent Treatment
If the Contract requires a penetrating water repellent treatment, apply in accordance with Section 511.3.8.6, “Penetrating Water Repellent Treatment Solution,” and Section 532, “Penetrating Water Repellent Treatment.”

533.3.6 Special Surface Finish
Finish exposed surfaces of piers, abutments, edges of decks and barrier railings, and other locations to a Class 4 finish in accordance with Section 511.3.8.5, “Class 4, Special Surface Finish,” after repairs and curing are complete.

533.3.7 Final Operations
Clean, remove, and dispose of debris resulting from the concrete repair work as approved by the Project Manager.

533.4 METHOD OF MEASUREMENT
If the repair depth does not exceed 4 in, the Department will measure the Work by the square yard. If the repair depth exceeds 4 in, the Department will negotiate a unit price with the Contractor. The Department will measure exposed surfaces before the application of the special surface finish.

533.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair of Concrete Structures</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

533.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately: sampling and submittals, saw cutting operations and removal of debris.
**SECTION 534: EPOXY INJECTION**

**534.1 DESCRIPTION**
This Work consists of rebonding cracks or delaminations in existing concrete using an epoxy adhesive injection system.

**534.2 MATERIAL**

**534.2.1 General**
Use non-shrink epoxy Materials, 100% solid, two-component, moisture-insensitive adhesives in accordance with Table 534.2.1.1, "Epoxy Injection Material Requirements."

<table>
<thead>
<tr>
<th>Property</th>
<th>Type I</th>
<th>Type II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slant shear strength, minimum*</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Test</td>
<td>AASHTO T 237</td>
<td>AASHTO T 237</td>
</tr>
<tr>
<td>Set time @ 77 °F, maximum</td>
<td>18 h</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>AASHTO T 237</td>
<td></td>
</tr>
<tr>
<td>Pot life @ 77 °F, minimum</td>
<td>10 min</td>
<td>60 min</td>
</tr>
<tr>
<td>Test</td>
<td>AASHTO T 237</td>
<td></td>
</tr>
<tr>
<td>Viscosity @ 77 °F ± 3 °F</td>
<td>2.5–9.0</td>
<td>90 ± 20</td>
</tr>
<tr>
<td>(poises)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific gravity @ 77 °F</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile strength, minimum</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Test</td>
<td>ASTM D 638</td>
<td></td>
</tr>
<tr>
<td>Compressive strength, minimum</td>
<td>6,000</td>
<td>6,000</td>
</tr>
<tr>
<td>Test</td>
<td>ASTM D 695</td>
<td></td>
</tr>
</tbody>
</table>

*If bonded to saturated surface dry samples, cure for 7 Days at 40 °F and 90 to 100% relative humidity. The Department will use a joint width of 3/16 in for Type I, and 3/8 in for Type II for testing purposes.

bAdhere to the manufacturer’s specified set time for construction purposes on these wider cracks.

Use Type I epoxy Material for cracks less than 1/4 in wide. Use Type II epoxy Material for cracks 1/4 in wide or wider. Obtain Department approval of epoxy Materials before use. If the product provides unsatisfactory results, the Department may rescind the approval.

534.2.2 Product Data and Packaging
Label each container with the following:
1. Product name;
2. Component designation, "A" and "B;"
3. Manufacturer’s name;
4. Batch number;
5. Ratio of component mixture;
6. Complete instructions for storing, mixing, and using; and
7. Safety requirements.

Package components in separate containers.

534.2.3 Test Reports
Provide CTRs for each batch of the epoxy system, verifying that the mixed epoxy is in accordance with Table 534.2.1.1, "Epoxy Injection Material Requirements."

534.2.4 Injection Port Materials
Injection ports are tubes, fittings, pressure plates, or other devices used as entry points for the epoxy adhesive. Use suitable methods to scale each port after injecting epoxy at that port.

534.2.5 Temporary Surface Sealant
Use a temporary surface sealant to retain the injected epoxy adhesive. The Department will also allow pressure plates or other methods for retaining the epoxy adhesive.
534.3 CONSTRUCTION REQUIREMENTS

534.3.1 General
Perform the epoxy injection process in accordance with the manufacturer's recommendations.

The Department will mark cracks and delaminated areas for injection.

Inject epoxy when concrete temperature is between 50 °F and 80 °F. Inject epoxy continuously over the entire crack or area of delamination. Maintain low pumping pressures to prevent lifting the delamination.

534.3.1.1 Epoxy Sampling During Operations
Before starting injection work, at hourly intervals during continuous injection work, and when requested by the Project Manager, take a 3-fluid-ounce sample of mixed epoxy from the injection device. If the sample indicates improper proportioning or mixing of the epoxy, the Project Manager will suspend injection work until the Contractor corrects the problem.

534.3.1.2 Core Sampling
Take core samples from injected cracks and delaminated areas and submit them to the Project Manager to verify penetration and bonding adequacy. Cut cores with a diameter of 1 1/2 in and to the full crack depth or 6 in, whichever is smaller.

The Project Manager will specify core sample locations. Submit at least one core sample for every 50 ft of injected crack or every 50 ft² of injected delamination. Fill core holes with a Department-approved epoxy mortar.

534.3.2 Equipment
Use positive displacing dispensing Equipment that is capable of injecting epoxy at set pressures without pressure build-up.

Where the Contractor uses pressure plates to seal cracks, the Contractor shall use a special pressure fitting on the injection device to prevent leakage.

If the Contractor drills out injection ports, the Contractor shall use drilling Equipment with a vacuum system to remove and not compact drilling dust into cracks or delaminations.

534.3.3 Crack Injection
534.3.3.1 Crack Preparation
Clean surface openings and crack interiors with oil-free compressed air to remove dirt, dust, silt, and other materials. If the Department determines the result is inadequate, use another cleaning method such as vacuuming, pressure flushing, routing, or sawing. If using pressure flushing, blow water out with oil-free compressed air.

534.3.3.2 Injection Ports
Unless the Project Manager approves other methods, drill holes along the crack to insert the injection ports.

534.3.3.3 Temporary Crack Sealing
Temporarily seal surface openings of cracks between injection ports with material that can retain the epoxy adhesive during pressure injection and until the epoxy hardens.

534.3.3.4 Crack Injection Process
When Material travel is indicated, the nozzle shall be moved to the port that shows epoxy, and the pumped port sealed and this method continued until the crack is completely filled. Where vertical and horizontal cracks intersect, inject the vertical crack below the intersection first. On wide cracks, where epoxy movement between ports will be rapid, the Contractor may pump two or more ports simultaneously.

534.3.4 Re-bonding Delaminated Areas by Epoxy Injection
534.3.4.1 Injection Ports
Use at least one port for every square yard of delaminated areas.

534.3.4.2 Temporary Sealing of Delaminated Openings
Temporarily seal the surface openings of cracks in the delaminated areas to prevent leakage of epoxy Material.
534.3.4.3 Delamination Injection Process

Begin injection at one port near the perimeter of the delaminated area and continue until there is epoxy at an adjacent port. Then plug the port being pumped and continue the injection at the adjacent port showing epoxy. Continue this process until the entire delaminated area has been injected. The Contractor may pump two or more ports simultaneously.

534.3.5 Finishing Operations

After curing is complete, remove excess sealing material from the concrete surface without altering the concrete surface color or texture.

534.3.6 Loading Restrictions

Do not allow traffic and other loads on the injected Structures until the epoxy adhesive is solid.

534.4 METHOD OF MEASUREMENT

The Department will verify the measured quantities with the Contractor daily.

534.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Injection Type</td>
<td>Gallon</td>
</tr>
</tbody>
</table>
SECTION 535: CRACK SEALING USING LOW-VISCOSITY, GRAVITY-FED SEALERS

535.1 DESCRIPTION
This Work consists of crack sealing using low-viscosity, gravity-fed sealers.

535.2 MATERIALS

535.2.1 High Molecular Weight Methacrylate
Provide low viscosity, non-fuming HMWM resin selected from the Department’s Approved Products List and in accordance with Table 535.2.1:1, “HMWM Property Requirements.”

<table>
<thead>
<tr>
<th>Property</th>
<th>Resin specifications:</th>
<th>Test Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, centipoises*</td>
<td>—</td>
<td>8–25</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>—</td>
<td>1.00–1.07</td>
</tr>
<tr>
<td>Flash point, °F, minimum</td>
<td>Pinsky-Martens CC</td>
<td>180</td>
</tr>
<tr>
<td>Tensile elongation, %, minimum</td>
<td>ASTM D 638</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 535.2.1:1

<table>
<thead>
<tr>
<th>Performance Properties of Resin:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cure speed:</td>
<td>—</td>
</tr>
<tr>
<td>Surface cure, hours, maximum @ 73 °F</td>
<td>—</td>
</tr>
<tr>
<td>Gel time, minutes, @ application temperature, 50 ml sample</td>
<td>—</td>
</tr>
<tr>
<td>@ application temperature</td>
<td>8</td>
</tr>
<tr>
<td>8 @ application temperature</td>
<td>24</td>
</tr>
<tr>
<td>20–90</td>
<td></td>
</tr>
</tbody>
</table>

*Brookfield Model LVT Viscometer, Spindle I at 60 rpm.

535.2.2 Low Viscosity, Low Surface Tension Polymer
Use low-viscosity, low surface tension polymer selected from the Department’s Approved Products List and in accordance with Table 535.2.2:1, “Physical Properties of Low-Viscosity, Low Surface Tension Crack Sealer.”

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength (psi), ASTM D 695 minimum @ 24 h</td>
<td>5,500–6,000</td>
</tr>
<tr>
<td>Tensile strength (psi), ASTM D 638, minimum @ 24 h</td>
<td>3,100–3,400</td>
</tr>
<tr>
<td>Tensile elongation, %, ASTM D 638, minimum @ 24 h</td>
<td>30</td>
</tr>
<tr>
<td>Water absorption, % by weight, ASTM D 570, maximum @ 24 h</td>
<td>0.10</td>
</tr>
<tr>
<td>Shore D hardness, °F, minimum</td>
<td>65</td>
</tr>
<tr>
<td>Gel time, minutes - 7.0 ounces</td>
<td>48–52</td>
</tr>
<tr>
<td>Adhesion to concrete</td>
<td>100% failure in concrete</td>
</tr>
<tr>
<td>Surface tension, maximum</td>
<td>32 Dynes/cm</td>
</tr>
<tr>
<td>Percent solids</td>
<td>100</td>
</tr>
</tbody>
</table>

535.2.3 Certificates of Compliance and Product Data Sheets
At least 15 Days before using the sealer, submit a notarized certificate of Material compliance to the Project Manager. List batch numbers and the manufacture date for all components of each Material in the Certificate of Compliance and on the Material containers. Submit detailed MSDS for sealer components.

535.2.4 Fine Aggregate
Provide fine aggregate for spreading over treated areas that is free from dirt, clay, asphalt, and other Deleterious Materials, and has moisture content of less than 0.2% when applied. Unless otherwise approved by the State Materials Bureau, provide sand in accordance with Table 535.2.4:1, “Fine Aggregate Gradation Requirements.”
TABLE 535.2.4:1
Fine Aggregate Gradation Requirements

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO. 8</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>No. 16</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>No. 30</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>No. 100</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

535.3 CONSTRUCTION REQUIREMENTS

535.3.1 General
Seal individual cracks. Where closely spaced map cracking has occurred on concrete Bridge decks, seal by flooding the entire surface. The Project Manager will direct which method to use.

535.3.1.1 Planning and Demonstration
At least 15 Days before applying the sealer, submit a written crack-sealing plan to the Project Manager that includes the following:
1. Material descriptions;
2. Deck preparation and application methods;
3. Safety considerations for blasting and sealing personnel; and
4. Plans to protect other persons, vehicles, and property from injury or damage.

535.3.1.2 Sequence of Operations
Seal cracks on new concrete bridge decks or approach slabs after 28 Days of curing. For latex-modified concrete overlays, seal cracks after 7 Days of curing. Apply penetrating water repellent treatment first, if specified in the Contract.

535.3.2 Surface Preparation
Clean concrete surfaces from 3 in to 5 in on either side of individual cracks. Remove asphalt Material, oil, dirt, rubber, curing compounds, paint, and other Deleterious Materials by flooding, sandblasting, or shot blasting. Air blast, with oil free compressed air, or vacuum all loose material from visible cracks. Apply sealer when concrete surfaces and cracks are dry.

535.3.3 Storage of Sealer
Store the sealer or its components separately and within the manufacturer recommended temperature ranges.

535.3.4 Application of Sealer
Surface temperature shall comply with the minimum manufacturer’s recommendations. Follow the manufacturer’s mixing and application recommendations. Apply 1 gal per 200 ft for crack sealing and 1 gal per 100 ft² for surface sealing. The Department may require two or more applications of sealer for cracks 1/32 in or larger. The Department may require application of a temporary surface sealer to wider, full depth deck cracks on the deck underside.
Prior to use on the Project, ensure that the curing period recommended by the manufacturer confirms proper curing of the Material.

535.3.4.1 Excess Sealer
Sweep away sealer that does not fill cracks, is not absorbed by the concrete surface, and fills or partially fills the grooves of a tined or grooved surface.

535.3.5 Sand Application
Apply dry silica sand with coverage of 8 lb per square yard. Place sand before the sealer starts to gel. Remove excess sand after the curing period.

535.3.6 Limitation of Operations
Prevent the sealer from leaking through cracks onto persons, traffic, and property. If deck preparation procedures or the sealer deface the appearance of bridge components other than the crack sealed areas, repair those components at no additional cost to the Department.
### 535.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crack Sealing</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Concrete Surface Treatment</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

**Section 535**: Crack Sealing Using Low-Viscosity, Gravity-Fed Sealers
536.1 DESCRIPTION
This Work consists of providing and applying a polymer concrete bridge deck overlay.

536.2 MATERIALS
536.2.1 Epoxy
Provide a two-part epoxy, or epoxy urethane resin base, composed of a 100% solid, thermosetting, moisture-insensitive, flexible, high-elongation compound in accordance with Table 536.2.1:1, “Epoxy Physical Requirements,” or Table 536.2.1:2, “Epoxy Urethane Physical Requirements.”

<table>
<thead>
<tr>
<th>Property</th>
<th>Test method</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>ASTM D 2393, Brookfield RVT, Spindle #3 @ 20 rpm</td>
<td>7 poises</td>
<td>25 poises</td>
<td>—</td>
</tr>
<tr>
<td>Gel time</td>
<td>ASTM C 881, Paragraph 11.2 modified</td>
<td>15 min</td>
<td>45 min</td>
<td>—</td>
</tr>
<tr>
<td>Compressive strength @ 3 h</td>
<td>ASTM C 579 modified (with plastic inserts)</td>
<td>1,000 psi</td>
<td>—</td>
<td>Mixed with aggregate</td>
</tr>
<tr>
<td>Compressive strength @ 24 h</td>
<td>ASTM C 579 modified (with plastic inserts)</td>
<td>5,000 psi</td>
<td>—</td>
<td>Mixed with aggregate</td>
</tr>
<tr>
<td>Tensile strength (neat) @ 7 Days</td>
<td>ASTM D 638</td>
<td>2,200 psi</td>
<td>5,000 psi</td>
<td>—</td>
</tr>
<tr>
<td>Elongation (neat) @ 7 Days</td>
<td>ASTM D 638</td>
<td>30%</td>
<td>80%</td>
<td>—</td>
</tr>
<tr>
<td>Adhesive strength @ 24 h</td>
<td>ACI 503R, Appendix A, VTM 92</td>
<td>250 psi</td>
<td>—</td>
<td>Mixed with aggregate with 100% failure in concrete</td>
</tr>
<tr>
<td>Permeability to chloride ion @ 28 Days</td>
<td>AASHTO T 277</td>
<td>—</td>
<td>100 coulombs</td>
<td>—</td>
</tr>
<tr>
<td>Absorption (neat) @ 24 h</td>
<td>ASTM D 570</td>
<td>—</td>
<td>1%</td>
<td>—</td>
</tr>
<tr>
<td>Thermal compatibility</td>
<td>ASTM C 884</td>
<td>No delamination of overlay</td>
<td>Mixed with aggregate</td>
<td></td>
</tr>
<tr>
<td>Infrared spectrum</td>
<td>AASHTO T 237, Paragraphs 5 and 6</td>
<td>To be established for each component</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>
### Table 536.2.1: Epoxy Urethane Physical Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test method</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>ASTM D 2393 Brookfield RVT, Spindle #3 @ 20 rpm</td>
<td>35 poises</td>
<td>70 poises</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ASTM C 881, Paragraph 11.2 modified</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gel time</td>
<td>ASTMC 579 modified</td>
<td>15 min</td>
<td>45 min</td>
<td></td>
</tr>
<tr>
<td>Compressive strength @ 3 h</td>
<td>ASTMC 579 modified</td>
<td>1,000 psi</td>
<td></td>
<td>Mixed with aggregate</td>
</tr>
<tr>
<td>Compressive strength @ 24 h</td>
<td>ASTMC 579 modified</td>
<td>5,000 psi</td>
<td></td>
<td>Mixed with aggregate</td>
</tr>
<tr>
<td>Tensile strength (neat) @ 7 Days</td>
<td>ASTMD 638</td>
<td>2,200 psi</td>
<td>5,000 psi</td>
<td></td>
</tr>
<tr>
<td>Elongation (neat) @ 7 Days</td>
<td>ASTMD 638</td>
<td>30%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Adhesive strength @ 24 h</td>
<td>ACI 503R, Appendix A, VTM 92</td>
<td>250 psi</td>
<td></td>
<td>Mixed with aggregate with 100% failure in concrete</td>
</tr>
<tr>
<td>Permeability to chloride ion @ 28 Days Shore D hardness</td>
<td>AASHTO T 277</td>
<td></td>
<td>100 coulombs</td>
<td></td>
</tr>
<tr>
<td>Flexural creep, total movement in 7 Days</td>
<td>California Test Method 419</td>
<td>0.0065 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexural yield strength Absorption (neat) @ 24 h</td>
<td>ASTMD 790</td>
<td>5,000 psi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal compatibility</td>
<td>ASTMD 570</td>
<td></td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Infrared spectrum</td>
<td>ASTMC 884, AASHTO T 237, Paragraphs 5 and 6</td>
<td></td>
<td></td>
<td>To be established for each component</td>
</tr>
</tbody>
</table>

#### 536.2.2 Submittals

Submit the manufacturer’s recommendations for the proposed Material to the Project Manager 14 Days before use. Provide a certified report from a Department approved Laboratory and the manufacturer certification verifying the Materials are in accordance with this specification. Include a Fourier Transform Infrared Spectrophotometry spectrum in transmittance mode and a bulk sample of each component tested in the manufacturer’s certification. The Department will maintain confidentiality of the data.

#### 536.2.3 Department Testing

The Department will test the epoxy or epoxy urethane Materials the Contractor submits and provide results within 14 Days. The Project Manager shall obtain a single 1/2 pint sample of each component and send to the State Materials Bureau for comparative infrared spectrum testing.

The Project Manager will accept the Materials based on the certified Laboratory report and the Department’s test results.
536.2.4 Aggregate
Provide angular grained, stone aggregate free of dirt, clay, and Deleterious Material in accordance with Table 536.2.4:1, “Required Aggregate Properties,” and Table 536.2.4:2, “Required Aggregate Gradation.”

<table>
<thead>
<tr>
<th>Property</th>
<th>Test method</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soundness loss, 5 cycles in magnesium sulfate</td>
<td>AASHTO T 104</td>
<td>—</td>
<td>8%</td>
<td>Aggregate must meet the gradation shown in Table 536.2.4:2, “Required Aggregate Gradation”</td>
</tr>
<tr>
<td>Micro-Deval</td>
<td>AASHTO T 327</td>
<td>—</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Moh's hardness Moisture content</td>
<td>AASHTO T 255</td>
<td>—</td>
<td>0.2%</td>
<td></td>
</tr>
</tbody>
</table>

Table 536.2.4:2
Required Aggregate Gradation

<table>
<thead>
<tr>
<th>Sieve size</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>No. 8</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>No. 16</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>No. 30</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>No. 200</td>
<td>0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

536.2.4.1 Acceptance of Aggregate
The Department will base acceptance of aggregate on the State Materials Bureau recommendations and Table 536.2.4:1, “Required Aggregate Properties.”

536.3 CONSTRUCTION REQUIREMENTS
536.3.1 Equipment
536.3.1.1 Surface Preparation Equipment
Use shot-blasting Equipment capable of producing a surface relief equal to the International Concrete Repair Institute Surface Preparation Level 5-7, or ASTM E 965 pavement macrotexture depth of from 0.04 in to 0.08 in.

536.3.1.2 Mechanical Application Equipment
Use an epoxy or epoxy urethane distribution system that completely mixes the epoxy or epoxy urethane resin with hardening agent, and provides a uniform distribution of the Materials at the required application rate.
Use a self-propelled aggregate spreader.
Use an air compressor that produces oil-free and moisture-free compressed air to remove dust and loose material from the application surface before applying epoxy or epoxy urethane.

536.3.1.3 Hand Application Equipment
Use calibrated epoxy containers.
Use notched squeegees and brooms that spread the epoxy or epoxy urethane Material in accordance with the manufacturer’s requirements. Periodically inspect squeegees during application for wear of the notch depth.
Use an aggregate spreader that uniformly and applies the dry aggregate at the manufacturer’s recommended application rate.
536.3.1.4 Vacuum Trucks
Use vacuum trucks that are clean and do not drip engine fluids, or install drip pans to protect the clean deck and overlay.

536.3.1.5 Power Brooms
Use power brooms that are clean and do not drip engine fluids, or install drip pans to protect the clean deck and overlay.

536.3.2 Pre-construction
536.3.2.1 Deck Preparation
Complete deck repairs for patches, delamination, and crack filling before applying the overlay per Section 533, “Concrete Structure Repair” and Section 534, “Epoxy Injection” as specified in the Contract.
Identify moist areas by taping an 18 in × 18 in plastic sheet to the deck for at least 2 h in accordance with ASTM D 4263. If moisture appears on the bottom of the plastic sheet, do not proceed with the overlay process. Use compressed air to dry the deck surface.
Close and protect deck drains and areas of curb or railing above the proposed surface to ensure epoxy or epoxy urethane and aggregate does not pass through the drains.

536.3.2.2 Cleaning
Obtain Project Manager’s approval of bridge deck cleaning and preparation before placing the first course.
Before placing the overlay, clean the deck surface to remove materials that may interfere with bonding or curing.
The Department will consider cleaning acceptable when the color of the concrete and mortar changes and coarse aggregate particles are exposed. Cleaning shall open the pores of sound mortar. The Department will consider pavement markings clean when exposed aggregate shows through the markings. Use a vacuum cleaner or air compressor to remove dust and other loose material. Do not use brooms.

536.3.3 Safety Provisions
Use personnel certified in the safe handling of Materials in accordance with the manufacturer’s requirements. Submit written documentation of Material handlers’ training to the Project Manager before applying the overlay.

536.3.4 Storage of Materials
Store Materials in accordance with the manufacturer’s recommendations.

536.3.5 Temperature Limitations
Follow the manufacturer’s deck temperature recommendations. Do not use artificial methods to raise the deck temperature.
Follow the manufacturer’s temperature requirements for epoxy or epoxy urethane and aggregate components. The Contractor shall not apply epoxy or epoxy urethane for the following reasons:
1. The Contractor expects the air temperature to drop below the manufacturer-required temperature within 8 h after application; or
2. The epoxy or epoxy urethane’s gel time is less than 10 min.

536.3.6 Usage Limitations
Do not overlay Bridges constructed with unventilated stay-in-place forms, unless forms are ventilated at a minimum rate of 1/2 square inch for every square foot, or on PCC that is less than 56 Days of age with polymer concrete overlay. Additionally, manufacturer’s recommendations concerning moisture content must be followed.

536.3.7 Application
Apply the overlay as two separate applications with a total coverage of at least 7.5 gal per 100 ft².
Apply the first application of polymer at a rate of at least 2.5 gal per 100 ft². Cover with a minimum of 10 pounds of aggregate per square yard, or enough to completely cover the deck surface.
epoxy or epoxy urethane. Apply the second application of polymer at a rate of at least 5.0 gal per 100 ft². Cover with at least 14 pounds of aggregate per square yard, or enough to completely cover the epoxy or epoxy urethane.

Remove and replace first applications that do not receive enough aggregate before the polymer gels, at no additional cost to the Department. The Department will allow second applications not covered with enough aggregate to remain in place, but the Contractor must apply additional applications before opening to traffic, at no additional cost to the Department.

536.3.8 Curing
Cure each application of overlay (polymer and aggregate) until a vacuuming or broom does not tear or damage the surface.

After the first application cures, remove loose aggregate with a vacuum or broom, then apply the second application.

536.3.9 Expansion Joints
Place expansion joints with bond breakers in bridge deck expansion joints. Apply polymer over the expansion joints. Within 12 h after application and before opening to traffic, remove the polymer over the expansion joints using the following procedure:
1. Remove the bond breakers;
2. Score the polymer before gelling; or,
3. Saw cut after the cure.

536.3.10 Corrective Work
Correct surface variations that exceed ± 1/4 in per 3 ft, unless otherwise directed by the Project Manager.

Repair the damaged overlay areas by saw cutting in rectangular sections to the top of the concrete deck surface and replacing the Material at no additional cost to the Department.

536.3.11 Warranty
Provide a 5-year warranty for the overlay Material and installation.

The Department will evaluate the overlay performance annually using a pre-established joint team consisting of a Contractor and a Department representative. The evaluation will take place on the same date, ± 30 Days, as the previous year for the life of the warranty. No spalling, scaling, cracking or delamination is acceptable during the warranty period, as defined by the following:

1. **Spalling.** Broken or missing pieces of concrete overlay;
2. **Scaling.** The bridge deck overlay surface has a visible, exposed, rough surface texture resulting from a loss of aggregate or mortar;
3. **Delamination.** There is visible debonding of the concrete bridge deck overlay from the existing bridge deck surface;
4. **Cracking.** Any visible crack.

At the end of each yearly evaluation period, the Department will provide the Contractor with a report that describes occurrences of spalling, scaling, cracking, or delamination. The Department will perform an annual skid in accordance with AASHTO T 242. For the warranty period, an average skid number of 45 or higher is acceptable.

If the overlay is not acceptable, the Department will direct the Contractor, in writing, to perform corrective work within 180 Days, at no additional cost to the Department.

536.4 METHOD OF MEASUREMENT—Vacant

536.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Polymer Concrete Bridge Deck Overlay</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Epoxy Urethane Polymer Concrete Bridge Deck Overlay</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>
540.1 DESCRIPTION
This Work consists of providing and placing steel reinforcement.

540.2 MATERIALS
540.2.1 Bar Reinforcement
Provide deformed bars in accordance with AASHTO M 31, Grade 60, at the nominal dimensions in accordance with Table 540.2.1.1, "Nominal Dimensions of Reinforcement."

<table>
<thead>
<tr>
<th>Bar size</th>
<th>Nominal weight (lb/ft)</th>
<th>Diameter (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 3</td>
<td>0.376</td>
<td>0.375</td>
</tr>
<tr>
<td>No. 4</td>
<td>0.668</td>
<td>0.500</td>
</tr>
<tr>
<td>No. 5</td>
<td>1.043</td>
<td>0.625</td>
</tr>
<tr>
<td>No. 6</td>
<td>1.502</td>
<td>0.750</td>
</tr>
<tr>
<td>No. 7</td>
<td>2.044</td>
<td>0.875</td>
</tr>
<tr>
<td>No. 8</td>
<td>2.670</td>
<td>1.000</td>
</tr>
<tr>
<td>No. 9</td>
<td>3.400</td>
<td>1.128</td>
</tr>
<tr>
<td>No. 10</td>
<td>4.303</td>
<td>1.270</td>
</tr>
<tr>
<td>No. 11</td>
<td>5.313</td>
<td>1.410</td>
</tr>
<tr>
<td>No. 14</td>
<td>7.650</td>
<td>1.693</td>
</tr>
<tr>
<td>No. 18</td>
<td>13.600</td>
<td>2.257</td>
</tr>
</tbody>
</table>

The Department will allow Grade 60 reinforcing bars where Grade 40 bars are specified, except for vertical bars in abutment back walls and stirrup bars projecting from pre-stressed concrete beams or other precast units.

540.2.2 Welded Wire Fabric
Provide welded wire fabric in accordance with AASHTO M 55.

540.2.3 Spiral Reinforcement
Provide spiral reinforcement fabricated from steel bars in accordance with AASHTO M 31, or from cold drawn steel wire in accordance with AASHTO M 32.

540.2.4 Reinforcing Wire
Provide reinforcing wire in accordance with AASHTO M 32.

540.2.5 Epoxy-Coated Reinforcing Bars
Provide epoxy-coated reinforcing bars in accordance with AASHTO M 284, and from plants certified by the Concrete Reinforcing Steel Institute (CRSI) for the coating and fabrication process.

540.2.6 Coating Material
The Contractor may use the following coating systems:
1. Uncoated steel;
2. Epoxy-coated reinforcement; and
3. Hot-dipped galvanized reinforcement.

Use epoxy-coating Material and hot-dipped galvanizing Material to coat reinforcing bars for Bridge decks and other concrete components exposed to weather and road salts.

Provide a light colored powdered epoxy resin coating Material that highlights rusting of untreated bar areas. Select coating Material from the Department’s Approved Products List.
Submit at least one 4 oz sample of the resin powder to the Department.

540.2.7 Accessories
Provide plastic-coated reinforcing tie wire. Provide one of the following types of chairs, supports, and clips:
1. Steel, fully coated with plastic or fusion-bonded epoxy;
2. Galvanized steel with the cradle and the upper 2 in of the chair, support, or clip, coated with fusion-bonded epoxy or plastic;
3. Galvanized metal chairs or other metal supports for reinforcement that contacts exposed concrete surfaces;
4. Galvanized, painted, or epoxy coated metal chairs or other metal supports for regular reinforcement;
5. Epoxy coated metal chairs or other metal supports for epoxy-coated reinforcement;
6. Galvanized sand chairs or other metal supports placed directly on dirt; or
7. Use of concrete blocks instead of sand chairs or other metal supports placed directly on the dirt is acceptable.
Use continuous chairs or supports with pre-formed metal forms.

540.2.8 Epoxy Certificates of Compliance
Provide Certificates of Compliance to the Project Manager with each reinforcing steel shipment.
Show the project number, shipping invoice number, name of the manufacturer, pounds shipped, heat numbers, Laboratory test reports, and grade of steel on the Certificate of Compliance. This requirement is the same for each of the three coating systems.

540.2.9 Epoxy-Coated Reinforcing Bar Certificates of Compliance
Provide the Department’s Inspector with three copies of a Certificate of Compliance for each shipment of coated bars. State on the certificate that samples of coated bars were tested and that the test results were in accordance with AASHTO M 284, and this specification. Show epoxy resin batch numbers on the certificate.
Provide coating test results to Department for inclusion in final inspection reports.

540.2.10 Hot Dip-Galvanized Reinforcing Bars
Provide hot-dip galvanized reinforcing bars in accordance with AASHTO M 111 from a Department-approved galvanizing plant. Galvanize bars after cutting and bending.

540.2.11 Galvanizing Material
Provide galvanizing zinc in accordance with ASTM B 6.

540.2.12 Galvanizing Accessories
Use galvanized tie wire for tying galvanized reinforcing bars and galvanize chairs, supports, and clips, or cover them with plastic in accordance with Section 540.2.6, “Coating Material.”

540.2.13 Galvanized Steel Certificates of Compliance
Provide the Project Manager with Certificates of Compliance for the uncoated (black) steel in accordance with Section 540.2.8, “Epoxy Certificates of Compliance.”
Provide the Department’s Inspector with three copies of a Certificate of Compliance for each shipment of galvanized bars in accordance with Section 540.2.8, “Epoxy Certificates of Compliance.” Include inspection results for galvanizing thickness, adherence, and smoothness or appearance.

540.2.14 Uncoated Corrosion Resistant Bar Reinforcement
Provide uncoated corrosion resistant bar reinforcement in compliance with ASTM A615 Grade 75 and meeting a chemical composition of a minimum content of 8.0% chromium and a maximum carbon content of 0.15% by weight.
Uncoated corrosion resistant bar reinforcement may be Grade 316 stainless steel or other manufactured steels meeting the above chemistry.
Provide accessories in accordance with section 540.2.7, “Accessories.”

540.3 CONSTRUCTION REQUIREMENTS
540.3.1 General
Measure dimensions from centerline of bar to centerline of bar.
Do not store reinforcing bars on the ground.

540.3.1.1 Bundling and Tagging
Tag and mark reinforcement bar shipments in accordance with CSRI’s Code of Standard Practice.
540.3.1.2 Bar Bending

The Department will allow cold bending around a pin. Do not field bend Grade 60 or epoxy-coated bars.

Unless otherwise directed, ensure the bend diameter is in accordance with Table 540.3.1.2:1, “Minimum Diameter of Bends.” This table specifies minimum pin diameters for coating systems.

<table>
<thead>
<tr>
<th>Type of reinforcement</th>
<th>Size</th>
<th>Minimum pin diameter (bar diameters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Uncoated bars</td>
</tr>
<tr>
<td>Stirrups and ties</td>
<td>#3–#5</td>
<td>5</td>
</tr>
<tr>
<td>Main reinforcement</td>
<td>#3–#5</td>
<td>6</td>
</tr>
<tr>
<td>All types</td>
<td>#6–#8</td>
<td>6</td>
</tr>
<tr>
<td>All types</td>
<td>#9–#11</td>
<td>8</td>
</tr>
<tr>
<td>All types</td>
<td>#14–#18</td>
<td>10</td>
</tr>
</tbody>
</table>

540.3.1.3 Splicing

Splice bars only in accordance with the Plans unless otherwise approved by the Project Manager.

Place and tie bars in lapped splices to maintain minimum reinforcing cover.
Place spiral reinforcement by lapping or butt-welding. If lap splicing, ensure that laps are at least 48 bar or wire diameters long, but not less than 1 ft.

The Department will allow mechanical couplers if the verified splice strength is equal to or greater than 125% of the spliced reinforcing bars’ yield stress.

Unless otherwise specified, ensure that welded wire and bar mat overlap is at least one spacing of cross wires plus 2 in when measured between the outer-most cross wires of each sheet.

540.3.1.4 Field Cutting

If field cutting bars, shearing or sawing is allowable, do not flame cut coated bars. Patch the ends of coated bars. The Department will allow flame cutting of uncoated bars, if the Contractor makes the cut at least 6 in beyond the specified length.

540.3.1.4.1 Reinforcing Bar Placement

Tie reinforcing bars with 16-gauge wire.

Tie all intersections where bar spacing is greater than or equal to 1 ft in either direction. Tie alternate intersections where bar spacing is less than 1 ft in either direction.

Use metal spacers, chairs, hangers, concrete blocks and other approved devices to hold the reinforcing bars in position.

When using concrete blocks to support the bottom mat of reinforcement in slabs that are cast on earth, use dense, rectangular concrete blocks that:

1. Have compressive strength and density equal to or greater than the concrete to be placed;
2. Occupy a small area; and
3. Contain embedded tie wires for attachment.

Do not use wooden spacers or supports.

Tie reinforcing bar mats in Bridge deck and concrete box Culvert slabs to beams and forms to prevent upward movement during concrete placement. Ensure that the space between ties does not exceed 10 ft.

540.3.1.4.2 Reinforcing Bar Placement Tolerances

Ensure that the space between adjacent bars does not vary more than the greater of either 1/2 in or 1/24 of the spacing dimension shown on the Plans.

Except for slabs cast on earth, ensure that the clear cover of reinforcement does not vary more than the greater of either 1/4 in or 1/8 of the dimension shown on the Plans.

Ensure that the reinforcement clear cover in slabs cast on earth does not vary more than minus 1/2 in from the position shown on the Plans.
540.3.1.5 Cleaning Reinforcing Bars
Before placing concrete, clean the reinforcing bars of materials that would reduce or destroy the bond.

540.3.1.6 Welding of Reinforcing Steel
Weld reinforcing steel only if the Contract requires or the State Bridge Engineer authorizes in writing. Weld in accordance with AWS Specification D1.4, Reinforcing Steel Welding Code.

540.3.1.7 Concrete Cover Requirements
Concrete cover is the distance from the surface of concrete to the edge of the bar nearest to that surface. If cover dimensions are not specified in the Contract, use the concrete cover dimensions in accordance with Table 540.3.1.7:1, “Concrete Cover Requirements.”

<table>
<thead>
<tr>
<th>Location</th>
<th>Minimum cover (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete cast against and permanently exposed to earth</td>
<td>3</td>
</tr>
<tr>
<td>Concrete exposed to earth or weather</td>
<td></td>
</tr>
<tr>
<td>Principal reinforcement</td>
<td>2</td>
</tr>
<tr>
<td>Stirrups, ties, and spirals</td>
<td>1 1/2</td>
</tr>
<tr>
<td>Concrete Bridge slabs</td>
<td></td>
</tr>
<tr>
<td>Top reinforcement</td>
<td>2</td>
</tr>
<tr>
<td>Bottom reinforcement</td>
<td>1</td>
</tr>
<tr>
<td>Concrete not exposed to weather or in contact with ground</td>
<td></td>
</tr>
<tr>
<td>Principal reinforcement</td>
<td>1 1/2</td>
</tr>
<tr>
<td>Stirrups, ties, and spirals</td>
<td>1</td>
</tr>
<tr>
<td>Bar bundles</td>
<td>2*</td>
</tr>
</tbody>
</table>

*a* Or equal to the diameter of a single bar of equivalent area, whichever is greater.

540.3.1.8 Final Inspection
Do not place concrete until the Department inspects the reinforcing steel. Acceptance of the reinforcing steel does not relieve the Contractor of responsibility for the cover and position control of the steel.

540.3.2 Requirements for Epoxy-Coated Reinforcing Bars
Where epoxy-coated bars are detailed over 60 ft long, the Contractor may provide the bars in two sections with lap splices, upon the Department’s approval of a written request. Provide the State Bridge Engineer with a written request for this change. Show splice locations and lap splice lengths in the request and submit before fabricating the bars. Allow at least two weeks for review and approval. Perform a trial run of the coating process to ensure that it meets the requirements. Test the trial specimens before beginning bar production. Notify the Department at least 30 Days before the date of the trial run.

540.3.2.1 Coating Thickness
Ensure that at least 80% of the coating after curing is from 6 mils to 10 mils.

540.3.2.2 Cure of Coating
Fully cure the epoxy coating film. Supply the entire coated production lot in a fully cured condition.

540.3.2.3 Coating Continuity
Ensure that the coating is free of holes, voids, contamination, cracks, and damaged areas. Use a 67.5-volt holiday detector in the production line to continuously check the coated bar for holidays. Ensure that there are no more than three holidays or pinholes per linear foot of coated bar.
540.3.2.4 Coating Inspection and Tagging
   Epoxy-coat reinforcing bars only after the Department tags and approves bar bundles. Maintain these tags throughout the coating process. Feed the tagged bar of a bundle through the cleaning unit last. Remove the tag before cleaning and place it on the last bar between coating and re-bundling. After coating, the Inspector will attach a second tag to the bundle, indicating that the bundle was inspected and approved for epoxy coating.
   The Department will not accept bundles of epoxy-coated reinforcing bars at the project without inspection tags.

540.3.2.5 Storage and Handling of Epoxy-Coated Reinforcing Bars
   Transport and store epoxy-coated reinforcing steel on wooden or padded supports. Use devices with padded contact areas to handle epoxy-coated reinforcement bars and prevent bar-to-bar abrasion. Do not drop or drag bars or bundles. Do not store epoxy-coated reinforcing bars in sunlight for more than 30 Days.

540.3.2.6 Repair of Damaged Coating
   Repair visible damage before shipping. Ensure that the total surface area of patched coating Material is not more than 1% of the total coated area in any 1-foot section. The Department will reject bars shipped to the project that show more than 1% patched coating Material.
   Patch sheared ends, cuts, and exposed areas before detrimental oxidation occurs. Keep exposed areas free of contaminants before patching.
   Patch coating damage before placing concrete. Ensure that the total patched surface area does not exceed 2% of the total coated area in any 1-foot section. The Department will reject installed bars with more than 2% patching.

540.3.3 Requirements for Galvanized Reinforcing Bars
   Where galvanized bars are detailed more than 60 ft, provide such bars in two sections with lap splices if necessary.
   Submit a written request to the State Bridge Engineer for such a substitution, showing details of splice locations and lengths of lap splices. Submit the request before fabricating the bars and allow at least two weeks for review and approval. If necessary, provide longer bar lengths resulting from the proposal at no additional cost to the Department.
   Perform a trial run of the galvanizing process to ensure that it meets the requirements. Notify the State Bridge Design Section at least 30 Days before the date of the trial run.

540.3.3.1 Surface Preparation
   Prepare bar surface by removing dirt and grease with a hot alkaline solution. Use a diluted solution of sulfuric acid to pickle. Use a solution of zinc ammonium chloride to flux. Ensure that the resulting surface condition is about equal to SSPC-SP 10 as described by the SSPC.

540.3.3.2 Thickness of Galvanizing
   Ensure that the galvanizing after drying with air, steam, or wiping is from 3 mil to 3.9 mil thick. Determine the thickness with a magnetic thickness gauge.

540.3.3.3 Chromating
   Treat the galvanized coating with chromate. This prevents a reaction between the bars and fresh portland cement paste. The Department will allow proprietary chromate treatment solutions of equivalent strength instead of the generic chemical treatment in accordance with ASTM A 767, Section 4.3.

540.3.3.4 Finish and Adherence of Coating
   Ensure that the zinc coating is free of bare spots, blisters, flux spots or inclusions, dross, and acid or black spots. The Department will reject bars that stick together after galvanizing or bars with tears or sharp spikes. A matte gray finish appearance is not, by itself, a cause for rejection.
   Ensure that the coating cannot be removed through normal handling.

540.3.3.5 Coating Inspection and Tagging
   Obtain approval of the bar bundles before galvanizing. After galvanizing, the Department
will tag approved bar bundles. The Department will not accept bundles without inspection tags.

540.3.3.6 Storage, Handling, and Repair of Galvanized Reinforcing Bars
Store, handle, and repair galvanized reinforcing bars in accordance with ASTM A 767, Guidelines for Job-Site Practices described in Appendix XI.

540.4 METHOD OF MEASUREMENT
The Department will measure reinforcing bar weight in accordance with Table 540.2.1:1, “Nominal Dimensions of Reinforcement,” whether it is black steel, epoxy-coated, or galvanized. The Department will not include splice overlaps in the measurement.

540.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Bars</td>
<td>Pound</td>
</tr>
<tr>
<td>Epoxy-Coated Bars</td>
<td>Pound</td>
</tr>
<tr>
<td>Galvanized Bars</td>
<td>Pound</td>
</tr>
<tr>
<td>Corrosion Resistant Bars</td>
<td>Pound</td>
</tr>
</tbody>
</table>

540.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:
A. Clips, supports, wire, and other material used for fastening reinforcement; and
B. Samples and submittals;
C. Welded wire fabric shall be considered as included in the cost for concrete.
541.1 DESCRIPTION
This Work consists of fabricating, providing, erecting, and coating Structural Steel. Structural Steel includes forged or cast steel, bolts, tie rods, other ferrous or nonferrous Materials, and miscellaneous steel.
The term “miscellaneous steel” refers to items such as:
1. Drop inlet grates and frames,
2. Safety grates,
3. Pedestrian rail, and
4. Cattle guard grates.

541.2 MATERIALS
541.2.1 Structural Steel
Provide Structural Steel in accordance with AASHTO M 270, Grade 36, unless otherwise designated in the Contract. Provide steel for anchor bolts, sole plates, minor Bridge components, inlet grates, and cattle guards in accordance with AASHTO M 183.

541.2.1.1 Impact Testing Requirements for Non-Fracture-Critical Structures
For Materials requiring impact testing, do not weld repair the base metal at the producing mill. The Department will consider Structures to be non-fracture-critical, unless otherwise designated in the Contract. Fabricate the following in accordance with AASHTO M 270, Table 10 when subject to tensile stresses:
1. Wide flange beams used as main load carrying members;
2. Flanges, and web plates used in plate girders;
3. Flange cover plates;
4. Flange and web splice plates; and
5. Other components designated in the Contract.
Conduct Charpy V-notch (CVN) impact “H” or “P” frequency testing in accordance with AASHTO T 243.
Ensure that Structural Steel meets requirements for minimum service temperatures as described for Zone 2 of the AASHTO’s Standard Specifications for Highway Bridges (-1 °F to 30 °F).
Conduct plate-frequency testing instead of hat-lot testing for plate Material thicker than 1 1/2 in.

541.2.1.2 Impact Testing Requirements for Fracture-Critical Bridge Components
The Contract will specify the CVN requirements for fracture-critical Bridge components.

541.2.2 Shear Connector Studs
Provide shear connector studs fabricated from cold-drawn bars, grades 1015, 1018, or 1020, either semi-killed or fully-killed in accordance with AASHTO M 169.
If using flux-retaining caps, use the low carbon grade steel for the caps that is suitable for welding and in accordance with ASTM A 109. Produce the finish by cold drawing, cold rolling, or machining.
Ensure stud tensile properties are in accordance with Table 541.2.2:1, “Tensile Properties of Shear Connector Studs,” as determined by tests of bar stock (after drawing) or finished studs, in accordance with ASTM A 370.

<table>
<thead>
<tr>
<th>Property</th>
<th>Minimum requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength</td>
<td>60,000 psi</td>
</tr>
<tr>
<td>Yield strength @ 0.2% offset</td>
<td>50,000 psi</td>
</tr>
<tr>
<td>Elongation in 2 in</td>
<td>20%</td>
</tr>
<tr>
<td>Reduction of area</td>
<td>50%</td>
</tr>
</tbody>
</table>

541.2.3 Bearing Pads
Obtain Department approval for impregnated fabric pads used beneath Bridge bearings.
541.2.4 Aluminum
Provide aluminum and aluminum alloy Materials in accordance with ASTM aluminum alloy designation and in accordance with the Plans.

541.2.5 Bolts
Provide high-strength bolts in accordance with Section 542, “High-Strength Bolts.” Provide other bolts in accordance with ASTM A 307, Grade A.

541.2.5.1 Unfinished Bolts
Provide unfinished ASTM A 307 bolts. Thread bolts so that not more than two threads are within the grip of the connected parts. Use bolts that will extend beyond the nut at least two threads, but not more than 1/2 in.

541.2.6 Structural Steel Coating
Provide coated Structural Steel in accordance with Table 541.2.6:1, “Coating of Structural Steel.”

<table>
<thead>
<tr>
<th>Item</th>
<th>Coating requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Steel for steel Bridges</td>
<td>Section 544, “Protective Coating of New Structural Steel”</td>
</tr>
<tr>
<td>Structural Steel for concrete Bridges</td>
<td>Section 544, “Protective Coating of New Structural Steel” or Section 545, “Protective Coating of Miscellaneous Structures”</td>
</tr>
<tr>
<td>Structural Steel for miscellaneous Structures</td>
<td>Section 545, “Protective Coating of Miscellaneous Structural Steel”</td>
</tr>
<tr>
<td>Metal bridge railing</td>
<td>Section 545, “Protective Coating of Miscellaneous Structural Steel”</td>
</tr>
<tr>
<td>New exposed steel Bridge piling and similar applications</td>
<td>Section 545, “Protective Coating of Miscellaneous Structural Steel”</td>
</tr>
<tr>
<td>Recoating Bridges</td>
<td>Section 546, “Recoating Structures”</td>
</tr>
</tbody>
</table>

If the Contract requires a galvanized coating, coat steel after fabrication in accordance with AASHTO M 111.

541.3 CONSTRUCTION REQUIREMENTS

541.3.1 Applicable Codes and Documents
Fabricate and erect steel Structures in accordance with the current edition of the following codes and documents:

1. AASHTO/AWS D1.5 – Bridge Welding Code;
2. AASHTO/AWS D1.1 – Structural Welding Code;
3. AWS D1.4 – Reinforcing Steel Code;
4. The following AASHTO/NSBA Steel Collaboration documents:
   4.1. S 2.1 Steel Bridge Fabrication Guide Specification
   4.2. S 4.1 Steel Bridge Fabrication QC/QA Guide Specification
   4.3. S 10.1 Steel Bridge Erection Guide Specification
   4.4. G 1.1 Shop Drawing Review / Approval Guidelines
   4.5. G 1.3 Shop Detail Drawing Presentation Guidelines
   4.6. G 12.1 Guidelines for design for Constructability

Although the AASHTO/AWS Steel Collaboration documents are titled “Guidelines” or “Guide Specifications”, consider them to have the same importance and standing as a code or a specification. If the content of the collaboration documents appears permissive with words such as “should”, “could”, “may”, etc, consider the content to be a requirement unless otherwise approved by the Department.

In the event of a conflict between a referenced code and this specification, this specification will take precedence.
541.3.2 Quality Control and Quality Assurance
Conduct QC and QA operations in accordance with AASHTO/NSBA Steel Bridge Collaboration S 4.1. For shops fabricating miscellaneous steel items, the Department may waive the requirement that the QC inspector be a certified welding inspector.

541.3.2.1 Submittals to the QA Inspector
The Department’s shop Inspectors will prepare inspection reports covering the Structural Steel fabrication. Provide six copies of the following items for inclusion in the inspection report:
- Structural Steel MTRs;
- Certificates of Compliance and other documentation for the protective coating;
- The manufacturer’s Certificate of Compliance for welding consumables;
- Weld procedures;
- QC inspection reports; and
- A general Certificate of Compliance for the fabricated product.
Submit Certificates of Compliance instead of MTRs for Materials subjected to minimal stress levels, such as sole plates, shoe plates, anchor bolts, and fill plates.

541.3.3 Shop and Erection Drawings
Prepare shop drawings in accordance with AASHTO/NSBA G 1.3, Shop Drawing Presentation Guidelines. The Department will review and approve shop drawings in accordance with AASHTO/NSBA G 1.1, Shop Drawing Review / Approval Guidelines. Submit 10 complete sets of shop and erection drawings for preliminary review to the Project Manager. Retain two additional complete sets.

541.3.3.1 Approval of Initial Submittal
The Department will review the preliminary drawings. The Department will return three sets of drawings stamped “Approved except as noted” to the Contractor.

541.3.3.2 Errors and Changes Requiring Re-submittal
If numerous drawing changes and corrections are needed, the Department will return three sets of marked-up drawings to the Contractor with a letter requesting corrections and re-submittal.
Make changes and corrections as noted on the marked-up drawings and re-submit nine sets of corrected drawings; retain two additional sets.
Do not fabricate Materials before receiving drawings stamped “Approved” or “Approved as Noted.” Mark non-approved drawings “VOID.”
Allow at least 30 Days for review and approval of final shop plans and re-submitted shop drawings.

541.3.4 Shop Drawings for Structural Steel Items Detailed on Standard Drawings
The Contractor may submit standardized shop drawings instead of project-specific drawings for Structural Steel items such as cattle guard grills and drop inlet grates.
Include the Fabricator’s name and address, drawing title, drawing number, drawing date, revision dates, and standard serial number on shop drawings.
The Department will retain an approved set of shop drawings in a permanent file. Do not make any changes to approved shop drawings. If changes are made, re-submit the drawings for approval.
Before fabrication, submit a letter of intent to fabricate to the Project Manager containing the following information:
- Names of the Fabricator;
- Project number;
- Drawing number;
- Number of pieces to be fabricated;
- Expected date of manufacture.
Submit a detailed bill-of-material in accordance with AASHTO/NSBA Steel Bridge Collaboration G 1.1 with the letter of intent to fabricate, to supplement the standardized drawings.
Submit one copy of each standard drawing to the Project Manager and the State Bridge Engineer at least 7 Days before starting Work. Notify the State Bridge Engineer at least 5 Days before starting Work.
For steel items unique to a project, prepare and submit shop drawings. 

541.3.5 Reserved

541.3.6 Fabrication

Ensure shop drawings fabricating Bridges, overhead sign supports, and other major steel structures are certified in accordance with AASHTO/NSBA Steel Collaboration S 2.1, Steel Bridge Fabrication Guide Specification. The Department will not require certification for shops fabricating miscellaneous steel items, but the Department must inspect and approve these shops before fabrication.

Steel will be fabricated in the shop unless otherwise approved by the Department.

541.3.6.1 Attachment and Fit of Gussets and Stiffeners

Where welding of gusset plates, stiffeners or other secondary attachments to main structural members would otherwise result in intersections of welds, clip back the corners of the attachments 1 1/4 in minimum from the corner in each direction to avoid such intersections.

Terminate welds attaching secondary components to main members 1/4 in short of the end of the attachments.

If the Plans require bearing stiffeners “finished to bear,” mill or grind the ends and obtain an even bearing against the flange the stiffeners will bear on.

If the Plans require “tight fit” stiffeners, fit the stiffeners tight against the flange to exclude water after being coated.

541.3.6.2 Straightening of Flanges

At pier bearings, abutment bearings and splices, straighten girder or beam flanges perpendicular to the webs. At bearings, straighten flanges before fitting stiffeners. At splices, straighten flanges before coating and shipment. Do not cold bend.

541.3.6.3 Bearing Plates, Pins, and Rollers

541.3.6.3.1 Sole, Masonry, and Shoe Plates

Flatten the top and bottom surfaces of sole masonry and shoe plates to within ± 1/32 in. Machine sole plate surfaces that will contact elastomeric bearing pads perpendicular to the direction of expansion.

Machine other expansion surfaces in the direction of expansion.

541.3.6.3.2 Pins and Rollers

Accurately turn pins and rollers to dimensions and ensure that they are smooth, straight, and free of flaws.

541.3.6.3.3 Pin Holes

Bore a 2 in diameter hole longitudinally through the center of pins with an 8 in diameter or larger.

Bore pinholes true to the specified diameter, smooth and straight, at right angles to the axis of the member and parallel with each other unless otherwise required. Produce the final surface with a finishing cut.

Do not vary the outside to outside distance of end holes in tension members and inside to inside distance of end holes in compression members by more than 1/32 in. Bore holes in built-up members after shop assembly.

541.3.6.3.4 Threads

Ensure that bolt and pin threads are in accordance with Unified Standard Series UNC-ANSI B1.1, Class 2A for external threads and Class 2B for internal threads. Thread pin ends with a diameter of 1 3/8 in or greater with six threads per inch.

541.3.6.3.5 Surface Finish

Finish the surfaces of bearings, base plates, pins, rollers, and other bearing steel that will come into contact with each other or with concrete in accordance with ANSI B46.1, Surface Roughness, Waviness and Lay.
541.3.6.4 Connections

541.3.6.4.1 Welding

541.3.6.4.1.1 Welder Qualifications

Use annually certified welders or those who provide documentation demonstrating continuing experience in the process and are position qualified.

541.3.6.4.1.2 Testing of Complete Penetration Welds

Conduct nondestructive QC radiographic testing on complete penetration welds in accordance with AWS D1.5 or D1.1 (as applicable).

The Department may allow ultrasonic testing as a substitute for radiography. Submit an ultrasonic testing plan for approval at least 30 Days before the start of fabrication. Provide detailed information about the Fabricator’s previous experience with ultrasonic testing and resumes showing the training and experience of persons performing the testing. Do not use ultrasonic testing for cases described in Section 6.7.1.1 of the Bridge Welding Code.

541.3.6.4.2 Bolted Connections

Bolt with high strength bolts in accordance with Section 542, “High-Strength Bolts.”

Make bolt holes 1/16 in larger than the nominal diameter of the connector, unless otherwise specified.

541.3.6.4.3 Gaps Between Ends of Abutting Members

Where the Contract requires abutting milled joints, ensure there are no gaps. Face the ends to provide a full and even bearing when assembled.

Where the Contract requires close joints, do not exceed 1/8 in between the ends of abutting members. Do not exceed 1/4 in between abutting ends of girders at splices.

541.3.6.5 Camber Verification

Verify girder camber during the laydown operation. Unless assembling girders in the horizontal position, meet the total camber dimensions less the deflections produced by the weight of the girder.

541.3.7 Erection Requirements

Erect the Structure in accordance with AASHTO/NSBA Steel Bridge Collaboration S10.1, Steel Bridge Erection Guide Specification.

541.3.7.1 Acceptance Mark

The Department will stamp fabricated members at the fabrication facility upon acceptance. Do not use any piece that does not bear the acceptance stamp.

541.3.7.2 Placement of Bearings

Ensure that column bases and bearing devices bear fully and uniformly on Substructures. Do not place bearings on pier or abutment Bridge seat areas that are improperly finished or irregular. Grout to achieve uniform bearing only when the Contract allows grouting.

Place masonry plates and beam and girder span pedestals on impregnated fabric pads approved by the Project Manager at least 1/8 in thick.

541.3.7.2.1 Anchor Bolt Holes

Core drill anchor bolt holes in accordance with Table 541.3.7.2.1:1, “Required Nominal Anchor Bolt Hole Diameters.”

<table>
<thead>
<tr>
<th>Bolt diameter (in)</th>
<th>Hole diameter (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4</td>
<td>1 1/2</td>
</tr>
<tr>
<td>1</td>
<td>1 3/4</td>
</tr>
<tr>
<td>1 1/4</td>
<td>2</td>
</tr>
</tbody>
</table>

Set anchor bolts using non-shrink grout from the Department’s Approved Products List. Remove excess mortar after the grout has set. Ensure that anchor bolt washers and nuts bear evenly against the steel-bearing surface. Ensure anchor bolts at the expansion ends of spans allow the free movement of the span.
541.3.7.2.2 Welding Sole Plates to Girders
At expansion bearings, weld sole plates to girder flanges or shoe plates after placing the concrete deck.
Before welding, adjust sole plate position to compensate for temperature expansion.

541.3.7.3 Field Bolting
Install high strength bolts in accordance with Section 542, “High-Strength Bolts.”
Block main structural members to the desired camber before torquing the bolted splice connections.
For skewed steel Bridges with diaphragms perpendicular to the longitudinal centerline, finger tighten diaphragm attachment bolts before deck placement. Fully torque bolts after the deck slab is in place.
Following completion of the Superstructure and after priming, fill open holes in exterior beams and girders with button head bolts before final acceptance.

541.3.7.4 Field Welding
Employ a QC inspector to monitor field welding certified in accordance with AASHTO / NSBA Steel Bridge Collaboration S2.1.
Provide QC reports certifying that welds meet specification requirements following each welding operation. Include the following in the report:
1. Welder qualification;
2. Weld procedure;
3. Electrode storage;
4. Preheat requirements; and
5. Acceptability of completed welds.

541.3.7.5 Pilot and Driving Nuts
Use pilot and driving nuts in driving pins. Show details on the shop plans. Furnish one pilot and one driving nut for each size pin.

541.3.7.6 Removal of Lead-Paint Coated Steel Items
Do not reuse salvaged steel items from existing Structures. Dispose of them in accordance with Section 547, “Safety and Environmental Requirements for Painting Operations.”

541.4 METHOD OF MEASUREMENT
If structural members are specified by a nominal unit weight, the Department will calculate weight based on the nominal weights and dimensions.
When structural members are not designated by a nominal unit weight, the Department will calculate weight using the unit weights listed in Table 541.4:1, “Metal Unit Weights for Measurement.”
The Department will deduct the weight of copes, cuts, bevels, and open holes from the gross weight. The Department will not make deductions for bolt holes.

<table>
<thead>
<tr>
<th>Material</th>
<th>Unit weight (lb/ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>490</td>
</tr>
<tr>
<td>Cast iron</td>
<td>445</td>
</tr>
<tr>
<td>Bronze</td>
<td>536</td>
</tr>
</tbody>
</table>

541.4.1 Bolts
The Department will calculate the weight of fasteners, except for anchor bolts, using weights listed in Table 541.4.1:1, “Bolt Unit Weights for Measurement.”
Table 541.4.1:1
Bolt Unit Weights for Measurement

<table>
<thead>
<tr>
<th>Bolt diameter (in)</th>
<th>High-strength bolts (lb/100)</th>
<th>A 307 bolts (lb/100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>22.8</td>
<td>19.7</td>
</tr>
<tr>
<td>5/8</td>
<td>36.1</td>
<td>31.7</td>
</tr>
<tr>
<td>3/4</td>
<td>59.3</td>
<td>52.4</td>
</tr>
<tr>
<td>7/8</td>
<td>89.2</td>
<td>80.4</td>
</tr>
<tr>
<td>1</td>
<td>127.0</td>
<td>116.7</td>
</tr>
</tbody>
</table>

The Department will not include the weld material weight or the coating weight.

541.5 BASIS OF PAYMENT

Pay Item                      Pay Unit
Structural Steel for Concrete Bridges    Pound
Structural Steel for Steel Bridges    Pound
Structural Steel for Miscellaneous Structures  Pound

541.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:

A. Submittals; nondestructive testing; protective coatings; and
B. Additional weight of heavier sections provided solely for the Contractor's convenience;
C. All incidentals necessary for the completion of the work.
542.1 DESCRIPTION
This Work consists of providing and installing high-strength bolts.

542.2 MATERIALS
When the Contract requires galvanized fasteners, mechanically galvanize in accordance with AASHTO M 298, Class 50 (ASTM B 695, Class 50).
Mark bolts, nuts, and washers in accordance with the applicable AASHTO or ASTM specifications.

542.2.1 Bolts
Provide bolts in accordance with AASHTO M 164 (ASTM A 325). Ensure that bolt dimensions are in accordance with ANSI B 18.2.1 and nut dimensions are in accordance with ANSI B 18.2.2. These dimensions are tabulated in Table 542.2.1.1, “Dimensions of High-Strength Bolts.” For dimension labels, refer to Figure 542.2.1.1, “AASHTO M 164 (ASTM A 325) Bolts.”
Ensure that hardness for bolts with diameters from 1/2 in to 1 in is in accordance with Table 542.2.1:2, “Bolt Hardness Requirements.”
### Table 542.2.1:1
Dimensions of High-Strength Bolts

<table>
<thead>
<tr>
<th>Nominal bolt size, D</th>
<th>Width across flats, F</th>
<th>Height, H</th>
<th>Thread length</th>
<th>Width across flats, W</th>
<th>Height, H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>7/8</td>
<td>5/16</td>
<td>1</td>
<td>7/8</td>
<td>31/64</td>
</tr>
<tr>
<td>5/8</td>
<td>1 1/16</td>
<td>25/64</td>
<td>1 1/4</td>
<td>1 1/16</td>
<td>39/64</td>
</tr>
<tr>
<td>3/4</td>
<td>1 1/4</td>
<td>15/32</td>
<td>1 3/8</td>
<td>1 1/4</td>
<td>47/64</td>
</tr>
<tr>
<td>7/8</td>
<td>1 7/16</td>
<td>35/64</td>
<td>1 1/2</td>
<td>1 7/16</td>
<td>55/64</td>
</tr>
<tr>
<td>1</td>
<td>1 5/8</td>
<td>39/64</td>
<td>1 3/4</td>
<td>1 5/8</td>
<td>63/64</td>
</tr>
<tr>
<td>1 1/8</td>
<td>1 13/16</td>
<td>11/16</td>
<td>2</td>
<td>1 3/16</td>
<td>17/64</td>
</tr>
<tr>
<td>1 1/4</td>
<td>2</td>
<td>25/32</td>
<td>2</td>
<td>2</td>
<td>17/32</td>
</tr>
<tr>
<td>1 3/8</td>
<td>2 3/16</td>
<td>27/32</td>
<td>2 1/4</td>
<td>2 3/16</td>
<td>11 3/32</td>
</tr>
<tr>
<td>1 1/2</td>
<td>2 3/8</td>
<td>15/16</td>
<td>2 1/4</td>
<td>2 3/8</td>
<td>1 15/32</td>
</tr>
</tbody>
</table>

**Note:** All dimensions in inches

### Table 542.2.1:2
Bolt Hardness Requirements

<table>
<thead>
<tr>
<th>Bolt diameter</th>
<th>Brinnell Minimum</th>
<th>Brinnell Maximum</th>
<th>Rockwell C Minimum</th>
<th>Rockwell C Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 in–1 in</td>
<td>248</td>
<td>311</td>
<td>24</td>
<td>33</td>
</tr>
</tbody>
</table>

Use Table 542.2.1:3, “Bolt Lengths,” to determine bolt lengths by adding the values shown to the grip. Grip is the total thickness of all connected material, exclusive of washers.

### Table 542.2.1:3
Bolt Lengths

<table>
<thead>
<tr>
<th>Bolt size</th>
<th>Length to be added to grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1 1/16</td>
</tr>
<tr>
<td>5/8</td>
<td>1 3/16</td>
</tr>
<tr>
<td>3/4</td>
<td>1 3/8</td>
</tr>
<tr>
<td>7/8</td>
<td>1 9/16</td>
</tr>
<tr>
<td>1</td>
<td>1 3/4</td>
</tr>
<tr>
<td>1 1/8</td>
<td>1 7/8</td>
</tr>
<tr>
<td>1 1/4</td>
<td>2</td>
</tr>
<tr>
<td>1 3/8</td>
<td>2 1/8</td>
</tr>
<tr>
<td>1 1/2</td>
<td>2 1/4</td>
</tr>
</tbody>
</table>

**Note:** All dimensions in inches

These values are based on using one hardened flat washer and one direct tension indicator.

When using beveled washers, subtract the thickness of a flat washer and add 5/16 in for the beveled washer. Adjust the length in accordance with Table 542.2.1:3, “Bolt Lengths,” to the next longer 1/4 in.

### 542.2.2 Nuts

Provide nuts in accordance with AASHTO M 291 (ASTM A 563) with dimensions in accordance with ANSI B 18.2.2 and Table 542.2.1:1, “Dimensions of High-Strength Bolts.”

Ensure plain (ungalvanized) nuts are of grades 2, C, D, or C3 with a minimum Rockwell B hardness of 89 or Brinell hardness of 180, or heat-treated grades 2H, DH, or DH3.

Provide heat-treated galvanized nuts graded 2H, DH, or DH3.

Provide mechanically galvanized nuts in accordance with AASHTO M 298, Class 50.

Overtap nuts before galvanizing. Overtap so the nut will assemble freely on the coated bolt in accordance with AASHTO M 291 (ASTM A 563).

Lubricate galvanized nuts with a dyed lubricant of a color that contrasts with the galvanizing color.
Provide washers in accordance with AASHTO M 293 (ASTM F 436). Use flat circular hardened washers in accordance with Table 542.2.3:1, “Circular Washer Dimensions,” and Table 542.2.3:3, “Washer Tolerances.”

Use square or rectangular beveled washers that taper in thickness in accordance with Table 542.2.3:2, “Square or Rectangular Beveled Washers for American Standard Beams and Channels,” and Table 542.2.3:3, “Washer Tolerances.” Where necessary to provide a proper fit, clip washers on one side no closer than \( \frac{3}{8} \) of the bolt diameter from the center of the washer.

### Table 542.2.3:1
Circular Washer Dimensions

<table>
<thead>
<tr>
<th>Bolt size D</th>
<th>Nominal outside diameter</th>
<th>Nominal diameter of hole</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maximum</td>
</tr>
<tr>
<td>1/2</td>
<td>1 1/16</td>
<td>17/32</td>
<td>0.097</td>
</tr>
<tr>
<td>5/8</td>
<td>1 5/16</td>
<td>21/32</td>
<td>0.122</td>
</tr>
<tr>
<td>3/4</td>
<td>115/32</td>
<td>13/16</td>
<td>0.122</td>
</tr>
<tr>
<td>7/8</td>
<td>1 3/4</td>
<td>15/16</td>
<td>0.136</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>11/16</td>
<td>0.136</td>
</tr>
<tr>
<td>1 1/8</td>
<td>2 1/4</td>
<td>1 1/4</td>
<td>0.136</td>
</tr>
<tr>
<td>1 1/4</td>
<td>2 1/2</td>
<td>1 3/8</td>
<td>0.136</td>
</tr>
<tr>
<td>1 3/8</td>
<td>2 3/4</td>
<td>1 1/2</td>
<td>0.136</td>
</tr>
<tr>
<td>1 1/2</td>
<td>3</td>
<td>1 5/8</td>
<td>0.136</td>
</tr>
<tr>
<td>1 3/4</td>
<td>3 3/8</td>
<td>1 7/8</td>
<td>0.178³</td>
</tr>
<tr>
<td>2</td>
<td>3 3/4</td>
<td>2 1/8</td>
<td>0.178³</td>
</tr>
<tr>
<td>Over 2 to 4 incl.</td>
<td>2D-1/2</td>
<td>D+1/8</td>
<td>0.24⁴</td>
</tr>
</tbody>
</table>

Note: All dimensions in inches.

³ 3/16 inch nominal.

⁴ 1/4 inch nominal.

### Table 542.2.3:2
Square or Rectangular Beveled Washers for American Standard Beams and Channels

<table>
<thead>
<tr>
<th>Bolt size (in)</th>
<th>Minimum side dimension (in)</th>
<th>Mean thickness (in)</th>
<th>Slope or taper in thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1 3/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
<tr>
<td>5/8</td>
<td>1 3/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
<tr>
<td>3/4</td>
<td>1 3/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
<tr>
<td>7/8</td>
<td>1 3/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
<tr>
<td>1</td>
<td>1 3/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
<tr>
<td>1 1/8</td>
<td>2 1/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
<tr>
<td>1 1/4</td>
<td>2 1/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
<tr>
<td>1 3/8</td>
<td>2 1/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
<tr>
<td>1 1/2</td>
<td>2 1/4</td>
<td>5/16</td>
<td>1:6</td>
</tr>
</tbody>
</table>

Note: Hole tolerances are the same as for circular washers.
Table 542.2.3:3
Washer Tolerances

<table>
<thead>
<tr>
<th>Dimension</th>
<th>≤ 1 1/2 in nominal size, inclusive</th>
<th>&gt; 1 1/2 in nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal diameter of hole</td>
<td>-0, +1/32</td>
<td>-0, +1/16</td>
</tr>
<tr>
<td>Nominal outside dimensions</td>
<td>-1/32, +1/4</td>
<td>-1/32, +1/4</td>
</tr>
<tr>
<td>Flatness; maximum deviation from straightedge placed on &quot;cut&quot; side shall not exceed</td>
<td>0.01 in</td>
<td>0.015 in</td>
</tr>
<tr>
<td>Burr shall not project above immediately adjacent washer face more than</td>
<td>0.01 in</td>
<td>0.015 in</td>
</tr>
</tbody>
</table>

542.2.4 Direct Tension Indicators

Use direct tension indicators in accordance with ASTM F 959.
Provide test reports for each production lot of a shipment in accordance with ASTM F 959, paragraph 15.2.

Table 542.2.4:1
Dimensions of Direct Tension Indicators, Type A 325

<table>
<thead>
<tr>
<th>Bolt size (in)</th>
<th>Outside diameter (in)</th>
<th>No. of protrusions (equally spaced)</th>
<th>Thickness (in) Without protrusions, minimum</th>
<th>Thickness (in) With protrusions, maximum</th>
<th>Inside diameter (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1.167</td>
<td>4</td>
<td>0.104</td>
<td>0.180</td>
<td>0.523</td>
</tr>
<tr>
<td>5/8</td>
<td>1.355</td>
<td>4</td>
<td>0.126</td>
<td>0.220</td>
<td>0.654</td>
</tr>
<tr>
<td>3/4</td>
<td>1.605</td>
<td>5</td>
<td>0.126</td>
<td>0.230</td>
<td>0.786</td>
</tr>
<tr>
<td>7/8</td>
<td>1.855</td>
<td>5</td>
<td>0.142</td>
<td>0.240</td>
<td>0.917</td>
</tr>
<tr>
<td>1</td>
<td>1.980</td>
<td>6</td>
<td>0.158</td>
<td>0.270</td>
<td>1.048</td>
</tr>
<tr>
<td>1 1/8</td>
<td>2.230</td>
<td>6</td>
<td>0.158</td>
<td>0.270</td>
<td>1.179</td>
</tr>
<tr>
<td>1 1/4</td>
<td>2.480</td>
<td>7</td>
<td>0.158</td>
<td>0.270</td>
<td>1.311</td>
</tr>
<tr>
<td>1 3/8</td>
<td>2.730</td>
<td>7</td>
<td>0.158</td>
<td>0.270</td>
<td>1.442</td>
</tr>
<tr>
<td>1 1/2</td>
<td>2.980</td>
<td>8</td>
<td>0.158</td>
<td>0.270</td>
<td>1.573</td>
</tr>
</tbody>
</table>

542.2.5 Testing and Test Reports

542.2.5.1 Testing of Bolts

Conduct proof load tests in accordance with ASTM F 606, Method 1.
Conduct wedge tests on full size bolts in accordance with ASTM F 606, paragraph 3.5.
Perform tests on galvanized bolts after galvanizing.
Ensure that the minimum testing frequency is in accordance with AASHTO M 164, paragraph 9.5.1 (ASTM A 325). Measure zinc coating thickness on galvanized bolts on the wrench flats or bolt head tops.

542.2.5.2 Testing of Nuts

Proof load test in accordance with ASTM F 606, paragraph 4.2.
Ensure that the minimum testing frequency is in accordance with AASHTO M 291, paragraph 9.3 (ASTM A 563). Test galvanized nuts after overtapping, galvanizing, and lubricating.

542.2.5.3 Testing of Washers

Test galvanized washers for hardness after galvanizing. Remove the coating before conducting the hardness tests.

542.2.5.4 Testing of Assemblies

Provide the manufacturer’s or distributor’s rotational capacity test results on bolt, nut, and washer assemblies. Use washers in the test, even if washers are not used in the assembly on
Test each combination of bolt production lot, nut lot, and washer lot as an assembly. Unless required by the installation procedures, do not include washers in the lot identification. Assign a rotational capacity lot number to each lot combination tested. The minimum testing frequency is two assemblies per rotational capacity lot.

**542.2.5.4.1 Procedure for Rotational Capacity Tests for Long Bolts**

Test bolts long enough to test in a tension calibrator in accordance with the following procedures:

1. Mark the calibrator face plate with lines at vertical and at 1/3 (120°) and 2/3 (240°) of a turn, clockwise from vertical;
2. Use a calibrated torque wrench;
3. Use spacers with a hole size no larger than 1/16 in larger than the bolt to be tested;
4. Mount the bolt calibrator on a steel frame or section such as a flange or a cross frame.

4.1. Put the nut on the bolt. Measure from the end of the threaded shank to the underside of the bolt head when there are 3 to 4 full threads of the bolt between the bearing face of the nut and the bolt head;

4.2. Put the bolt in the tension calibrator and install the required number of shim plates and washers needed to produce the measurement from Step 4.1 (always install one washer under the nut);

4.3. Snug tighten the bolt with a hand wrench to the tension listed in Table 542.2.5.4.1.1, “Snug Tight Tension;” do not exceed two kips more than that value.

<table>
<thead>
<tr>
<th>Bolt diameter (in)</th>
<th>Installation tension, minimum (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1</td>
</tr>
<tr>
<td>5/8</td>
<td>2</td>
</tr>
<tr>
<td>3/4</td>
<td>3</td>
</tr>
<tr>
<td>7/8</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>1 1/8</td>
<td>6</td>
</tr>
<tr>
<td>1 1/4</td>
<td>7</td>
</tr>
<tr>
<td>1 3/8</td>
<td>9</td>
</tr>
<tr>
<td>1 1/2</td>
<td>10</td>
</tr>
</tbody>
</table>

4.4. Match mark the nut to the vertical line on the bolt calibrator faceplate;

4.5. Using the calibrated manual torque wrench, tighten the bolt to at least the tension listed in Table 542.2.5.4.1.2, “Installation Tension.” Measure and record the torque and the tension generated simultaneously with that torque. Measure torque with the nut in motion;

<table>
<thead>
<tr>
<th>Bolt diameter (in)</th>
<th>Snug tension, minimum (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>12</td>
</tr>
<tr>
<td>5/8</td>
<td>19</td>
</tr>
<tr>
<td>3/4</td>
<td>28</td>
</tr>
<tr>
<td>7/8</td>
<td>39</td>
</tr>
<tr>
<td>1</td>
<td>51</td>
</tr>
<tr>
<td>1 1/8</td>
<td>56</td>
</tr>
<tr>
<td>1 1/4</td>
<td>71</td>
</tr>
<tr>
<td>1 3/8</td>
<td>85</td>
</tr>
<tr>
<td>1 1/2</td>
<td>103</td>
</tr>
</tbody>
</table>

4.6. Calculate the torque in accordance with the following equation:

---

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where

\[ V = \frac{T \times d}{4} \]  

(1)

\( V \) is the calculated torque value
\( T \) is the measured tension in pounds
\( d \) is the bolt diameter in feet

Record the calculated value. The measured torque values must equal or be less than the calculated torque. Assemblies with measured torque values exceeding this calculated value fail the test.

4.7. For assemblies passing Step 4.6, further tighten the bolt to the rotation listed in Table 542.2.5.4.1.3, “Required Rotation.” Measure the rotation from the vertical line to the initial match marking in Step 4.4. Record the bolt tension.

**Table 542.2.5.4.1.3**

<table>
<thead>
<tr>
<th>Bolt length (L) measured in step 1</th>
<th>Required rotation (turns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( L \leq 4d )</td>
<td>2/3</td>
</tr>
<tr>
<td>( 4d &lt; L \leq 8d )</td>
<td>1</td>
</tr>
<tr>
<td>( L &gt; 8d )</td>
<td>1 1/3</td>
</tr>
</tbody>
</table>

Note: \( d \) = bolt diameter.

Assemblies that fail before completing the required rotation by stripping or fracture fail the test.

Bolt tension measured at the required rotation must equal or exceed the values in Table 542.2.5.4.1.4, “Minimum Tension Requirements.” Assemblies that do not meet this tension fail.

**Table 542.2.5.4.1.4**

<table>
<thead>
<tr>
<th>Bolt diameter (in)</th>
<th>Tension, minimum (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>14</td>
</tr>
<tr>
<td>5/8</td>
<td>22</td>
</tr>
<tr>
<td>3/4</td>
<td>32</td>
</tr>
<tr>
<td>7/8</td>
<td>45</td>
</tr>
<tr>
<td>1</td>
<td>59</td>
</tr>
<tr>
<td>1 1/8</td>
<td>64</td>
</tr>
<tr>
<td>1 1/4</td>
<td>82</td>
</tr>
<tr>
<td>1 3/8</td>
<td>98</td>
</tr>
<tr>
<td>1 1/2</td>
<td>118</td>
</tr>
</tbody>
</table>

4.8. Loosen and remove nut and examine the threads on the nut and bolt. Assemblies showing evidence of thread shear failure, stripping, or torsion failure fail.

**542.2.5.4.2 Procedure for Rotational Capacity Test for Short Bolts**

Test bolts that are too short for a tension calibrator in accordance with these procedures:

Equipment requirements:
1. A calibrated torque wrench and a spud wrench;
2. Spacers with a hole size no larger than 1/16 in greater than the tested bolt;
3. A steel section with a normal size hole to install bolt. Any available splice hole with plate thicknesses that will provide the number of threads under the nut required in Step 3.1 of the following procedures is acceptable.

The procedure is as follows:

3.1 Mark the steel section with lines at vertical and at 1/3 (120°) and 2/3 (240°) of a turn, clockwise from vertical;
3.2 Put the nut on the bolt. Measure the bolt length and the distance from the end of the threaded shank to the underside of the bolt head when there are three to five full threads of the bolt between the bearing face of the nut and the bolt head.
3.3. Put the bolt in the hole and install the required number of shim plates to produce the thread stick-out measured in Step 3.1. Always install one washer under the nut.

3.4. Snug using a hand wrench. Do not exceed 20% of the torque determined in Step 3.6 of this procedure.

3.5. Match mark the nut to the vertical line on the steel section.

3.6. Tighten the bolt using the torque wrench by turning the nut to the rotation listed in Table 542.2.5.4.2:1, “Initial Required Rotation.” Use a second wrench to prevent bolt head rotation during tightening. Record the torque required to reach this rotation. Measure torque with the nut in motion.

<table>
<thead>
<tr>
<th>Table 542.2.5.4.2:1</th>
<th>Initial Required Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt length (L)</td>
<td>Required rotation (turns)</td>
</tr>
<tr>
<td>measured in Step 3.2</td>
<td></td>
</tr>
<tr>
<td>L ≤ 4d</td>
<td>1/3</td>
</tr>
<tr>
<td>4d &lt; L ≤ 8d</td>
<td>1/2</td>
</tr>
<tr>
<td>L &gt; 8d</td>
<td>2/3</td>
</tr>
</tbody>
</table>

Note: d = bolt diameter.

Assemblies that exceed the torque values listed in Table 542.2.5.4.2:2, “Torque Requirements,” fail.

<table>
<thead>
<tr>
<th>Table 542.2.5.4.2:2</th>
<th>Torque Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt diameter (in)</td>
<td>Torque foot-pounds, maximum</td>
</tr>
<tr>
<td>1/2</td>
<td>150</td>
</tr>
<tr>
<td>5/8</td>
<td>290</td>
</tr>
<tr>
<td>3/4</td>
<td>500</td>
</tr>
<tr>
<td>7/8</td>
<td>820</td>
</tr>
<tr>
<td>1</td>
<td>1,230</td>
</tr>
<tr>
<td>1 1/8</td>
<td>1,500</td>
</tr>
<tr>
<td>1 1/4</td>
<td>2,140</td>
</tr>
<tr>
<td>1 3/8</td>
<td>2,810</td>
</tr>
<tr>
<td>1 1/2</td>
<td>3,690</td>
</tr>
</tbody>
</table>

3.7. For assemblies that pass Step 3.5, further tighten the bolt to the rotation required in Table 542.2.5.4.2:3, “Final Rotation Requirements.” Measure the rotation from the vertical line to the initial match marking in Step 3.4.

<table>
<thead>
<tr>
<th>Table 542.2.5.4.2:3</th>
<th>Final Rotation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt length (L)</td>
<td>Required rotation (turns)</td>
</tr>
<tr>
<td>measured in step 1</td>
<td></td>
</tr>
<tr>
<td>L ≤ 4d</td>
<td>2/3</td>
</tr>
<tr>
<td>4d &lt; L ≤ 8d</td>
<td>1</td>
</tr>
<tr>
<td>L &gt; 8d</td>
<td>1 1/3</td>
</tr>
</tbody>
</table>

Note: d = bolt diameter.

3.8. Loosen and remove nut and examine the threads on the nut and the bolt. Assemblies showing evidence of thread shear failure, stripping, or torsional failure fail the test.

542.2.5.5 Reporting

Provide notarized manufacturer and distributor CTR and MTR for mill steel used to manufacture bolts, nuts and washers. Indicate the steel melting and manufacture location in the MTR.

Show test results, including zinc coating thicknesses, in the CTR. Show test performance locations and test dates in the CTR.
542.2.5.5.1 Manufacturer CTR
Provide CTRs from the bolt, nut, and washer manufacturers that include the following:
1. Lot numbers of each item tested;
2. Rotational capacity test results, rotational capacity lot numbers, and individual lot numbers of the items tested, if performed by the manufacturer;
3. Results of all other required tests; and
4. Locations where the bolt assembly components were manufactured.

542.2.5.5.2 Distributor CTR
Provide CTR from the bolt, nut and washer distributors that include:
1. Documentation required in Section 542.2.5.5.1, “Manufacturer CTR;”
2. Rotational capacity test results, rotational capacity lot number, and individual lot numbers of the items tested, if performed by the distributor;
3. A statement that the manufacturer’s CTR represents the same items.

542.2.5.6 Sampling and Testing by the Department
Before installation, the Project Manager will select two bolt, nut and hardened washer assemblies from each rotational capacity lot and at least three direct-tension indicators with accompanying bolts, nuts and hardened washers, for each diameter and grade of fastener for testing by the State Materials Bureau.

542.2.5.7 Shipping
Ship bolts, nuts, and washers from each rotational capacity lot in the same container. If there is only one production lot number for each size of nut, washer, and direct tension indicator, the Contractor may ship the nuts, washers, and direct tension indicators in separate containers.
Permanently mark each container with the rotational capacity lot number.

542.3 CONSTRUCTION REQUIREMENTS
The Contractor shall fabricate Materials it shall connect with high-strength bolts in accordance with Section 541, “Steel Structures.”
Blast clean steel faying surfaces in accordance with SSPC-SP 10.
Ensure that the bolted part surfaces adjacent to the bolt head and nut are parallel within the 3 degrees for parallel surface rolled steel members. Use beveled washers on surfaces with more than a 1:20 slope for proper seating. Use bolted parts that fit solidly together when assembled. Do not use gaskets or other flexible material.
Erect joints and splices with cylindrical erection pins and bolts in accordance with Section 541, “Steel Structures.” Use high-strength bolts instead of erection bolts if necessary. These can be left in place, provided they are not loosened and retightened.

542.3.1 Installation of Bolts
Ensure that bolt, nut, and washer combinations are from the same rotational capacity lot.

542.3.2 Lubrication
Ensure that black bolts are oily to the touch when delivered and installed.
Clean and relubricate weathered or rusted bolts and nuts before installation. Retest recleaned or relubricated bolt, nut, and washer assemblies.
Before installing galvanized nuts, inspect the nuts to ensure the threads are properly lubricated. If lubricant is not visible or if tensioning indicates that thread friction is too high, apply an approved lubricant to the remaining threads before installation.

542.3.3 Method of Installation
Install bolts in accordance with Figure 542.3.3:1, “Installation Details.” In general, use Method I. Use Method 2 and Method 3, as approved by the Department, where bolt entry, wrench clearances, or inspection procedures make Method I impossible.
Prevent the stationary element from turning.
For oversized or slotted holes, place additional hardened washers between the bolted Material and the fastener.
Wherever practical, place the nut where it is not visible from the Traveled Way. When one end of a bolted assembly is embedded in concrete, place the assembly so the nut end is
in the concrete.

When tightening connections involving several bolts, draw together plies of the steel by snugging the bolts before starting the tightening operations. On connections involving a large number of bolts or thick Materials, tighten the bolts to the point where the direct-tension indicators are partially compressed. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening before final tightening to deform the direct-tension indicators to the specified gap.

Ensure that the final gap between the bolt head and the direct-tension indicator is less than or equal to 0.015 in for Method I and less than or equal to 0.005 in for Method 2 or Method 3.

Ensure that the final gap between the bolt head and the direct-tension indicator is less than or equal to 0.015 in for Method I and less than or equal to 0.005 in for Method 2 or Method 3.

542.3.3 Inspection
The Department will visually inspect every bolt for gaps. The Department will also check at least 10% of the bolts, but not less than two bolts in each connection, using feeler gauges as described in the direct tension indicator manufacturer’s instructions and in ASTM F 959. If the inspections indicate improper installation, the Project Manager may reject the assemblies.

542.4 METHOD OF MEASUREMENT—Vacant

542.5 BASIS OF PAYMENT
The Department will pay for high strength bolts as a part of structural steel tonnage in accordance with Section 541, “Steel Structures.”
543.1 DESCRIPTION
This Work consists of providing and placing metal railing.

543.2 MATERIALS
543.2.1 Steel Railings
Unless otherwise shown in the Contract, provide railing in accordance with AASHTO M 183 or AASHTO M 270, Grade 36 English.
Provide square or rectangular tube steel in accordance with ASTM A 500, Grade B or ASTM A 501.
Provide black, seamless steel pipe in accordance with ASTM A 53. Hydrostatic testing is not required.

543.2.2 Bolts
543.2.2.1 Anchor Bolts
Provide anchor bolts in accordance with AASHTO M 164M (ASTM A 325M) or fabricate alternatively from AISI C-1144 or AISI C-1045 steel bar. Hot dip galvanized anchor bolts in accordance with AASHTO M 232 or mechanically galvanize in accordance with AASHTO M 298, Class 50.

543.2.2.2 Connection Bolts
Provide connection bolts, nuts and washers in accordance with Section 542, “High-Strength Bolts.” Do not use direct tension indicators.

543.2.3 Caulking Compound
Use a caulking that is a single component cold applied non-sagging compound with a silicone or a synthetic chemically curing type rubber base in accordance with Federal Specifications TT-S-001543 A or TT-S-230 C.

543.3 CONSTRUCTION REQUIREMENTS
Fabricate, weld, and erect railing in accordance with Section 541, “Steel Structures.”
For purposes of impact testing, the Department considers steel bridge railings and posts as main members.
Submit railing shop drawings and erection plans in accordance with Section 541.3.3, “Shop and Erection Drawings.”

543.3.1 Erection Tolerances
For a Bridge on a tangent, ensure the railing is visually straight. In general, ensure that the railing does not deviate more than 3/8 in within 20 horizontal feet.
For a Bridge on a curve, do not deviate more than 13/16 in from the curve within 20 horizontal feet.
Ensure the rail posts are plumb within 1/4 in over the full height.

543.3.2 Protective Coating
Coat the railing in accordance with Section 545, “Protective Coatings of Miscellaneous Structural Steel,” unless otherwise specified in the Contract.
When the Contract specifies railing to be galvanized, galvanize in accordance with AASHTO M 111.

543.3.3 Cutting Rail Posts
Bevel cut posts to compensate for Roadway grade, crown, and superelevation.
If the Roadway grade is less than or equal to 1%, fabricate rail posts perpendicular to the grade line, but bevel cut crown and superelevation where necessary.

543.3.4 Caulking Rail Post Base Plates
Before placing rail posts into position on a bridge deck, apply a full circle bead of caulking compound on the deck surface around each of the anchor bolts. After erecting and coating the bridge railing, apply a bead of caulking compound around the perimeter of each rail-post base plate. Clean the deck surface and the surface of the rail-post anchor plates before applying the caulking compound.
543.4 METHOD OF MEASUREMENT
The Department will measure in place metal railing from end to end.

543.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Railing</td>
<td>Foot</td>
</tr>
</tbody>
</table>

541.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:
A. Submittals; nondestructive testing; protective coatings; and
B. Additional weight of heavier sections provided solely for the Contractor's convenience;
C. All incidentals necessary for the completion of the work.
SECTION 544: PROTECTIVE COATING OF NEW STRUCTURAL STEEL

544.1 DESCRIPTION
This Work consists of applying steel coating Materials. Refer to Section 545, “Protective Coating of Miscellaneous Structural Steel” for powder coating.

544.2 MATERIALS

544.2.1 Coating System
Select a complete system from the Department’s Approved Products List.
If the Contract does not specify a color, use a light gray or aluminum color.

544.2.2 Submittals
Provide a submittal for the proposed coating option and manufacturer to the Project Manager at least 30 Days before coating operations. If the color varies from the specified color, the Contractor may submit color samples on boards at least 8 in by 10 in for review and approval.
At least 30 Days before coating, submit one pint sample of each batch of coating Material to the Department for testing and approval. Provide a copy of the MSDS for each coating Material with the samples. Show the Material identification number, batch number, name and number of the project and date of manufacture on the samples and on the coating containers.
The Department may take random coating Materials samples during the Work.

544.2.2.1 Certification
After the Department approves the coating Material, submit notarized manufacturer’s Certificates of Compliance stating that the Materials are the same as those described in the Department’s Approved Products List and the manufacturer’s product data sheets. Submit two notarized Certificates of Compliance to the Department.

544.2.2.2 Product Data Sheets
Provide manufacturer’s product data sheets and MSDS with each Material Certificate of Compliance that shows the following:
1. Mixing and thinning directions;
2. Recommended spray nozzles and pressures;
3. Minimum drying time for shop or field applied coats; and
4. Manufacturer recommended application procedures.

544.2.3 Zinc Coatings
Mechanically galvanize position dowels and anchor bolts in accordance with AASHTO M 298, Class 50 or hot-dip galvanize in accordance with AASHTO M 232. Galvanize bearing parts not welded to structural members in accordance with AASHTO M 111. Blast clean fabricated bearing components before galvanizing.
After steel erection, coat galvanized hardware with an epoxy topcoat and a protective coat.

544.3 CONSTRUCTION REQUIREMENTS
During the coating operations, protect Structures from blast cleaning operations, paint splatter, splashes and smirches with protective covering or other methods approved by the Project Manager.
When the protective devices or procedures are ineffective, the Project Manager may suspend the Work until corrections take place.
Remove blasting and coating debris before reopening the area to traffic.

544.3.1 Surface Preparation for Priming
Remove oil, grease, and other contaminants with methods specified in SSPC-SP 1, or other Department-approved methods. Blast-clean the surfaces, in preparation for coating, in accordance with SSPC-SP 10.
Ensure to clean corners, pockets, re-entrant angles, splice plates and bolted or riveted connection plates.
Remove fins, tears, slivers, and burred or sharp edges found during the blast cleaning operation. Grind and re-blast the area to achieve a 1 mil to 2 mil surface profile.
Use only scaling hammers to remove heavy scale. Do not use chipping hammers that
Use blast-cleaning abrasives such as dry sand, steel shot, mineral grit, or manufactured grit. Ensure that the abrasives produce a uniform profile of from 1 mil to 2 mil with an angular pattern as measured with testex replica tape.

Remove abrasive and paint residue from steel surfaces with vacuum cleaner equipped with a brush-type cleaning tool or by double blowing. When using the double-blowing method, vacuum the top surfaces of Structural Steel after completing the double-blowing operations.

Keep the steel dust free and prime within 8 h after blast cleaning.

Use a wire brush on blast damaged or rusted surfaces and re-blast in accordance with SSPC-SP 10.

544.3.2 Coating Preparation

544.3.2.1 Mixing Coatings

Mix coatings using a high shear mixer. Do not use paddle mixers or paint shakers. Mix the coatings, as much as possible, in the original containers.

Strain coatings through a No. 50 sieve in accordance with AASHTO M 92.

Agitate mixed primers continuously from straining to application.

544.3.2.2 Thinning Coatings

Do not thin the coating Material without Department approval.

544.3.3 Temperature and Weather Limitations

Apply the coating when the air and surface temperatures are above 50 °F and at least 5 °F above the dew point.

Apply the coatings when the relative humidity is 90% or lower.

Apply inorganic zinc primers when the relative humidity is 40% or higher, unless otherwise specified by the coating manufacturer.

544.3.4 Coating Applications

Do not apply coatings until the Department approves the surface preparation. The Department may waive this approval.

Have a coating manufacturer representative present to provide technical assistance at the start of each coating operation.

Apply the more stringent requirements between those of the coating manufacturer and those in this specification.

Vacuum the steel after priming or top coating, before applying subsequent coats. Scrub with a mild detergent solution and rinse with water before applying the coating, if any of the following conditions exist:

1. Vacuuming is ineffective;
2. More than three weeks have elapsed since priming the steel; or
3. The surface is unfit for further coating.

If more than 120 Days pass between coats, completely blast clean the surfaces in accordance with SSPC-SP 10 before coating, at no additional cost to the Department.

544.3.4.1 Required Coatings

Coat new Structural Steel components with a zinc rich primer, an epoxy topcoat, and a urethane protective coat.

Apply a urethane protective coat on the following:

1. Surfaces exposed to sunlight;
2. The bottom and outside surfaces of fascia girders including the bottom of the outside top flange;
3. The outside surface of the web;
4. The top of the outside bottom flange;
5. The outside edge of the bottom flange;
6. The bottom of the bottom flange; and
7. Exterior stiffeners.

Coat bridge railings in accordance with Section 545, “Protective Coating of Miscellaneous Structural Steel.”

544.3.4.2 Coating Options

Use one of the following coating options:
1. Apply the primer, topcoat, and protective coat in the shop; or
2. Apply the prime coat in the shop and the topcoat and the protective coat in the field.

544.3.4.3 Spray Equipment
Apply coatings with spray nozzles at pressures recommended by the coating system manufacturer.
Use conventional or airless spray systems to apply the coatings. When applying field coating of bolted connections, use conventional spray equipment.

544.3.4.4 Film Thickness Requirements
The Department will reject the coating if the take off or banana gauge shows less than the specified minimum thickness for any coating. Provide coating thicknesses in accordance with Table 544.3.4.4:1, “Required Film Thicknesses.”

Table 544.3.4.4:1
Required Film Thicknesses

<table>
<thead>
<tr>
<th>Coating</th>
<th>Dry film thickness range (mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer</td>
<td>2.5–4.5</td>
</tr>
<tr>
<td>Topcoat</td>
<td>3.5–6</td>
</tr>
<tr>
<td>Urethane protective coat</td>
<td>1.5 minimum</td>
</tr>
</tbody>
</table>

Determine the dry film thickness using magnetic film thickness gauges. Calibrate the gauges on blasted steel with plastic shims approximately the same thickness as the minimum dry film thickness.

The Contractor may use a takeoff film thickness gauge to verify coating thickness with the Department’s approval.

544.3.4.5 Primer Application
Do not apply primers over blasted steel that has begun to rust or bloom. Apply primer in a smooth, wet, continuous film.
Adjust the spray Equipment to apply an even wet coat with minimal overspray. Hold the spray gun at right angles to the surface, making even, parallel passes with about a 50% overlap. Apply the primer in two or more wet coats avoiding heavy coats.
Remove dry overspray with light sanding. Pre-spray edges, welds, bends, and other areas that will likely fail to meet the minimum thickness.
Repair deficiently primed areas in accordance with the manufacturer’s recommendations and as directed by the Inspector.
Prime coat Structural Steel surfaces, except as noted in Section 544.3.4.6, “Bolted and Welded Connections.”
Give steel Bridge sole plates one coat of zinc rich primer. Mask-off strips where sole plates will be welded to beam flanges and surfaces that will be in contact with elastomeric bearing pads. After welding, apply a primer touch-up to the welded areas.

544.3.4.6 Bolted and Welded Connections
Blast clean faying (contact) surfaces in accordance with SSPC-SP 10, and leave uncoated for bolting.
Make uncoated areas slightly larger than the contact areas to ensure that the bolted connections clamp down only on the blast-cleaned Material and not on painted surfaces.
Mask off faying areas to protect them from rust during hauling and storage. Apply a rust prohibitor to the faying surfaces or coat the faying areas with a Class B primer (slip coefficient equal to or greater than 0.50). The Department will approve the rust prohibitor or Class B primer. Before bolting, remove the rust prohibitor. Do not remove Class B primers before bolting, unless required.
Immediately before bolting, ensure the exposed connection areas are in accordance with SSPC-SP 10. Apply the complete coating system to these surfaces after erection.
Mask-off coating systems at connections to leave neat lines between the connections and previously coated areas.
After blast cleaning, mask-off field weld areas before applying the primer and topcoats. After field welding, clean the welded areas in accordance with SSPC-SP 10 and apply the coating system.
Apply the topcoats on bolted field connections after placing the deck.
544.3.4.7 Topcoat Application

After cleaning and before applying the coating system, mask opposite sides of the diaphragms and stiffeners over areas that the direct tension indicators will bear on. Do not coat these areas until after erection and bolt tightening.

Before applying the topcoat, tie coat the galvanized components using manufacturer’s recommended tie coat Material. Apply with a brush.

The Project Manager will inspect the primed surfaces before the Contractor applies the topcoat.

Do not apply the topcoat to the following Structural Steel surfaces:
1. Faying surfaces of bolted connections (Section 544.3.4.6, “Bolted and Welded Connections”);
2. The top flange top surfaces of beams, girders or diaphragms to be embedded in concrete;
3. Bearing surfaces resting on concrete Substructures or are subject to sliding and rotational movement; and
4. Bearing surfaces in contact with elastomeric bearing pads.

Spray the topcoat with multiple spray gun passes. Apply a mist coat on the primer. Pre-spray edges, welds, bends, and other areas likely to be under the minimum thickness requirements.

Apply full wet cross coats, separated by a few minutes if necessary, to achieve the desired film build with minimal surface bubbling.

On weld seams, bolt heads, and flange joints it may be necessary to brush thinned-out Material to avoid bridging and to fill cracks and crevasses.

544.3.4.8 Urethane Protective Coat Application

Apply the urethane protective coat after the topcoat has cured. Apply urethane protective coat in accordance with Section 544.3.4.1, “Required Coatings.”

544.3.5 Handling Steel

Protect uncoated faying surfaces to minimize corrosion during shipping and storage.

Store Structural Steel on pallets so it does not rest on dirt. Store beams and girders in an upright (as erected) position.

Use softeners to insulate steel from chains. Pad hooks and stings for hoisting steel. Space parts during shipment so that no rubbing occurs.

Use rubber rollers, soft support pads, or other protective devices on Equipment support members or fasteners resting on or attached to newly coated surfaces.

544.3.6 Inspection

Notify the Department at least 7 Days before coating to allow adequate time to plan inspection activities.

After completing erection, the Project Manager will inspect the surfaces to be embedded in concrete. Repair damaged or rusted surfaces before placing decks.

After placing the deck and at an agreed upon time, the Project Manager will inspect the entire steel Structure for coating system damage.

The Project Manager will mark damaged areas for repair and will re-inspect after repairs are complete.

544.3.7 Final Operations

544.3.7.1 Final Cleaning

Clean the steel Structure, bearings, and bridge seat tops after completing coating activities.

544.3.7.2 Stenciling

At the completion of coating operations, stencil in 4 in high black letters on the inside of the fascia girders at two locations designated by the Project Manager:

1. The completion month and year;
2. The term “Section 544;” and
3. The coating manufacturer.

Make the markings with the same material used for the urethane protective coats.

Example: “6/93-Section 544, Excel Coatings”
544.5 BASIS OF PAYMENT

The Department will pay for the coating system as incidental to Structural Steel, in accordance with Section 541, "Steel Structures."
SECTION 545: PROTECTIVE COATING OF MISCELLANEOUS STRUCTURAL STEEL

545.1 DESCRIPTION
This Work consists of coating new steel bridge railing and miscellaneous Structural Steel items.

545.1.1 Coating Options
Apply the primer and topcoat in the shop.

545.1.2 Terminology and Standards
Use terminology in accordance with the definitions in Volume 2, Systems and Specifications of SSPC’s Steel Structures Painting Manual. Use the SSPC-SP designation when referring to Standards specified in The Society for Protective Coatings Specifications (SSPC-SP).

545.2 MATERIALS

545.2.1 Coating System
Obtain primer and topcoat from one manufacturer. Select a coating system from the Department’s Approved Products List.
Use aluminum or light gray for the topcoat color, unless otherwise specified in the Contract.

545.2.2 Submittals, Certification, and Sampling
See Section 544.2.2, “Submittals,” Section 544.2.2.1, “Certification,” and Section 544.2.2.2, “Product Data Sheets.”

545.2.3 Zinc Coatings
Mechanically galvanize position dowels and anchor bolts for bridge railing and bearings in accordance with AASHTO M 298, Class 50, or hot-dip galvanize these items in accordance with AASHTO M 232. Galvanize the portions of bearings not welded to structural members and parts requiring zinc coats in accordance with AASHTO M 111.

545.2.4 Powder Coatings
Obtain primer and topcoat from one manufacturer. Select a coating system from the Department’s Approved Products List.
Use light gray for the topcoat color, unless otherwise specified in the Contract.

545.2.4.1 Primer
Use a primer that is zinc rich and a specially formulated thermoset epoxy powder coating designed for use over ferrous metal substrates, Corvel Zinc Rich Gray 13-7004 or and approved equal.

545.2.4.2 Topcoat
Use a topcoat that is a polyester powder coating designed to provide for maximum UV exposure protection, Corvel TGIC Polyester, ANSI 70 Gray, or and approved equal.

545.2.4.3 Submittals, Certification, and Sampling
See Section 544.2.2, “Submittals,” Section 544.2.2.1, “Certification,” and Section 544.2.2.2, “Product Data Sheets.”

545.3 CONSTRUCTION REQUIREMENTS

545.3.1 Surface Preparation
Remove contaminants in accordance with SSPC-SP I, or other methods approved by the Project Manager.
Blast clean in accordance with SSPC-SP 6, Commercial Blast Cleaning.
Remove cleaning residue from steel surfaces with a commercial grade vacuum cleaner or by double blowing. When double blowing, vacuum the top surfaces of Structural Steel after finishing.
Ensure the interiors of rail tubes are free of blasting debris.
Maintain the steel dust free and primed for 8 h after blast cleaning.
Re-clean rusted or contaminated surfaces at no additional cost to the Department.
Mask areas that require field welding before coating. After priming the steel, clean again before applying the topcoat.

545.3.2 Mixing the Coating
Mix the coating with a high shear mixer to a smooth and lump-free consistency, in accordance with the coating manufacturer’s specifications.
Mix the coating as much as possible in the original containers and continue mixing until the metallic powder or pigment is in suspension. Keep mixed primers continuously agitated before and during application.

545.3.3 Thinning the Coating
Do not thin the coatings without the approval of the Project Manager. If it is necessary to thin the coatings, thin the Material in accordance with the manufacturer’s recommendations.

545.3.4 Temperature and Weather Limitations
Only apply the coatings when the ambient air temperature and surface temperature of the steel are both above 50 °F and at least 5 °F above the dew point.
Do not apply the coatings when there is condensation or frost on the metal surfaces.
Do not apply the coatings when the relative humidity is higher than 90 percent.

545.3.5 Coating Applications
Do not apply coating until the Department approves the surface preparation. The Department may waive this inspection.
Pre-spray areas that are likely to not achieve the minimum coating thickness when the larger areas are sprayed.
Repair coated areas where the primer or topcoat runs, sags or cracks.
Do not apply the topcoat until the primer has fully cured.
Allow the manufacturer’s minimum recommended cure time to lapse between coats. If more than 30 Days elapse between the primer application and the topcoat application, contact the coating system manufacturer for surface preparation recommendations before applying the topcoat.
Apply the more stringent requirements between those of the coating manufacturer and those in this specification.
The Department may accept minor cosmetic defects in ground level miscellaneous Structural Steel components not in public view, if the defects will not affect durability.

545.3.5.1 Required Coating of Components
Apply the primer and topcoat to steel surfaces, except those that will contact elastomeric bearing pads or are subject to sliding and rotational movements.
Coat new steel piling from the bottoms of the pier caps to 2 ft below the finished grade or streambed elevations.

545.3.5.1.1 Coating of Sole Plates for Concrete Bridges
Deliver sole plates to the Project with one coat of primer applied to all surfaces except masked-off strips, where the sole plates will be welded to the shoe plates, and surfaces that will contact elastomeric bearing pads.
Before installation, clean surfaces that will contact pads in accordance with SSPC-SP 6.
After installing the pads and welding the sole plates to the shoe plates, touch up the primer and apply topcoat to exposed surfaces.

545.3.5.1.2 Coating of Galvanized Components
Apply tie coats to galvanized components in accordance with the coating manufacturer’s recommendations. Brush the tie coats if necessary.
After erecting the steel, topcoat the galvanized hardware.

545.3.5.2 Spray Equipment
Apply the coatings with spray nozzles at the manufacturer-recommended pressures.

545.3.5.3 Film Thickness Requirements
Apply coatings in accordance with Table 545.3.5.3:1, “Required FilmThicknesses.”
Table 545.3.5.3.1: Required Film Thicknesses

<table>
<thead>
<tr>
<th>Coating</th>
<th>Dry film thickness range (mils)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer</td>
<td>2–4</td>
</tr>
<tr>
<td>Topcoat</td>
<td>3–6</td>
</tr>
</tbody>
</table>

Use a magnetic film thickness gage or an electronic film thickness detector to determine dry film thickness.

545.3.6 Coating of Powder Coated Components
Prepare the surfaces in accordance with Section 545.3.1, “Surface Preparation” and additionally an iron or zinc phosphate wash shall be included to provide long-term corrosion protection.

545.3.6.1 Primer Application
Apply the zinc rich epoxy primer to a minimum of 2 mils dry film thickness and leave in the oven long enough for the powder to melt, flow out and gel, but not to cure.

545.3.6.2 Topcoat Application
Apply the polyester topcoat to a minimum of 3 mils dry film thickness before the primer has cured.

545.3.6.3 Fixturing
Suspend the Materials by suitable metal hooks or fixtures to provide a sufficient electrical grounding path for the Materials. Affix the Materials with a minimum of direct contact area with the fixture device.

545.3.6.4 Curing
Place the powder-coated Material in a suitable oven and cure per the manufacturer’s recommended cure cycle. Remove the Material from the oven and allow to cool. Visually inspect the Material to ensure a smooth continuous uniform finish free from runs, sags, or defects.

545.3.6.5 Touch-up Painting
Touch-up areas of the Material that were not powder coated with a liquid paint, using a brush or aerosol of the same color as the original powder coating. Touch-up epoxy powder coating with an epoxy liquid paint meeting Military Specification MIL-C-22750. Touch-up polyester powder coating with a urethane liquid paint meeting Military Specification MIL-C-85285.

545.3.7 Handling Steel
Handle or load newly coated Structural Steel only with a cured coating. Store on pallets or in other approved ways so that the steel does not rest on dirt. Insulate steel from binding chains with approved softeners. Hoist with padded hooks and slings. Space parts during shipment to ensure that no rubbing occurs.

545.3.8 Provisions for Inspection
Notify the Project Manager at least 3 Working Days before coating, to allow time to plan an inspection.

545.3.9 Field Repair
Field repair coated areas that are rusted or damaged. Clean the surface with methods approved by the Project Manager. Blast clean large areas in accordance with SSPC-SP 6. Use power tools with abrasive disks to clean small areas. Apply both coats on areas that rusted or experienced full-thickness damage. Prime large areas using spray Equipment, brush, or roller. Prime small areas with a brush. Spray or brush the topcoat.

Two or more coats may be necessary to build up the required film thickness. Apply topcoat only to areas where the topcoat is damaged.
545.3.10 Protection of the Work and Public
   Protect Structures during coating operations with a protective covering or with other methods approved by the Project Manager.

545.4 METHOD OF MEASUREMENT—Vacant

545.5 BASIS OF PAYMENT
   The Department will pay for the coating system as incidental to Structural Steel, in accordance with Section 541, “Steel Structures.”
546.1 DESCRIPTION
This Work consists of cleaning and recoating exposed Structural Steel.

546.2 MATERIALS
546.2.1 Coating System
Provide a coat system from a single manufacturer. Select an approved system from the Department’s Approved Products List. Use aluminum or light gray as the topcoat color, unless otherwise specified in the Contract. If another color is specified in the Contract, select an approved system that is also available in the specified color.

546.2.2 Submittals and Certification
Notify the Department of the chosen coating system at least 30 Days before coating. Include color samples on 8 in by 10 in panels in this notification. Submit notarized Certificates of Compliance from the coating manufacturer verifying the Materials described in the Department’s Approved Products List and the manufacturer’s data sheets. Submit one notarized Certificate of Compliance to the Project Manager and one to the State Bridge Engineer. Submit certificates on the Department’s form sheets.

546.2.2.1 Product Data Sheets
Manufacturer’s product data sheets and MSDS will accompany each Material Certificate of Compliance. The product data sheets will indicate the mixing and thinning directions, the recommended spray nozzles and pressures, and the minimum drying time.

546.2.2.2 Sampling
Submit a 1 qt sample of each coating Material to the State Materials Bureau at least 30 Days before coating. A copy of the MSDS will accompany each sample. The samples shall clearly identify the Material, batch number, project name and number, and manufacture date.

546.3 CONSTRUCTION REQUIREMENTS
546.3.1 Surface Preparation of Existing Bridges and Structures
546.3.1.1 Solvent (SSPC-SP 1) and Hand-Tool (SSPC-SP2) Cleaning
Clean exposed areas in accordance with SSPC-SP 1. The Project Manager may approve scrubbing with water and a mild detergent to supplement solvent cleaning. Clean small areas showing minor damage or deterioration with hand-tools in accordance with SSPC-SP 2 or with power-tools in accordance with SSPC-SP 3. Contain and remove cleaning debris.

546.3.1.2 Power-Tool Cleaning to Bare Metal (SSPC-SP 11)
Clean large corroded areas and areas that show moderate to severe corrosion in accordance with SSPC-SP 11. The Project Manager will mark additional areas for cleaning in accordance with SSPC-SP 11. Clean at least 2 in beyond the damaged areas in all directions. Feather the exposed edges of the cleaned areas in accordance with SSPC-SP 11. Do not leave ragged edges of intact paint. During and after power-tool cleaning, use a high-efficiency vacuum to remove the residue.

The Department will accept these surfaces by visually comparing them to a prepared standard on the project. Prepare a project standard by power-tool cleaning an area designated for recoating. Before cleaning, ensure that the prepared standard is in accordance with SSPC-Vis 3, Visual Standard for Power and Hand-Tool Cleaned Steel, Pictorial Standard E SP 11, F SP 11, and G SP 11, and obtain Department approval. Prepare at least one standard for each Structure. More than one standard may be necessary if the cleaned steel differs significantly from the photographic standards. For recoating Bridges, make the standard at least 1 ft × 1 ft. For recoating bridge railing or minor Structures, the standard may be smaller. Protect the project standard from corrosion and contamination by applying a clear polyurethane coat. Upon completing the cleaning work, re-clean and coat the standard. If the standard becomes deteriorated or ineffective, re-establish it at no additional cost to the...
546.3.1.3 Power-Tool (SSPC-SP 3) Cleaning
Remove poorly adhering topcoats. Roughen the primer surface with power-tools in accordance with SSPC-SP 3. The Department will accept results in accordance with SSPC-SP 7, Brush-Off Blast Cleaning.

Clean large areas of the Structure with a power-tool (SSPC-SP 3) to remove topcoats that adhere poorly, in accordance with the Plans, or as directed by the Project Manager. Ensure the final prepared surface is free of poorly adhering paint, oil, grease, dust, loose mill scale and loose rust. Tightly adhering paint, mill scale and rust may remain.

Use power-tools with attached vacuum systems capable of containing the resulting dust. Maintain airborne dusts and lead-containing residues below the OSHA action level.

546.3.2 Coating
546.3.2.1 Mixing the Coatings
Mix the coatings with a high-shear mixer in accordance with the coating manufacturer’s directions until the Material is smooth and lump-free. Do not use paddle mixers or paint shakers.

Mix the Material as far as possible in its original container and continue mixing until the metallic powder or pigment is in suspension.

Thoroughly disperse the coating solids that may have settled to the bottom of the container.

Continuously agitate mixed coatings until application.

546.3.2.2 Thinning the Coating
Do not thin the coatings without the approval of the Project Manager. If it is necessary to thin the coatings, thin the Material in accordance with the manufacturer’s recommendations.

546.3.2.3 Coating Application
Apply the primer and topcoat with a brush, roller, or by spraying (preferred). Use nozzles and pressures in accordance with the manufacturer’s recommendations. Pre-spray or pre-brush corners, edges, bolt and rivet heads and nuts to ensure adequate film thickness.

Perform coating in accordance with SSPC-PA 1.

546.3.2.4 Temperature and Weather Limitations
546.3.2.4.1 Temperature
Apply the coating when the air and surface temperatures are above 50 °F and at least 5 °F above the dew point.

Do not apply coatings on metal surfaces with condensation or frost.

546.3.2.4.2 Humidity
Do not apply the coatings when the relative humidity is above 90%. If the relative humidity is below 20%, follow the manufacturer’s coating directions to ensure proper curing.

546.3.2.5 Priming
Before priming, use a commercial grade vacuum equipped with a brush-type cleaning tool to remove Deleterious Material. Do not double blow.

The Department will approve areas cleaned in accordance with SSPC-SP 1, SSPC-SP 2, SSPC-SP 3, or SSPC-SP 11 before application of the primer or topcoat.

Prime coat cleaned areas in accordance with SSPC-SP 11 and SSPC-SP 3 Power-Tool Cleaning. Apply primer the same day as cleaning, unless otherwise authorized by the Project Manager. Re-clean surfaces that develop rust or are contaminated with Deleterious Material before coating, at no additional cost to the Department.

Remove primer sprayed over the existing paint by hand rubbing or other methods approved by the Project Manager.

546.3.3 Topcoat
Vacuum the surface before applying the topcoat. If vacuuming is ineffective or if in the Project Manager determines the surface is unfit for top coating, scrub with a mild detergent.
and rinse with water before top coating.  
Ensure the primer is cured and dry before applying the topcoat.  
Allow the manufacturer’s recommended maximum time to lapse between coats.

### 546.3.4 Thickness of Coatings
Refer to Table 546.3.4:1, “Required Film Thicknesses” for the required thicknesses of the coatings.

<table>
<thead>
<tr>
<th>Table 546.3.4:1</th>
<th>Required Film Thicknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating</td>
<td>Dry film thickness range (mils)</td>
</tr>
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</tr>
</tbody>
</table>

Determine dry film thicknesses with magnetic or electronic film thickness gauges.

### 546.3.5 Protection of the Work and Public
During surface preparation and coating operations, protect Structures with protective covering or other methods approved by the Project Manager. If the protective devices or procedures are ineffective, the Project Manager may suspend Work until corrections are complete.

### 546.3.6 Final Operations
Re-caulk railing post base plate perimeters with silicon or synthetic rubber caulking compounds in accordance with Federal Specifications TT-S-001543A or TT-S-230C.

### 546.4 METHOD OF MEASUREMENT
The Project Manager will measure cleaned areas in accordance with SSPC-SP 11 and SSPC-SP 3 before the application of the prime coat.

### 546.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recoating Structures</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>SP 11 Power Tool Cleaning and Priming</td>
<td>Square Foot</td>
</tr>
<tr>
<td>SP 3 Power Tool Cleaning and Priming</td>
<td>Square Foot</td>
</tr>
</tbody>
</table>

### 546.5.1 Work Included in Payment
The following items will be considered as included in the payment for Recoating Structures and will not be measured and paid for separately:

A. Cleaning all exposed areas of existing steel members in accordance with SSPC-SP 1 and SSPC-SP 2;
B. Pot priming of small areas cleaned by hand-tool or, at the option of the Contractor, power-tool methods;
C. SSPC-SP 11 power-tool cleaning and priming of those areas designated in the contract to be so included in the lump sum price;
D. SSPC-SP 3 power-tool cleaning and priming of those areas designated in the contract to be so included in the lump sum price;
E. Furnishing and applying the topcoat to all exposed steel surfaces of the structure;
F. Final cleanup of the structure and the immediate area; and
G. Recaulking the perimeters of all railing post base plates.
547.1 DESCRIPTION
This Work consists of providing safety and environmental precautions for paint removal and painting operations.

547.2 MATERIALS—Vacant

547.3 CONSTRUCTION REQUIREMENTS
547.3.1 General Safety and Protection Requirements
Follow the guidelines recommended in SSPC-PA Guide 3, A Guide to Safety in Paint Application. Comply with the following general requirements from 29 CFR Part 1926, the New Mexico Hazardous Waste Management Regulations 7 (HWMR7), and the SSPC-PA Guide 3. These general requirements include, but are not limited to the following:

1. Safety Nets (1926.105)—including safety nets beneath the immediate work areas that are more than 23 ft above the ground or water surfaces;
2. Life Lines (1926.951(b) and 1926.959);
3. Rigging (SSPC-PA Guide 3, Section 10);
4. Ladders and Scaffolding (1926.450 and 1926.451);
5. Guardrails, Handrails and Covers (1926.500);
6. Sanitation (1926.51, 1926.62 and 1910.141);
7. Medical Services and First Aid (1926.50);
8. Eye and Face Protection (1910.133 and 1926.102);
9. Noise Protection (1910.95);
10. Personal Protective Equipment (1926.62(g) and SSPC-PA Guide 3, section 11.3);
11. Tools, Equipment (1926.300, 1926.301, 1926.302, 1926.951, 1910.244);
12. Respirators (1910.134, 1926.62 and 1926.103);
13. Compressed Air (1926.803); and

547.3.1.1 Verification of Compliance
Comply with the requirements of 29 CFR 1926.62 and maintain records that verify compliance. Providing documentation to the Department does not relieve the Contractor of safety obligations. The Department will not assume responsibility for Contractor noncompliance.

To assist compliance verification, submit the following to the Project Manager:
1. A copy of the written compliance program, as required by 29 CFR 1926.62(e)(2), at least two weeks before beginning surface preparation;
2. A description of the exposure assessment process, including identification of monitoring methods and documentation establishing the accuracy of those methods;
3. A report on the results of the assessment program and summary of measures to protect the workers;
4. The name of the person who will make job site inspections, with documentation establishing that person’s competency;
5. Medical surveillance data on workers who will be exposed to lead levels above the action level. Include results of initial testing or such historical data that establishes the person’s suitability for the assigned task. Define the required schedule for additional testing. Also submit additional testing conducted during the duration of the operation that requires it;
6. A certification stating that the employee training required by 29 CFR 1926.62 was conducted. Submit the certification before commencement of paint removal and surface preparation operations and identify the trained workers. If additional workers are later assigned these tasks, submit certification for each additional worker before participation in the Work.

547.3.1.2 Provisions for Department Employees
Provide respirators, protective clothing and equipment, and medical surveillance required by 29 CFR 1926.62 for two Department employees to inspect the paint removal and surface preparation operations.
547.3.2 Environmental Requirements
Contain waste material generated from paint removal and surface preparation operations within the work area.

547.3.2.1 Waste Containment
Ensure that levels of air pollution and soil and water contamination resulting from surface preparations for coating in accordance with Section 107, “Legal Relations, Environmental Requirements and Responsibilities to the Public.”

Provide containment structures in accordance with SSPC Guide 6. Estimate debris containment efficiency by using the Weigh In / Weigh Out Method described in SSPC Guide 6, section 5.5.6.

547.3.2.2 Collection
Collect paint removal and surface preparation debris and remove it from the project in accordance with SSPC Guide 6.

547.3.2.3 Disposal
Dispose of paint removal and surface preparation debris in accordance with HWMR7 and SSPC Guide 7, which is the primary reference document for waste disposal. If there is a conflict between HWMR7 and SSPC Guide 7, HWMR7 takes precedence.

547.3.2.4 Air Quality and Soil Contamination
If required by the Contract, monitor air quality and soil conditions at representative locations before blast cleaning or preparing the surface in accordance with Section 5.5 of SSPC Guide 6. Use the results to determine background air quality and lead contamination in the soil surrounding the construction site during and after coating operations.

547.3.2.5 Submittals and Certification
At least 30 Days before beginning paint removal operations, submit a complete description of the methods to the Project Manager for compliance with the environmental requirements, including comprehensive plans for containment structures.

Submit a certificate to the Project Manager stating the material was disposed of in accordance with Section 547.3.2.3, “Disposal,” within 90 Days of removal. Upon request, provide the Project Manager with documentation verifying compliance. Include information on traceability, storage, sampling, testing, shipping, or treatment.

547.4 METHOD OF MEASUREMENT—Vacant

547.5 BASIS OF PAYMENT
Pay Item Pay Unit
Safety and Environmental Requirements Lump Sum

547.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: labor, tools, equipment, materials, loading, hauling, monitoring, testing, means for disposal of debris and other appurtenances necessary to comply with these safety and environmental requirements.
SECTION 550: TREATED TIMBER

550.1 DESCRIPTION
This Work consists of constructing timber Structures and the timber portions of composite Structures.

550.2 MATERIALS
550.2.1 Sawn Lumber and Timber
Meet grading rules and design values in accordance with Supplement to the National Design Specifications for Wood Construction.

550.2.2 Preservatives and Treatment Methods
Treat timber with preservatives in accordance with AASHTO M 133. Unless otherwise specified in the Contract, use pentachlorophenol, Type C preservative treatment in accordance with AWPA P8 and P9.

550.2.3 Fasteners
Provide bolts, nuts, and washers in accordance with ASTM A 307.
Provide bolts that have standard, square or hex heads, and coarse threads with Class 2 tolerances in accordance with ANSI’s Standard Specifications for Bolted Connections.
Provide washers that bear on timber surfaces in accordance with Table 550.2.3:1, “Washer Dimensions.”

<table>
<thead>
<tr>
<th>Bolt diameter</th>
<th>Hole diameter</th>
<th>Washer diameter</th>
<th>Washer thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>9/16</td>
<td>1 3/8</td>
<td>3/32</td>
</tr>
<tr>
<td>3/4</td>
<td>13/16</td>
<td>2</td>
<td>5/32</td>
</tr>
<tr>
<td>7/8</td>
<td>15/16</td>
<td>2 1/4</td>
<td>11/64</td>
</tr>
</tbody>
</table>

Provide shear plates and split ring connectors in accordance with the Contract. The Department will not accept connector plates with punched-through spikes or nailer plates.
Provide shear plates, split ring connectors, and accompanying washers made of pressed steel or malleable iron in accordance with AITC’s Timber Construction Manual.
Use nails cut from round wire of standard form. Use cut or wire spikes.
Use galvanized metal fasteners in accordance with AASHTO M 232. Tap galvanized nuts oversize after galvanizing in accordance with section 7.3 of AASHTO M 164M and section 7.4 of AASHTO M 291M.
Provide steel plates in accordance with AASHTO M 183; galvanize in accordance with AASHTO M 232 or M 111.

550.2.4 Timber and Lumber Certification
Provide timber and lumber certified by an American Lumber Standards Committee certified agency.

550.2.5 Preservative Treatment Certification
Provide a certificate from the treatment facility or an independent inspection agency containing the following:
1. Preservative type and composition;
2. Quantity retained in pounds per cubic foot (ASSAY Method);
3. Confirmation that specification requirements were met; and
4. Copies of inspection reports.

550.3 CONSTRUCTION REQUIREMENTS
550.3.1 Drawings and Written Procedures
Submit three sets of shop and erection drawings to the Department. The Department will return one set with notations.
Provide up to eight sets, as required, of corrected shop drawings for final approval.
Do not begin fabrication before receiving written approval.

Ensure the drawings contain a minimum of the following:
1. Complete details of the Structure timber components, including the following:
   1.1. Dimensions;
   1.2. Details;
   1.3. Cut, bevel, and notch locations;
   1.4. Hole sizes.
2. Hardware details and parts lists for items such as connector plates, shear plates, split-ring connectors, lag screws, bolts, nuts and washers, including protective coating requirements;
3. Timber grade and species;
4. Preservative treatment (type, composition and percent retention);
5. An erection diagram showing piece marks, locations, orientations and attachment methods for Structure components or pieces; and
6. Special instructions required regarding Structure fabrication or erection.

550.3.2 Fabrication
Cut and frame lumber and timber so that the joints have an even bearing over the entire contact surfaces.

Tag prefabricated members with erection marks for identification and reference them in the erection drawings.

Unless otherwise specified, fabricate as far ahead of treatment as possible.

550.3.2.1 Bolt Holes
Unless otherwise specified in the Contract, bore holes perpendicular to the faces of the members they penetrate.

Bore connection holes for one or two bolts at the same diameter as the finished bolt, except bolt holes which are part of a shear plate or split-ring assembly.

Bore holes 1/16 in larger than the bolt diameter for bolted connections using more than two bolts, and for bolt holes which are part of a shear plate or split-ring assembly.

Drill holes in connector plates 1/16 in larger than the bolt diameter.

550.3.2.2 Holes for Lag Screws
For lag screws, bore holes with a bit no larger than the minor diameter of the lag screw thread.

To prevent splitting or stripping the threads, bore shank holes in the side of the joint containing the thread to the same diameter and to the same depth as the shank. Ensure that holes for the shank in connected parts (wood or metal) are from 1/32 in to 1/16 in greater than the diameter of the shank.

Make the hole depths approximately 1 in less than the length under the head.

550.3.2.3 Recesses and Countersinking
Countersink when the Contract requires a smooth or flush surface. Treat recesses in treated timber, formed for shear plates, split-ring connectors or countersinking, in accordance with Section 550.3.3, "Preservative Treatment."

550.3.2.4 Stringers
Size stringers at bearings and place so that knots near edges are in the top portions of the stringers.

The Contractor may construct outside stringers butt joints with the ends dapped or cut on a taper. Unless otherwise specified in the Contract, overlap interior stringers at each end to take the bearing over the full floor beam or cap width.

550.3.2.5 Cross Bridging
Toenail wood cross bridging between stringers with at least two nails in each end. Ensure the cross bridging members have full bearing at each end against the stringer sides. Use metal cross bridging members in accordance with the Contract or as approved by the Department.

550.3.2.6 Trusses
Ensure the following:
1. Completed trusses show no line irregularities;
2. Chords are straight and true from end to end in horizontal projection; and
3. Chords show a smooth curve through panel points in vertical projection.
The Department will reject pieces with uneven or rough cuts at the bearing points.

550.3.2.7 Bolts and Washers
Install washers under bolt heads and nuts unless using a steel plate or strap in conjunction with shear plates. If necessary, use washers to extend the bolt length to prevent metal connection plates from bearing on the threaded portion of the bolt.

550.3.2.8 Nailing
Unless otherwise specified, drive nails and spikes perpendicular to the surface of the timber with just enough force to set the heads flush with the surface of the wood. The Department may reject surfaces with deep hammer marks, considered evidence of poor workmanship.

550.3.3 Preservative Treatment
Apply preservative treatment in accordance with AWPA C1 and C2.

550.3.3.1 Marking
Ensure that each piece of treated timber has a legible brand, mark, or tag indicating the treatment facility name and the specification symbol or specification requirements identifying the treatment used. Place the brands or marks so that they are not visible after the Structure is erected.

550.3.3.2 Inspection at the Treatment Plant
The Contractor is responsible for inspection of Materials and preservative treatment. Ensure that inspections are conducted in accordance with AASHTO M 133 (WPA Standards). The Department and the American Wood Preservers' Bureau must approve the inspection agencies.
The Department may conduct surveillance inspections at any time.

550.3.3.3 Inspection at the Job Site
The Department may retest the Materials after delivery to the project. The Department will accept timber within 5% of specified moisture content and preservative retention.

550.3.4 Handling
Handle treated timber with web slings. Do not use devices that mar wood surfaces, such as cant hooks, peaveys, and pikes.
If using metal bands to bundle members, provide corner protectors to prevent damage to the treated timber.

550.3.5 Storage of Material
Store lumber and timber on the project in orderly stacks. Stack Material on supports at least 12 in above the ground surface. Keep the ground in the vicinity of the timber cleared of weeds and rubbish. Do not allow water to collect under or near the stored timber.
If required by the Project Manager, provide protection from the weather with a covering.

550.3.6 Erection
Treat cuts, abrasions, and recesses that occur after treatment with two liberal applications of a compatible preservative in accordance with AWPA M4.
Treat holes bored after treatment by filling the holes with the preservative used for field treatment. Use preservative treated plugs to plug holes not permanently filled with bolts or screws.
Tighten bolts securely, but not enough to crush the wood beneath the plates or washers. The Department will reject members that will not assemble after application of reasonable amounts of force.

550.4 METHOD OF MEASUREMENT
550.4.1 Treated Timber
The Department will use standard nominal dimensions and actual member lengths, in
550.4.2 Metal Components
The Department will pay for metal components, exclusive of nails and spikes, in accordance with Section 541, “Steel Structures.”

550.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated Timber</td>
<td>Thousand Board Feet</td>
</tr>
</tbody>
</table>

550.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for treated timber and will not be measured or paid for separately:
A. Inspection costs;
B. Coating of timber structures; and
C. Nails and spikes.
560.1 DESCRIPTION
This Work consists of providing, assembling, and installing elastomeric bridge bearing pads.

560.2 MATERIALS
560.2.1 General
Provide bearing pad Material and testing in accordance with the Contract and AASHTO’s LRFD Bridge Construction Specification, Section 18. Provide plain or laminated bearing pads reinforced with steel or fabric laminates. Reinforce bearing pads over 9/16 in thick with laminates spaced no greater than 9/16 in apart through the entire thickness. Provide shim thicknesses not less than 10 gauge.

560.2.2 Certification
Provide manufacturer’s Material certification in accordance with AASHTO’s LRFD Bridge Construction Specification, Section 18, showing that each bearing meets design specifications. Provide copies of certified test results with each bearing shipment.

560.2.3 Marking
Using indelible ink or paint that will remain intact after pad deformation, mark each laminated bearing pad on a face that is visible after Bridge erection, with the following information:
1. Order number;
2. Lot number;
3. Bearing identification number;
4. Elastomer type; and
5. Grade number.

560.2.4 Acceptance Criteria
The acceptance criteria shall have two levels in accordance with AASHTO’s LRFD Bridge Construction Specification, Section 18. Testing is the Contractor’s responsibility.

560.2.5 Fabrication
Cast bearing pads with steel laminates as a unit in a mold, bonded and vulcanized under heat and pressure. Provide molds with a standard mold finish. Sandblast internal steel laminates to remove surface coating rust and mill scale before bonding. Provide internal steel laminates free of sharp edges and burrs, with a minimum edge cover of 1/8 in.

Manufacture as a single unit bearing pads designed to act as a single unit with a given shape. The Contractor may provide molded or extruded plain bearing pads or fabric-reinforced bearings pads vulcanized in large sheets, and cut to size. Cut without heating the Materials, and to produce a smooth finish in accordance with ANSI 250, with no fabric separation from the elastomer.

Provide single ply fabric reinforcement at the top and bottom of the reinforced bearings and double ply for internal reinforcement layers. Provide fabric free of folds and ripples, and parallel to the top and bottom surfaces.

Provide flash tolerances, finishes, and appearances are in accordance with the current Rubber Handbook, published by the Rubber Manufacturer’s Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.
560.2.6 Tolerances
Build plain and laminated bearing pads in accordance with Table 560.2.6:1, “Bearing Pad Tolerances.”

<table>
<thead>
<tr>
<th>Parameter description</th>
<th>Tolerance requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Vertical thickness</td>
<td></td>
</tr>
<tr>
<td>1 1/4 in or less</td>
<td>0 in to +1/8 in</td>
</tr>
<tr>
<td>Over 1 1/4 in</td>
<td>0 in to +1/4 in</td>
</tr>
<tr>
<td>Overall horizontal dimensions</td>
<td></td>
</tr>
<tr>
<td>36 in and less</td>
<td>0 in to +1/4 in</td>
</tr>
<tr>
<td>Over 36 in</td>
<td>0 in to +1/2 in</td>
</tr>
<tr>
<td>Individual layer thickness*a</td>
<td>± 20% of design value</td>
</tr>
<tr>
<td></td>
<td>but no more than ± 1/8 in</td>
</tr>
<tr>
<td>Variations from a plane parallel to the theoretical surface^b</td>
<td></td>
</tr>
<tr>
<td>Top^c</td>
<td>0.005 radians</td>
</tr>
<tr>
<td>Sides</td>
<td>0.02 radians</td>
</tr>
<tr>
<td>Position of exposed connection members</td>
<td>1/8 in</td>
</tr>
<tr>
<td>Embedded steel plates edge cover or connection members</td>
<td>0 in to +1/8 in</td>
</tr>
<tr>
<td>Hole, slot, or insert sizes</td>
<td>+ 1/8 in</td>
</tr>
<tr>
<td>Hole, slot, or insert positions</td>
<td>1/8 in</td>
</tr>
<tr>
<td>^aElastomer-laminated bearing pads only.</td>
<td></td>
</tr>
<tr>
<td>^bAs determined by measurements at the bearing edges.</td>
<td></td>
</tr>
<tr>
<td>^cSlope relative to the bottom.</td>
<td></td>
</tr>
</tbody>
</table>

560.3 Construction Requirements
560.3.1 General
Ensure bearing pads in the completed Structure exhibit a compressive strain of no more than 10%.
Place bearing pads on level surfaces. Correct misalignments in the support to form a level surface.
Do not weld steel girders or base plates to the bearing pad sole plates unless there is more than 1 1/2 in of steel between the weld and the elastomer. Do not expose the elastomer or elastomer bond to temperatures greater than 400 °F.

560.4 Method of Measurement—Vacant

560.5 Basis of Payment—Vacant
561.1 DESCRIPTION
This Work consists of providing and placing elastomeric compression joint seals for bridge decks.

561.2 MATERIALS
561.2.1 General
Provide joint seals that prevent Material and water intrusion through the joint system. Provide preformed open cell seals, manufactured with elastomeric polychloroprene Material in accordance with AASHTO M 220. Mark the top surface of joint seals.

561.2.2 Dimensional Tolerance
Provide seals in accordance with the Contract and manufacturer’s tolerances.

561.2.3 Splicing
Provide seals in one continuous strip for each joint.

561.2.4 Lubricant Adhesive
Provide lubricant adhesives in accordance with the manufacturer's recommendations.

561.2.5 Submittals
Provide a submittal to the Project Manager with the manufacturer name, seal type, and Supplier name, within one month after the Contract is awarded. At least 14 Days before installation, submit to the Project Manager a copy of the manufacturer’s seal installation recommendations.

561.3 CONSTRUCTION REQUIREMENTS
561.3.1 Preparing Joint Recesses
Install joint seals in prefabricated steel recesses or in recesses saw cut in the concrete. For saw cut recesses, cut the joints narrower than required for the preformed seal Material. Before installing compression seals, saw cut a groove to receive the seal Material along the top of the joint.

Simultaneously cut both sides of a groove. Control alignment with a rigid guide. The Department will specify the groove width based on the temperature and age of the concrete. Bevel saw cut lips to prevent subsequent spalling. Repair spalls, cracks, and protrusions in the joint surface before installing seals.

Set prefabricated steel recesses before placing the deck slab. Ensure joint surfaces are free of paint, oil, scale, rust, and dust before applying the lubricant adhesive.

561.3.1.1 Oversized Joint Openings
The Contractor may use larger seals for oversized joint openings, at no additional cost to the Department.

561.3.2 Installation
Apply the lubricant adhesive to both joint faces before installing the steel. Compress the seal to the thickness required in the Contract, or as specified by the State Bridge Engineer for the rated opening and temperature conditions. The Department will not allow loose fits or open points between the seal and the deck concrete or metal armoring.

561.3.3 Replacing Joint Seals in Existing Decks
If replacing seals in existing bridge decks, completely remove the old seals and clean the side surfaces of the openings of all dirt, rust, and any other Deleterious Material. If required, modify existing joint components or deck slab openings before installing the replacement seals.

561.3.4 Acceptance
After installation, test joint seals for leakage by water flooding the joint. Perform testing in the presence of the Project Manager. Ensure the top edges of the seal are in continuous contact with the sides of the joint opening over the entire range of joint movement, or the...
Department may reject the seal.

561.4 METHOD OF MEASUREMENT—Vacant

561.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastomeric Compression Joint Seal Replacement</td>
<td>Foot</td>
</tr>
</tbody>
</table>
SECTION 562: BRIDGE JOINT STRIP SEALS, SYSTEM 1

562.1 DESCRIPTION
This Work consists of providing, assembling, and installing bridge joint strip seal assemblies.

562.2 MATERIALS
562.2.1 General
Provide bridge joint strip seals of elastomeric Material and metal components to allow expansion and contraction of the bridge Superstructure and to seal the deck surface.
Anchor bridge joint strip seal assemblies either directly in PCC with Type A anchorage or in elastomeric concrete headers or end dams with Type B anchorage.

562.2.2 Elastomer
Provide 100% virgin polychloroprene (neoprene) elastomeric sealing element in accordance with Table 562.2.2.1, “Elastomer Physical Property Requirements.”

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength, minimum</td>
<td>D 412</td>
<td>2,000 psi</td>
</tr>
<tr>
<td>Elongation at break, minimum</td>
<td>D 412</td>
<td>250%</td>
</tr>
<tr>
<td>Hardness, durometer, neoprene</td>
<td>D 2240</td>
<td>60 ± 5</td>
</tr>
<tr>
<td>Compression set, maximum(*)</td>
<td>D 395</td>
<td>40%</td>
</tr>
<tr>
<td>Brittleness @ -40 °F</td>
<td>D 746</td>
<td>Not brittle</td>
</tr>
<tr>
<td>Property deterioration(*)</td>
<td>D 573</td>
<td></td>
</tr>
<tr>
<td>Tensile strength loss, maximum</td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Elongation loss, maximum</td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Hardness point change, Type A(*)</td>
<td>D 2240</td>
<td>0 to ±10</td>
</tr>
<tr>
<td>Ozone resistance(*)</td>
<td>D 1149</td>
<td>No cracks</td>
</tr>
<tr>
<td>Oil swell(*)</td>
<td>D 471</td>
<td></td>
</tr>
<tr>
<td>Weight increase, maximum</td>
<td></td>
<td>+45%</td>
</tr>
<tr>
<td>Resistance to salt</td>
<td>D 471</td>
<td></td>
</tr>
<tr>
<td>Variation of volume</td>
<td></td>
<td>-5% to +10%</td>
</tr>
</tbody>
</table>

*After 70 h at 212 °F using Method B, modified.
*After 70 h at 212 °F.
*Durometer A.
*At 20% elongation and 300 ppm in air at 104 °F.
*Using ASTM Oil #3, after 70 h at 212 °F.
*After 70 h at 104 °F in calcium chloride solution.

562.2.3 Metal Components
Provide steel retaining bars in accordance with ASTM A 585. Provide anchoring Materials in accordance with AASHTO M 270, (grade 36) for Structural Steel and AASHTO M 31 (grade 40) for reinforcing steel.

562.2.4 Elastomeric Concrete
Provide elastomeric concrete composed of an elastomeric binder and precision blended aggregates, specifically formulated for use as an energy absorbing header Material for bridge-deck expansion joints. Select Material from the Department’s Approved Products List. Provide a manufacturer's materials certification.

562.3 CONSTRUCTION REQUIREMENTS
562.3.1 Shop Drawings and Submittals
Submit three sets of complete shop drawings to the State Bridge Engineer for preliminary review; include two copies of the product literature for elastomeric concrete and joint seals, containing complete materials data and installation instructions. Include the following information:
1. Detailed dimensions and sizes of component parts of the joint;
2. Details of miscellaneous parts;
3. Field splice details and locations;
4. Material specifications;
5. Weld symbols; and
6. Welding electrode specifications.

Upon receipt of the reviewed drawings, return one set to the manufacturer or Supplier with notations. After making the required corrections, submit eight sets of final shop drawings to the Department. Do not perform Work and do not change the drawing before obtaining Department approval.

562.3.2 Fabrication of Steel Components

Fabricate steel components in accordance with Section 541, “Steel Structures.” Stamp manufacturer’s name and model number at a visible location on each end of the steel extrusion.

562.3.2.1 Protective Coating

Unless otherwise specified in the Contract, coat or galvanize the surfaces of steel components in accordance with Section 545, “Protective Coatings of Miscellaneous Structural Steel.”

562.3.3 Manufacturer’s Representative

Ensure an elastomeric concrete manufacturer’s representative is at the site during installation to:
1. Advise and ensure adherence to the correct installation method;
2. Train assigned personnel in the correct methods of installation; and
3. Certify to the Project Manager that the Contractor installed the Material in accordance with the manufacturer’s instructions.

Both the representative and the Contractor shall sign and date written certifications for the Project Manager.

562.3.4 Temperature and Weather Limitations

Do not place elastomeric concrete when the air or Material temperatures are below 45 °F. Do not place elastomeric concrete during rain or snow.

562.3.4.1 Placement Temperatures

Preheat the ingredients of the elastomeric concrete in accordance with the manufacturer’s instructions and maintain the preheat temperatures within the specified tolerances.

562.3.5 Surface Preparation

Immediately before placing the elastomeric concrete, sandblast the surfaces of steel, concrete, and asphalt that will contact elastomeric concrete. Completely remove dirt, rust, grease, oil, and other Deleterious Material. After blasting, remove loose dirt, sand, and debris by vacuuming or blowing with dry, oil-free compressed air. Ensure surfaces are completely dry before placing the elastomeric concrete.

562.3.5.1 Priming

Before placing elastomeric concrete, prime the steel, concrete, and asphalt surfaces that will contact elastomeric concrete Material in accordance with the elastomeric concrete manufacturer’s recommendations.

562.3.6 Placement of the Steel Extrusions

Place steel extrusions 1/8 +/- 1/16 in below and parallel to the final deck elevations. Remove and replace joints with extrusions that protrude above final deck elevations at no additional cost to the Department. Unless otherwise specified in the Contract, install block-outs that have at least a 1/2 in clearance between the steel extrusions and the block-out bottoms if using elastomeric headers.

The Contractor may field splice steel retaining bars by welding at the crown point of the Roadway and at approximately 20 foot intervals in the remaining length of the seal. The Department will not allow any other field splicing.

562.3.7 Mixing and Placing of the Elastomeric Concrete

Install elastomeric concrete headers in accordance with the manufacturer’s instructions.
If there is a conflict between this specification and the manufacturer’s printed instructions, use the more stringent requirements.

During mixing and placement operations, do not spill or spread elastomeric concrete on deck surfaces or steel extrusion parts that are not part of header construction. Perform mixing off the bridge deck. Use plywood sheets and plastic sheeting to protect the bridge deck for longer Bridges where this is not practical.

Place forms along the void edges, beneath the steel extrusions. Place and compact elastomeric concrete the entire length of the header to eliminate voids and leakage.

The Project Manager may reject the installation if the elastomeric concrete has any of the following characteristics:
1. Contains voids or honeycombs beneath steel extrusions;
2. Creates a poor finish;
3. Sets before being fully placed and consolidated;
4. Is not properly bonded to the steel and the concrete substrate; or
5. Shows signs of delamination.

562.3.7.1 Placement of Elastomeric Concrete in Vertical Recesses
At curb, Sidewalk, or barrier joint upturns, follow procedures for placement of the elastomeric concrete into the vertical recesses without voids or honeycombs.

562.3.7.2 Heat Vulcanizing
Heat vulcanize the concrete after placement, if specified in the manufacturer’s instructions.

562.3.8 Placement of Elastomeric Sealing Element
Provide and install the sealing element in one continuous piece and in accordance with the manufacturer’s instructions. Do not field splice the sealing element.

562.3.9 Acceptance
Provide an installed seal that is undamaged and prevents moisture and other contaminants on the deck surface from leaking through the joints. After installation, test the bridge joint strip seals for leaks by flooding with water. Perform testing in the presence of the Project Manager.

562.4 METHOD OF MEASUREMENT—Vacant

562.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Joint Strip Seal</td>
<td>Linear Foot</td>
</tr>
</tbody>
</table>

562.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for bridge joint strip seals and will not be measured or paid for separately:
A. Steel components of the bridge joint strip seal;
B. Elastomeric concrete headers;
C. Testing;
D. Providing manufacturers’ representatives;
E. Water for leakage testing; and
F. Protective coating of steel components.
563.1 DESCRIPTION
This Work consists of providing and installing System 2, Type A and Type B polymer
bridge joint seals. Type A joints consist of a rapid-curing silicone or polyurethane sealing
element only. Type B joints consist of both sealing elements and polymer nosing elements.

563.2 MATERIALS
563.2.1 General
Select sealing Material and the nosing element from the Department’s Approved
Products List for System 2, polymer bridge joint seals. For Type B joints, provide sealing and
nosing elements from the same manufacturer.

563.2.2 Silicone Sealing Element
If using a silicone sealing element, provide a two-part, rapid-curing, self-leveling, cold-
applied silicone polymer Material that cures to a low-modulus rubber-like Material upon
exposure to moisture in accordance with Table 563.2.2:1, “Silicone Sealant Requirements.”
Deliver each sealing compound lot or batch to the Project in the original sealed container.
Indicate the manufacturer’s name, batch and lot number on each container.

Table 563.2.2:1
Silicone Sealant Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tack-free time, 77 °F</td>
<td>30–60 min</td>
</tr>
<tr>
<td>Nonvolatile content, minimum</td>
<td>93%</td>
</tr>
<tr>
<td>Tensile strength and 24 h extension test</td>
<td></td>
</tr>
<tr>
<td>Initial, 5-Day cure, 77 °F</td>
<td>4–29 psi</td>
</tr>
<tr>
<td>After water immersion</td>
<td>4–29 psi</td>
</tr>
<tr>
<td>After heat aging</td>
<td>4–29 psi</td>
</tr>
<tr>
<td>After cycling, −20 °F, 50%, 3 cycles</td>
<td>4–29 psi</td>
</tr>
<tr>
<td>24 h extension (all specimens)⁴</td>
<td>Pass</td>
</tr>
</tbody>
</table>

⁴After 24 h, no evidence of cracks, separation, or other opening that at any point is
over 1/8 in deep in the sealant or between the sealant and backup blocks.

563.2.3 Polyurethane Sealing Element
If using a polyurethane sealing element, provide a two-part joint sealant that cures quickly
at ambient temperatures to form a flexible, resilient, tear-resistant rubber. Provide
polyurethane sealant in accordance with Table 563.2.3:1, “Polyurethane Sealing
Requirements.”
Deliver each sealing Material lot or batch to the Project in the original sealed container.
Indicate the manufacturer’s name and batch and lot number on each container.

Table 563.2.3:1
Polyurethane Sealing Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond @ -20 °F, 50% extension (1/2 in)</td>
<td>D 5329</td>
<td>Pass 3 cycles</td>
</tr>
<tr>
<td>Water-immersed</td>
<td>D 5329</td>
<td>Pass 3 cycles</td>
</tr>
<tr>
<td>Tensile adhesion, minimum</td>
<td>D 412</td>
<td>800%</td>
</tr>
<tr>
<td>Penetration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ -13 °F</td>
<td>D 5329</td>
<td>5/16 in</td>
</tr>
<tr>
<td>@ 0 °F</td>
<td>D 5329</td>
<td>1/16 in</td>
</tr>
<tr>
<td>Flow 5 h @ 200 °F</td>
<td>D 5329</td>
<td>0</td>
</tr>
</tbody>
</table>

563.2.4 Nosing Material
For Type B joint nosing or end dams, provide Material compatible with the sealant
Material and recommended or supplied by the sealant manufacturer. Deliver each binder
Material lot or batch to the project in the original sealed container. Indicate the manufacturer’s
name, batch and lot number on each container.

Section 563: Polymer Bridge Joint Seals, System 2   Page 365
563.2.4.1 Nosing Material for Use with Silicone Type Sealants

For nosing Material used with silicone type sealants, provide a two-component, rapid-curing liquid polymer in accordance with Table 563.2.4.1:1, “Physical Properties of the Silicone Type Sealant Only, Without Aggregate” that cures to a dense, semi-flexible, weather, abrasion, and impact-resistant polymer. Provide Material that, if blended with recommended aggregates, forms a polymer-based mortar for nosing or joint repair or, if cured in the “neat” form, acts as a combination primer and protective steel coating. The Department will allow alternate primers as recommended by the manufacturer.

Table 563.2.4.1:1

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Components</td>
<td></td>
</tr>
<tr>
<td>Mixing ratio</td>
<td>1:1 by weight or volume</td>
</tr>
<tr>
<td>Color</td>
<td>Black</td>
</tr>
<tr>
<td>Weight per gallon</td>
<td>Average 1.8 lb</td>
</tr>
<tr>
<td>Pot life, @ 50 °F</td>
<td>60 min</td>
</tr>
<tr>
<td>Pot life, @ 59 °F</td>
<td>50 mina</td>
</tr>
<tr>
<td>Pot life, @ 68 °F</td>
<td>40 mina</td>
</tr>
<tr>
<td>Cured Properties</td>
<td></td>
</tr>
<tr>
<td>Tensile strength ASTMD 638</td>
<td>900 psi (minimum)</td>
</tr>
<tr>
<td>Tensile elongation ASTMD 638</td>
<td>50% (minimum)</td>
</tr>
<tr>
<td>Shore “D” hardness ASTM D 2240</td>
<td>45–55</td>
</tr>
</tbody>
</table>

563.2.4.2 Nosing Material for Use with Polyurethane Type Sealants

Provide nosing Material for use with polyurethane-type sealants, in accordance with Table 563.2.4.2:1, “Physical Properties of the Polyurethane Type Sealant Only, Without Aggregate” that is a two-part, polyurethane Material with sand and fiberglass in the aggregate. Use aggregate recommended or supplied by the manufacturer.

Table 563.2.4.2:1

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined components</td>
<td></td>
</tr>
<tr>
<td>Mixing ratio</td>
<td>2:1</td>
</tr>
<tr>
<td>Original properties (after 100 °F for 7 Days)</td>
<td>ASTM test</td>
</tr>
<tr>
<td>Tensile strength ASTM D 638</td>
<td>1500 psi minimum</td>
</tr>
<tr>
<td>Elongation ASTM D 638</td>
<td>200% minimum</td>
</tr>
<tr>
<td>Hardness, Durometer D ASTM D 2240</td>
<td>90 ±3</td>
</tr>
</tbody>
</table>

563.2.5 Aggregates

Provide nosing Material aggregates in accordance with the binder manufacturer’s recommendations.

563.2.6 Backer Rods

Provide backer rods in accordance with the sealant manufacturer’s recommendations.

563.2.7 Certificate of Compliance

Provide the Project Manager with a manufacturer’s Certificate of Compliance. Indicate the project number, batch numbers, and Material manufacture date on the Certificate of Compliance.

563.2.8 Sample Submittal

Submit a 4 fluid ounce sample of each sealant component and binder Material to the State Materials Bureau at least 30 Days before using the Materials.
563.3 CONSTRUCTION REQUIREMENTS

563.3.1 Technical Representative
Have the manufacturer’s technical representative on site for the initial joint installation to advise the construction personnel and ensure a satisfactory joint installation. If the Contractor can show proof of satisfactory past experience installing at least ten joints or 300 ft of joints of same Material, whichever is larger, the Project Manager may waive this requirement.

563.3.2 Manufacturer’s Instructions
Provide a complete set of written joint installation instructions to the Project Manager at least 14 Days before installing the joints.

563.3.3 Joint Preparation
Allow concrete in new bridge joints to cure for at least 7 Days before installing nosing or sealing Material. Clean bridge joints in new or existing concrete with a sandblaster before placing the nosing or sealant Materials. Obtain the Project Manager’s approval to use other cleaning methods. Before priming the joints, remove loose debris with a vacuum or blower. Use oil- and moisture-free compressed air for sandblasting or blowing debris. Dry joints before applying primers, nosing Material, and sealants.

563.3.4 Inspection Before Installation
Inspect joints for proper depth, width, alignment, and preparation, and obtain Project Manager approval before installing the nosing and sealant Material.

563.3.5 Mixing and Placing the Nosing Material
Provide the Project Manager with one set of the manufacturer’s mixing and placing instructions at least one week before the placing begins.

563.3.5.1 Mixing the Nosing Material
Combine the two components (base and reactor) in the proportions recommended by the manufacturer to form the nosing Material binder and the primer. Mix with paint-type paddle stirrers or a powered mortar mixer attached to a slow-speed hand drill. The Contractor may hand-mix smaller batches with clean spatulas or wood sticks. Mix for at least 2 min.

Make the mixed binder into a mortar by combining the binder with the recommended aggregate in the proportions suggested by the manufacturer. Mix until obtaining a uniform distribution of the polymer in the aggregate.

563.3.5.2 Placing the Nosing Material
Before placing the nosing Material, prime the surfaces of the substrate with neat binder or other primer Material recommended by the manufacturer. Apply and finish the mortar within the manufacturer’s recommended time limits and before the primer has set. Screed the mortar even with and parallel to the Roadway surface. Finish the mortar to provide a smooth surface free of voids and tears.

Place nosing Materials when the air and substrate temperatures are from 45 °F to 80 °F. Maintain the temperatures around the placed mortar at or above 45 °F for at least 4 h after placement.

563.3.6 Application of Sealing Element
Install a backer rod at least 25% larger in diameter than the joint opening, or a diameter specified by the manufacturer, to the specified depth. Before applying sealant, prime the substrate surfaces in accordance with the sealant manufacturer specifications.

Place sealant when the air and substrate temperatures are from 45 °F to 80 °F and maintain at or above 45 °F for at least 4 h.

Apply sealant in accordance with the manufacturer’s recommendations, using an approved applicator.

563.3.7 Traffic
Do not allow traffic on newly installed polymer nosing Materials or silicone or polyurethane sealing elements without Project Manager approval. Nosing Material should be ready for traffic within 2 h to 4 h, depending on the temperature. Silicone or polyurethane sealants are normally ready for traffic upon removal of the traffic control devices.
### 563.4 METHOD OF MEASUREMENT—Vacant

### 563.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
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<tbody>
<tr>
<td>Polymer Bridge Joint Seals, Type A</td>
<td>Foot</td>
</tr>
<tr>
<td>Polymer Bridge Joint Seals, Type B</td>
<td>Foot</td>
</tr>
</tbody>
</table>
SECTION 570: PIPE CULVERTS

570.1 DESCRIPTION
This Work consists of supplying, constructing, and reconstructing pipe Culverts.

570.2 MATERIALS
Provide Material in accordance with Table 570.2:1, "Culvert Material Applications."

Table 570.2:1
Culvert Material Applications

| Category/Material | Application | Sub-drainage | Cross Drains | Turnouts | Storm Drains<sup>b</sup> | Siphons<sup>c</sup> |
|-------------------|-------------|--------------|--------------|----------|------------------------|----------------|---|
| Metal (steel or aluminum) | | X | X | X | | |
| CMP | | X | X | X | | |
| Spiral Pipe | | X | X | X | | |
| Double Wall | | X | | | | |
| Smooth FLO | | X | | | | |
| Concrete Lined | | X | | | | |
| Concrete Reinforced | | X | X | X | | |
| Non-Reinforced<sup>d</sup> | | X | X | X | | |
| Pressure | | | | | X | |
| Cylinder | | | | | X | |
| Cast in Place | | X | X | X | | |
| Pre cast CBC<sup>h</sup> | | X | X | X | | |
| Thermoplastic, high density polyethylene (HDPE) | | | | | | |
| Pipe<sup>e</sup> | | X | | | | |
| Corrugated | | X | X | X | | |
| Profile<sup>f</sup> | | X | X | X | | |
| Solid | | X | | | | |
| Thermoplastic, PVC | | | | | | |
| Corrugated (in/out) | | X | X | X | | |
| Profile<sup>g</sup> | | X | X | X | | |
| Solid | | X | | | | |
| Pressure | | | | | X | |
| Ductile Iron | | | | | X | |

<sup>a</sup>Primary Applications (Could be used in other applications as approved by the Project Manager)
<sup>b</sup>Joints must be watertight in accordance with Section 570.2.2, "Joints," and have a maximum tested Manning’s coefficient roughness of 0.013 or less
<sup>c</sup>Must meet the pressure tight requirements of Section 570.2.2, "Joints"
<sup>d</sup>Must be approved by Project Manager
<sup>e</sup>Type S, Type D, or ASTM F 894
<sup>f</sup>ASTM F 794, F949, and ASTM F 1803
<sup>g</sup>Schedule 40
<sup>h</sup>For Precast box, refer to Special Provision 511 – F, if applicable

Design, manufacture, and install Culvert Materials in accordance with Table 570.2:2, "Culvert Materials Specifications, AASHTO LRFD (AWWA)," and Table 570.2:3, "Culvert Materials Specifications, ASTM (ACI)."
### Table 570.2:2
Culvert Materials Specifications, AASHTO (AWWA)

<table>
<thead>
<tr>
<th>Category/parameters</th>
<th>Material</th>
<th>Pipe Design</th>
<th>Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corrugated metal</strong></td>
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<tr>
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<td>M 218</td>
<td>M 36</td>
<td>Section 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Section 26</td>
</tr>
<tr>
<td>Aluminized, Type 2</td>
<td>M 274</td>
<td>M 36</td>
<td>Section 12</td>
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<td></td>
<td>Section 26</td>
</tr>
<tr>
<td>Aluminum</td>
<td>M 196</td>
<td>M 196</td>
<td>Section 12</td>
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<td></td>
<td>Section 26</td>
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<tr>
<td>Fiber-bonded</td>
<td>M 190, A</td>
<td>M 190, A</td>
<td>Section 12</td>
</tr>
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<tr>
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<td>M 245</td>
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<td><strong>Coatings pavements and lining</strong></td>
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<td>M 190, A</td>
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<td>Concrete lined</td>
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<td>C 302</td>
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<tr>
<td>Pipe 3 in–10 in</td>
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<td>Pipe 12 in–60 in</td>
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<td>M 294</td>
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<td>Profile 18 in–120 in</td>
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<td></td>
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<td></td>
<td>Section 30</td>
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<td></td>
<td></td>
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<td>Section 30</td>
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</table>

\(^a\)Install in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures,” Section 663, “Utility Items,” for Pressure Pipe

\(^b\)Must be approved by Project Manager.

\(^c\)See Section 572, “Cast-in-Place Concrete Pipe.”

If flowable fill is used as backfill, Section 30 deflection testing may be performed immediately after the flowable fill has cured in accordance with Section 516.3.3.
### 570.2.1 Pipe

#### 570.2.1.1 Metal Pipe

Provide helical corrugated pipe that have re-rolled ends with at least two annular corrugations. If using stab joints, only one end may have a factory attached coupling as

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**Table 570.2:3 Culvert Materials Specifications, ASTM (ACI)**

<table>
<thead>
<tr>
<th>Category/parameter</th>
<th>Material</th>
<th>Pipe Design</th>
<th>Installation</th>
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<tbody>
<tr>
<td>Corrugated metal</td>
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<tr>
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<td>—</td>
<td>C 76</td>
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</tr>
<tr>
<td>Arch</td>
<td>—</td>
<td>C 506</td>
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</tr>
<tr>
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<tr>
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</tr>
<tr>
<td></td>
<td>334433C</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Thermoplastic, HDPE solid smooth</td>
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<tr>
<td>Pipe 12 in–60 in</td>
<td>D 3350,</td>
<td>F 714</td>
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<tr>
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<td>335434C</td>
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<tr>
<td>Profile 4 in–48 in</td>
<td>D 1784,</td>
<td>F 794</td>
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<td></td>
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<tr>
<td>Pipe 4 in–15 in</td>
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<td>F 679</td>
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<td>F 679</td>
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</tr>
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<td>Pipe 18 in–27 in</td>
<td>D 1784,</td>
<td>F 679</td>
<td>—</td>
</tr>
<tr>
<td></td>
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<td>F 679</td>
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<td>Pipe 14 in–36 in</td>
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<td>Ductile Iron</td>
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<td>D 3550</td>
</tr>
</tbody>
</table>

*<sup>a</sup>Install in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures,” Section 663, “Utility Items,” for Pressure Pipe.

*<sup>b</sup>Use R. S. C. = 100 and 160 only.

*<sup>c</sup>Must be approved by Project Manager.

*<sup>d</sup>See Section 572, “Cast-in-Place Concrete Pipe.”

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Section 570: Pipe Culverts Page 371
appropriate for the end.

The following ends of pipe do not have to be re-rolled:

1. Connected to an existing pipe with helical corrugations;
2. Connecting to an end section; or
3. To be embedded in concrete.

The Department will allow direct connection of end sections utilizing a dimple band for cut ends on existing pipe, and straps or rods on new installations.

Use a half smooth, half corrugated sleeve or a concrete collar for extensions of concrete pipe to metal pipe.

If using smooth interior lined steel Culvert pipe (double wall), provide lock seams of the smooth interior liner and the corrugated shell that are continuous from end to end of each length of pipe section. Ensure the exterior gauge is not less than the specified gauge in the Contract for unlined corrugated steel Culvert pipe. The interior metal lines shall be at least 0.040 in.

Use pipe with gasketed lock seams and re-rolled ends for watertight installations.

570.2.1.2 Reinforced Concrete Pipe

Provide reinforced concrete pipe (RCP) with a bell and spigot design or a tongue and groove design.

The Contractor may use lift holes or lifting anchors to handle and place RCP. Do not use more than two lift holes in the wall of each piece of pipe. Place lift at the top of the pipe in line with the centerline of the pipe and along the minor axis of the reinforcement. When using a single lift hole, the Contractor shall place it at the balance point. When using two lift holes, the Contractor will place them equidistant from the balance point. The lift holes shall not interfere with the load carrying capacity of the pipe, shall be neatly made, shall be straight, and may be either drilled or cast.

After the Contractor has placed the pipe and before beginning backfill operations, the Contractor shall fill the lift holes with:

1. Non-shrink mortar, in accordance with Section 521, "Non-Shrink Mortar;"
2. Joint mortar, in accordance with Section 570.2.2.2.2, "RCP Joint Material," to which non-shrink admixture in accordance with Section 520, "Non-Shrink Grout for Post-Tensioned Bridge Members," has been added; or
3. Non-shrink grout, in accordance with Section 520, "Non-Shrink Grout for Post-Tensioned Bridge Members."

570.2.1.3 Plastic Pipe

When required for thermoplastic pipe, provide end sections located out of the clear zone that are either metal or HDPE with a minimum 2% carbon black in accordance with ASTM D 1248.

570.2.1.4 Pipe Certification and Identification Requirements

Provide certified test results showing that the Material supplied meets specifications. Provide record heat numbers and supply chemical analysis for metal pipe. The Department will inspect the RCP factory. Provide certification of cell classification and pipe stiffness for thermoplastic pipe in accordance with the Material selected using the fill height table in the Standard Plans.

Label each pipe before shipment. All thermoplastic pipe sections will clearly display the “Date Code Number.” RCP will display NMDOT stamp. Metal pipe will display a stencil or stamp displaying the manufacturer’s name, date and country of manufacture, thickness, coating, heat number, and applicable ASTM or AASHTO specification. All labels will correspond to test reports with a permanent print, stamp, or stencil.

570.2.1.5 Selecting Pipe

The Contractor may select any approved type of pipe, unless otherwise specified.

If the Plans specify storm drain Culvert pipes, the Contractor may select an approved type with a maximum tested Manning’s coefficient of roughness of 0.013.

If the Plans specify siphon Culvert pipes, the Contractor may select an approved pressure pipe.

Select a type of pipe based on the corrosion resistance number in accordance with Section 570.2.3.1, “Corrosion Resistance Number,” except when using siphon Culvert pipe.

If the Plans specify a nominal diameter for pipe arch, the Contractor may supply arched
Section 570.2.2 Joints

Select the appropriate joint in accordance with Table 570.2.2:1, "Joint Selection."

<table>
<thead>
<tr>
<th>Type of pipe Structure</th>
<th>Soil-tight</th>
<th>Water-tight</th>
<th>Pressure Tight</th>
<th>Restrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culverts under turnouts (not under road)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross drain Culverts</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbowed drop Culverts</td>
<td>X</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;a,c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Storm drains</td>
<td>X&lt;sup&gt;b&lt;/sup&gt;</td>
<td>X&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rundowns or downdrains&lt;sup&gt;a&lt;/sup&gt;</td>
<td>X</td>
<td></td>
<td></td>
<td>X&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Storm drains</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation pipe (non-pressure)</td>
<td>X&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation siphons and sag pipes</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Use where pipe slopes are steep (>10%) and or velocities are high.
<sup>b</sup>Elliptical and Arched Concrete, and Steel Arch pipe joints are not considered watertight without special joint design considerations (for RCP refer to Section 570.2.2.2.2, "RCP Joint Material;" for CMP refer to Section 570.2.2.2.1, "CMP Joint Material") or as approved by Project Manager.
<sup>c</sup>RCP and CMP only.

570.2.2.1 Joint Types

570.2.2.1.1 Soil-tight Joints

A soil-tight joint does not allow migration of soil into the pipe.

570.2.2.1.2 Watertight Joints

A gasketed joint restricts infiltration/exfiltration and exhibits no visible leakage when subject to 10.8 psi over the crown for 10 min under ASTM laboratory conditions.

When plant tested, the joint shall meet the requirements of ASTM D 3212 or ASTM C 443/C 497.

570.2.2.1.3 Pressure-tight Joints

Use pressure pipe in accordance with Section 663, "Utility Items," and the associated sections of the New Mexico Standard Specifications for Public Works Construction (NMSSPWC). Provide pipe with a pressure rating equal to or greater than the static head shown on the drawings. Select Materials in accordance with Table 570.2.2.1.3:1 "Pressure-Tight Joint Materials."

Test pressure-tight installations used in siphons and sag pipes shall show no leakage in excess of the allowable line leakage requirement when filled with water to the highest operating elevation and allowed to stand full for 24 h.

The minimum coupling requirement will be in accordance with the testing requirements of AASHTO's LRFD Bridge Construction Specifications, Section 26, for standard joints in non-erodible soils.

<table>
<thead>
<tr>
<th>Material</th>
<th>NMSSPWC Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyvinyl chloride</td>
<td>121 (AWWA C 905)</td>
</tr>
<tr>
<td>Reinforced concrete</td>
<td>124 (ASTM C 361M)</td>
</tr>
<tr>
<td>Concrete cylinder</td>
<td>128 (AWWA C 303)</td>
</tr>
<tr>
<td>Ductile iron</td>
<td>129 (AWWA C 151)</td>
</tr>
<tr>
<td>Ductile and cast iron fittings</td>
<td>130 (AWWA C 110 &amp; C 111)</td>
</tr>
<tr>
<td>Solid wall HDPE</td>
<td>ASTM F 714</td>
</tr>
</tbody>
</table>

Table 570.2.2.1.3:1 Pressure-Tight Joint Materials

Section 570: Pipe Culverts Page 373
570.2.2.1.4 Restrained joint
A restrained joint resists a tensile force in accordance with AASHTO's LRFD Bridge Construction Specifications; Section 26 or as approved by Project Manager.

570.2.2.2 Joint Materials
570.2.2.2.1 CMP Joint Material
The Department will accept factory-attached metal or plastic stab joints with modified gaskets, or hugger-type bands for soil tight joints.
The Department will accept factory-attached metal or plastic stab joints with modified gaskets, or hugger-type bands with O-ring gaskets, as a watertight joint system when backfilled with flowable fill.
If the Contract specifies watertight joints, use fully corrugated bands with 12 in width flat gaskets. Provide closed cell flat gaskets.
Use 5C fully corrugated couplings with rods and lugs and a 12 in neoprene sleeve gasket for watertight joints on arch pipe and restrained joints on round pipe.

570.2.2.2.2 RCP Joint Material
Provide pipe joint mortar that consists of one part portland cement and two parts fine aggregate with enough water to get the proper consistency. Provide portland cement in accordance with Section 510, “Portland Cement Concrete.” Provide fine aggregate in accordance with AASHTO M 45.
Provide grout that is a paste of portland cement and water. Provide grout Materials in accordance with Section 510, “Portland Cement Concrete.”
Provide thermoplastic joint compound that is suitable for joining concrete pipe and consists of a natural or processed asphalt base or both, suitable volatile solvents, and inert filler. Include fiber in the filler. Apply in accordance with manufacturer’s requirements. Provide Material in accordance with ASTM D 6, AASHTO T 111, and ASTM D 217.
Provide external sealing bands in accordance with ASTM C 877 for arch and elliptical pipe.
Provide closed-cell neoprene gaskets in accordance with ASTM D 1056 and AASHTO M 198, Type B.
Provide butyl rubber mastic sealant in accordance with AASHTO M 198.
Grout watertight and pressure-tight joints as directed by the Project Manager.

570.2.2.2.3 Thermoplastic Joint Material
Provide couplings that snap-on, and engage an equal number of corrugations on either side of the pipe joint. The Department will not accept wrap-around bands.
Provide bell and spigot joints in accordance with ASTM D 3212 and ASTM F 477.
Provide concrete Structure connections with a water stop or boot. Do not use expanding sealants or gaskets.

570.2.3 Durability
570.2.3.1 Corrosion Resistance Number
Unless specified on the Contract, provide pipe Culverts with a minimum corrosion resistance number of CR1. However, provide pipe Culverts with a minimum corrosion resistance number of CR3 for storm drains, rundowns, non-pressure irrigation pipe, and elbowed drop Culverts. If the Contract specifies a corrosion resistance number, use Table 570.2.3.1:1, “Pipe Culvert Durability,” to choose a pipe type from the column below the corrosion resistance number. Do not use Table 570.2.3.1:1, “Pipe Culvert Durability,” for siphon Culvert pipe.

<table>
<thead>
<tr>
<th>Table 570.2.3.1:1 Pipe Culvert Durability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of pipe</strong></td>
</tr>
<tr>
<td>Galvanized steel</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>Aluminized steel, Type 2&quot;</td>
</tr>
</tbody>
</table>
### Table 570.2.3.1:1
Pipe Culvert Durability

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>CR1</th>
<th>CR2</th>
<th>CR3</th>
<th>CR4</th>
<th>CR5</th>
<th>CR6</th>
<th>CR7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum alloy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>RCP, Type II cement&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Polymeric coated steel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Aramid fiber bonded steel</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Thermoplastic&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>RCP Type V cement&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<sup>a</sup>The table is based on a minimal structural gauge thickness. The Contractor may use a heavier gauge to increase the corrosion resistance number as approved by the Project Manager.

<sup>b</sup>Cement type based on Section 510, “Portland Cement Concrete.” If pH ≤ 5.0, use a rapid chloride permeability ≤ 1,200 coulombs.

<sup>c</sup>Cell Class corresponding to highest values on Fill Height Table must be used for CR4 – 7.

### 570.2.3.2 Dissimilar Metal Pipe Joints

Use rubber gaskets on joints between dissimilar metal pipes.

### 570.2.3 Coating Aluminum and Aluminized Steel Pipe, Type 2

Coat aluminum and aluminized steel pipe, Type 2 for the entire length of pipe in contact with fresh concrete (except for grouted pipe or flowable filled pipe) to a distance of 12 in beyond the back face of the concrete in accordance with the Contract. Provide a zinc-rich paint coating in accordance with AASHTO M 36.

### 570.3 CONSTRUCTION REQUIREMENTS

#### 570.3.1 General

Install pipe in accordance with Section 206 and the requirements of Table 570.2.2, “Culvert Materials Specifications, AASHTO (AWWA),” and current AASHTO LRFD Bridge Construction Specifications section applying to the pipe type. Ensure that no “floating” occurs during installation of pipe Culverts.

Use siphon Culvert pipe in accordance with Section 663, “Utility Items,” and the associated sections of the NMSSPWC.

#### 570.3.2 Excavation and Backfill

Excavate trenches in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures.” Make the trenches wide enough to properly join the pipe and thoroughly compact the bedding Material under and around the pipe. Where possible, make the trench wall vertical. When using flowable fill for backfill, in accordance with Section 516, “Flowable Fill,” make trench widths in accordance with AASHTO’s LRFD Bridge Construction Specifications Standard, Section 26 for metal pipe and section 30 for thermoplastic pipe.

#### 570.3.3 Fill Height Requirements

Provide minimum and maximum cover over the pipe in accordance with the Standard Drawings.

#### 570.3.4 Laying Pipe

Begin laying pipe at the downstream end of the pipeline except for extensions of existing pipes. Place the bottom of the pipe in contact with the shaped bedding throughout its full length.

Place the bell ends or outside circumferential laps of pipes facing upstream to obtain a shingling effect. Place pipe with longitudinal laps or seams with the laps or seams at the sides.
Lay paved or partially lined pipe so that the longitudinal centerline of the paved segment coincides with the flow line. Place elliptical and elliptically reinforced pipes with the major axis within 5° of a horizontal plane.

570.3.5 Joining Pipe
570.3.5.1 Joining RCP
Join pipe sections so that the ends are fully centered and the inner surfaces are flush within the inside diameter tolerance variations of AASHTO M 170, but shall not exceed 5/8 in.

Make watertight joints with the following:
1. Joint mortar;
2. Cement grout;
3. Flexible watertight gaskets;
4. Thermoplastic joint compound;
5. External sealing bands;
6. Mastic sealant;
7. Closed cell neoprene preformed gaskets; or
8. Any combination of these types.

Make mortar joints with an excess of mortar to form a bead around the outside of the pipe and finish them smooth on the inside.

For grouted joints, molds or runners shall be used to retain the poured grout. Flexible watertight gaskets shall be installed to form a flexible watertight seal.

If using portland cement mixtures, protect the completed joints against rapid drying with a curing method approved by the Project Manager. Replace coupling systems that do not fit snugly, in accordance with Section 570.2.1.2, “Reinforced Concrete Pipe,” at no additional cost to the Department.

If using thermoplastic joint compound, clean and dry the ends of the pipes. Use primer recommended by the manufacturer to coat pipe surfaces that will contact the compound. Completely seal the circumference of the joint.

After making the joint, remove excess compound projecting into the pipe.

570.3.5.2 Joining Flexible Pipe
Join metal or thermoplastic pipe with a flexible pipe coupling system. Ensure the coupling systems engage an equal number of corrugation or length on either side of the pipe joint. Replace coupling systems that do not fit snugly to the pipe ends, in accordance with Section 570.2.2.2.1, “CMP Joint Material,” and Section 570.2.2.2.3, “Thermoplastic Joint Material,” at no additional cost to the Department.

Use dimpled bands to attach end sections. Ensure the dimples fit snugly within the given pipe’s corrugations. If the dimpled band connections do not fit correctly, use an alternate way to connect the pipes.

Where joints must have beveled ends to meet construction requirements, form a continuous unit in accordance with the Plans.

Repair damaged protective coatings in accordance with AASHTO M 36 at no additional cost to the Department.

570.3.5.3 Pipe Installation Inspection
Inspect the pipe before placing any backfill. Replace or re-lay unacceptable pipe at no additional cost to the Department.

Ensure that flexible pipe is installed in full compliance with AASHTO’s LRFD Bridge Design, Section 26 (metal) or Section 30 (thermoplastic) requirements.

Provide the Department with the results of the deflection test detailed in Section 30.5.6 of AASHTO’s LRFD Bridge Design and a certification that the testing was completed. The required deflection testing shall be performed at no additional cost to the Department.

570.3.5.4 Salvaging Culvert Pipe
Remove Culvert pipe to be salvaged or reinstalled from the existing location in accordance with Section 601, “Removal of Structures and Obstructions.” Clean salvaged pipe of Deleterious Material before storing or reinstalling.
570.4 METHOD OF MEASUREMENT—Vacant

570.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culvert Pipe</td>
<td>Foot</td>
</tr>
<tr>
<td>Culvert Pipe End Section</td>
<td>Each</td>
</tr>
<tr>
<td>Culvert Pipe Arch</td>
<td>Foot</td>
</tr>
<tr>
<td>Culvert Pipe Arch End Section</td>
<td>Each</td>
</tr>
<tr>
<td>Storm Drain Culvert Pipe</td>
<td>Foot</td>
</tr>
<tr>
<td>Storm Drain Culvert Pipe End</td>
<td>Each</td>
</tr>
<tr>
<td>Storm Drain Culvert Pipe Arch</td>
<td>Foot</td>
</tr>
<tr>
<td>Storm Drain Culvert Pipe Arch</td>
<td>Each</td>
</tr>
<tr>
<td>Siphon Culvert Pipe</td>
<td>Foot</td>
</tr>
<tr>
<td>Reinstalling Culvert Pipe</td>
<td>Each</td>
</tr>
</tbody>
</table>

The Department will pay for the removal of Culvert pipe in accordance with Section 601, “Removal of Structures and Obstructions.”

The Department will pay for excavation for Culverts in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures.”

570.5.1 Work Included in Payment

The following work and items shall be considered as included in the payment for the major items and will not be measured or paid for separately:

A. All joint materials, shear connectors required for joining sections;
B. Testing and Certification of all culverts; and
C. The coating of aluminum and aluminized steel pipe Type 2 when placed with fresh concrete. Removal of culvert pipe shall be paid for in accordance with Section 601, Removal of Structures and Obstructions. Excavation for culverts shall be measured and paid for in accordance with Section 206, Excavation and Backfill for Culverts and Minor Structures. Siphon culvert pipe work shall include trenching, connections to transitions, pipe joining, dewatering, installation of pipe, fittings miscellaneous components; including elbows, drains and blowoffs, backfill and compaction, encasing or special backfill and hydrostatic testing.
571.1 DESCRIPTION
The Work consists of providing and installing pipe, pipe arches, long span Structures or metal box Culverts made of metal structural plate, in accordance with Table 571.1:1, "Structural Plate Specifications: AASHTO," and Table 571.1:2, "Structural Plate Specifications: ASTM."

<table>
<thead>
<tr>
<th>Table 571.1:1</th>
<th>Structural Plate Specifications: AASHTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category/parameter</td>
<td>Material</td>
</tr>
<tr>
<td>Structural plate</td>
<td>Galvanized</td>
</tr>
<tr>
<td></td>
<td>Aluminum</td>
</tr>
<tr>
<td></td>
<td>Box Culvert</td>
</tr>
<tr>
<td>Coatings, pavements, and linings</td>
<td>Asphalt coating</td>
</tr>
<tr>
<td></td>
<td>Paved invert</td>
</tr>
</tbody>
</table>

\[\text{a}^{\text{Division I, AASHTO Standard Specifications for Highway Bridges.}} \]

\[\text{b}^{\text{Division II, AASHTO Standard Specifications for Highway Bridges.}} \]

<table>
<thead>
<tr>
<th>Table 571.1:2</th>
<th>Structural Plate Specifications: ASTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category/parameter</td>
<td>Material</td>
</tr>
<tr>
<td>Structural plate</td>
<td>Galvanized plate</td>
</tr>
<tr>
<td></td>
<td>Aluminum</td>
</tr>
<tr>
<td></td>
<td>Box Culvert</td>
</tr>
<tr>
<td>Coatings, pavements, and linings</td>
<td>Asphalt coating</td>
</tr>
<tr>
<td></td>
<td>Paved invert</td>
</tr>
<tr>
<td>Nuts and bolts</td>
<td>Galvanized plate</td>
</tr>
<tr>
<td></td>
<td>Aluminum plate</td>
</tr>
<tr>
<td></td>
<td>&amp; A 153</td>
</tr>
<tr>
<td></td>
<td>Aluminum box Culvert</td>
</tr>
<tr>
<td></td>
<td>&amp; A 153</td>
</tr>
</tbody>
</table>

571.2 MATERIALS
571.2.1 General
The Contractor may provide aluminum or steel Structures, unless otherwise specified in the Contract.
Do not mix aluminum and steel Materials in an installation, except as specified for galvanized steel bolts and nuts on structural aluminum plate Structures.

571.2.2 Structural Plates
Provide steel structural plates in accordance with AASHTO M 167M.
Provide aluminum structural plates in accordance with AASHTO M 219M.

571.2.3 Fasteners
Provide fasteners for steel structural plates in accordance with AASHTO M 167M.
Provide fasteners for aluminum plate Structures in accordance with AASHTO M 219M.

571.2.4 Asphalt Coating
If required, protect structural plate Structures with asphalt coating in accordance with AASHTO M 190M. Provide field-applied coatings in accordance with AASHTO M 243M.
Coat fasteners extending outside of the pipe after installation. The Contractor may leave the portions of the fasteners extending inside the pipe uncoated.

Section 571: Structural Plate Structures Page 378
571.2.5 Design and Certification Requirements

571.2.5.1 Design

The Contractor is responsible for the structural design of metal box Culverts and other structural plate Structures with spans over 20 ft.

Design structural plate Structures in accordance with Section 12 of AASHTO's LRFD Bridge Design Specification.

At least 30 Days before beginning fabrication, submit to the State Bridge Engineer three sets of the following:
1. Complete design calculations;
2. Shop drawings; and
3. Construction details and installation instructions for long-span structural plate Structures and metal box Culverts.

The State Bridge Engineer will return one set, with notations, to the Contractor. Make the appropriate corrections and resubmit eight sets of calculations and drawings to the State Bridge Engineer for final review and approval.

Do not fabricate Materials until receipt of written notification of the Department's shop-drawings approval.

571.2.5.2 Certifications

Provide certificates to the Project Manager in accordance with Section 12 of AASHTO M 167M for Steel Structural Plates or Section 11 of AASHTO M 219M for Aluminum Structural Plates, and the Specifications, before installing the Structure at the project site.

571.3 CONSTRUCTION REQUIREMENTS

571.3.1 Assembling

When practical, connect plates with the seams and stagger them so that no more than three plates come together at one point.

Assemble structural plate Structures using bolts with a minimum 3/4 in diameter.

If assembling steel structural plates, apply from 100 lbf•ft to 300 lbf•ft of torque.
If assembling aluminum structural plates, apply from 100 lbf•ft to 200 lbf•ft of torque.

Tighten the longitudinal seams of joined plates, except for plates held in shape by cables, struts, or backfill.

571.3.1.1 Assembly Tolerances

Ensure that the plates do not vary from the specified dimension before backfill by more than 2% of the longest dimension (span or rise) or 5 in, whichever is less. However, only apply the 2% restriction for horizontal ellipse shapes having a ratio of top to side radii of three or less. When the rise of arches with a ratio of top to side radii of three or more, ensure that they do not vary from the specified dimension by more than 1% of the span.

571.3.1.2 Welding

Weld steel in accordance with ANSI/AASHTO/AWS Bridge Welding Code D1.5. Weld aluminum in accordance with AWS Structural Welding Code D1.2.

Ensure that qualified welders perform shop and field welding in accordance with Section 5 of ANSI/AASHTO/AWS Bridge Welding Code D1.5.

Perform welding on steel plates (other than fittings) before galvanizing.

571.3.2 Rejection of Damaged Materials

The Department may reject damaged or defective structural plate Structures or structural plates at any time during the construction operations, regardless of prior approval.

Replace installed Structures or plates that are damaged or that fail to meet the restrictions of structure shape in accordance with Section 571.3.1.1, “Assembly Tolerances,” at no additional cost to the Department.

571.3.3 Movement Monitoring

In long span structural plate Structures, place movement control devices at locations specified by the manufacturer for the entire length of the Structure. Ensure that a qualified representative continually monitors long-span structural plate Structures for movement to detect excessive distortion of the Structure shape due to progressive plate assembly, and Equipment and backfilling operations.

The Department will determine excessive distortion in accordance with Section 571.3.1.1,
“Assembly Tolerances,” and as a radius change more than 33% of the lower side plate of high-profile arches and the side plate of pear-shaped structures.
Upon completion of the Structure, submit the movement measurement records to the Project Manager with a statement certifying that any movements were within acceptable limits.

571.3.4 Excavation
Perform excavation in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures.”

571.3.5 Bedding and Backfill
Construct bedding Material for Culverts with closed bottoms in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures.”
Ensure that the backfill and bedding are in accordance with Table 571.3.5:1, “Electrochemical Criteria,” to ensure a 50-year service life.

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>pH</th>
<th>Resistivity, ohm-cm</th>
<th>Soluble salts, (\text{SO}_4), % by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvanized steel 2 oz coating</td>
<td>5.8–8.0</td>
<td>&gt;2,000</td>
<td>0.05</td>
</tr>
<tr>
<td>Galvanized steel 3 oz coating</td>
<td>5.0–10.0</td>
<td>&gt;2,000</td>
<td>0.05</td>
</tr>
<tr>
<td>Asphalt coating</td>
<td>*</td>
<td>&gt;2,000</td>
<td>0.075</td>
</tr>
<tr>
<td>Aluminum plate</td>
<td>4.0–9.0</td>
<td>&gt;500</td>
<td>0.125</td>
</tr>
</tbody>
</table>

*Lower the pH range of the galvanized pipe by one.

571.3.6 Backfill
Ensure that backfill Material is in accordance with soil classification A-1 or A-3 in AASHTO M 145, and compact it to at least 90% of maximum density in accordance with AASHTO T 180.
To avoid damaging the Structure, compact the initial 2 ft of backfill over the crown of the Structure with hand held Equipment or small compaction machinery. The Department defines the crown as the area between the points of compound curvature of top and side plates or the area between the location of longitudinal structural stiffeners.
The Department will not apply density requirements to the first two lifts of backfill placed over the crown of the Structure. Do not allow heavy machinery on the Structures, except for metal box Culverts, until the fill over the Structure is at least 4 ft deep, or 1/5 of the span, whichever is greater.

571.3.7 Repair of Damaged Coating
Repair damaged protective coating in accordance with AASHTO M 167M at no additional cost to the Department. Use zinc-rich paint in accordance with Federal Specification TT-P-641 or MIL-P21035.

571.4 METHOD OF MEASUREMENT—Vacant

571.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Plate Pipe</td>
<td>Foot</td>
</tr>
<tr>
<td>Structural Plate Pipe Arch</td>
<td>Foot</td>
</tr>
<tr>
<td>Metal Box Culvert</td>
<td>Foot</td>
</tr>
</tbody>
</table>

Excavation, disposal of unsuitable material, select backfill Material, placement and compaction of select backfill shall be included in the Bid Item Unit Price for each relevant pay item.
571.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the major items and will not be measured or paid for separately:

A. Submittals and design of structures;
B. Longitudinal stiffeners;
C. Reinforcing ribs;
D. Installation and removal of shoring or ties to maintain shape;
E. Repair of protective coating; and
F. Coating of the structures.
SECTION 572: CAST-IN-PLACE CONCRETE PIPE

572.1 DESCRIPTION
The Work consists of constructing cast-in-place monolithic concrete pipe in a prepared trench. The Department will allow the Contractor to use cast-in-place concrete pipe in a storm drain system. The Contractor shall determine the suitability of this construction method for use in the existing soil conditions on the project.

572.2 MATERIALS
Provide pipe that consists of portland cement, coarse and fine aggregates, admixtures (if required), and water in accordance with Section 509, “Portland Cement Concrete Mix Designs” for Special Class concrete, and the following requirements:
1. Hardened properties in accordance with Section 572.3.1, “Engineering Calculations;” and
2. Slump requirements in accordance with Table 572.2:1, “Slump Requirements.”

<table>
<thead>
<tr>
<th>Pipe diameter (in)</th>
<th>Slump (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;42</td>
<td>2.5 ± 1.5</td>
</tr>
<tr>
<td>42–72</td>
<td>2.5 ± 1.0</td>
</tr>
<tr>
<td>&gt;72</td>
<td>2.0 ± 0.5</td>
</tr>
</tbody>
</table>

572.2.1 Maximum Size of Coarse Aggregate
Use a concrete mix with a maximum sized aggregate that is no larger than one-third the size of the smallest clear space into which the Contractor shall place this concrete.

572.2.2 Mix Design
Prepare the mix design in accordance with Section 509, “Portland Cement Concrete Mix Designs.”

572.3 CONSTRUCTION REQUIREMENTS
572.3.1 Engineering Calculations
Provide engineering calculations supporting the use of cast-in-place concrete in the project soils with the Contract-required design loadings imposed. Use a qualified professional engineer licensed in the State of New Mexico to prepare the calculations.

572.3.2 Soil Conditions
Review the soil conditions and available geotechnical reports to ensure the project soils are competent to provide the specified trench.

572.3.3 Equipment
Construct the pipe with Equipment specifically designed for constructing cast-in-place monolithic concrete pipe. Obtain Project Manager approval of the Equipment before use. Provide evidence of successful operation of this Equipment on prior work.

572.3.4 Quality Control
Employ a quality control administrator (full-time employee or a consultant) who will be responsible for pipe quality. Provide the Project Manager with documentation that demonstrates the quality control administrator’s experience in the manufacture and placement of the pipe. Authorize the administrator to control the activities necessary to ensure a product that meets the Contract requirements including strength, grade, alignment, and wall thickness. Ensure that the administrator inspects the pipe construction and completes the field report form issued with the approved mix design supplied by the State Concrete Engineer. Have the administrator submit the completed form to the Project Manager on the first Working Day following each day work is performed on the pipe.

572.3.5 Dimensions of Cast-in-place Concrete Pipe
Provide cast-in-place concrete pipe with dimensions for the various sizes of pipe in accordance with Table 572.3.5:1, “Dimensions of Cast-in-place Concrete Pipe.”
Table 572.3.5:1  
Dimensions of Cast-in-place Concrete Pipe

<table>
<thead>
<tr>
<th>Inside diameter, D</th>
<th>Outside diameter, D'</th>
<th>Width of pipe trench, B</th>
<th>Wall thickness, t</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>30</td>
<td>31</td>
<td>3</td>
</tr>
<tr>
<td>27</td>
<td>33</td>
<td>34</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>36</td>
<td>37</td>
<td>3</td>
</tr>
<tr>
<td>36</td>
<td>43</td>
<td>44</td>
<td>3.5</td>
</tr>
<tr>
<td>42</td>
<td>50</td>
<td>51</td>
<td>4</td>
</tr>
<tr>
<td>48</td>
<td>58</td>
<td>59</td>
<td>5</td>
</tr>
<tr>
<td>54</td>
<td>65</td>
<td>66</td>
<td>5.5</td>
</tr>
<tr>
<td>60</td>
<td>72</td>
<td>73</td>
<td>6</td>
</tr>
<tr>
<td>66</td>
<td>79</td>
<td>80</td>
<td>6.5</td>
</tr>
<tr>
<td>72</td>
<td>86</td>
<td>87</td>
<td>7</td>
</tr>
<tr>
<td>78</td>
<td>91</td>
<td>92</td>
<td>7.5</td>
</tr>
<tr>
<td>84</td>
<td>100</td>
<td>101</td>
<td>8</td>
</tr>
<tr>
<td>96</td>
<td>114</td>
<td>115</td>
<td>9</td>
</tr>
<tr>
<td>108</td>
<td>129</td>
<td>130</td>
<td>10.5</td>
</tr>
<tr>
<td>120</td>
<td>144</td>
<td>145</td>
<td>12</td>
</tr>
</tbody>
</table>

Note: All dimensions are in inches.

572.3.6 Excavation and Backfill
Excavate and backfill in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures,” except as modified in Section 572.3.6.1, “Trench Excavation.”

572.3.6.1 Trench Excavation
Construct the pipe in native soil capable of standing unsupported from the bottom of the trench to the top of the pipe without sloughing. The Contractor may construct the pipe in a fill section if it is compacted to at least 90% of the maximum dry density if tested in accordance with ASTM D 1557.

Excavate the trench to the lines and grades established by the Project Manager. Use a laser or other electronic Equipment to control the grade of the trench. Shape the trench to form the bottom outside of the pipe. Grade and prepare it to provide full, firm, and uniform support by the undisturbed earth, or rock, over a minimum of the bottom 210° of the outside of the pipe.

When soft, spongy, or unstable Material appears in the pipe or in the bottom of the trench, remove the Material as directed by the quality administrator and the Project Manager. Backfill the resulting area with Material compacted to 90% of the maximum dry density in accordance with ASTM D 1557.

If boulders or rocks are in the bottom or sidewalls of the trench, remove them to at least 6 in from the nearest surface of the pipe. Next, backfill the space, and compact and reshape it as required for unsuitable Materials.

If necessary to provide stability in the trench, slope the trench walls from a point 12 in above the top of the pipe to the top of the trench, as required by soil conditions. Limit the pitch of the slope to a safe degree of stability that meets OSHA requirements for trench safety.

572.3.7 Placement
Remove water entering the trench before constructing the pipe. Keep adjacent surfaces free of standing water, mud, and debris. Thoroughly moisten dry surfaces adjacent to the concrete being placed with water to keep it from drawing moisture from the freshly placed concrete.

Place the concrete around the full circumference of the pipe in one placement with fixed and traveling metal forms. Keep the invert of the pipe available for inspection during the placing of the concrete. Keep concrete free of rock pockets, and completely fill the forms.

Achieve concrete consolidation with internal mechanical tampers or consolidation rings and vibrators that are an integral of the pipe forming Equipment. Use tamping and vibration to consolidate the concrete and secure a good bond between the pipe and the supporting soil. The Project Manager may require the use of a spud-type vibrator in the hopper to assist the flow and consolidation of the concrete.
572.3.7.1 Forms
Use a fixed metal form that is strong enough to withstand vibrating or tamping, and ensure that workmen walking on the forms do not cause springing, bulging, or other types of distress.
Ensure that the forms do not vary more than 1/2 in from the lower edge of a straight edge laid parallel to the centerline of the form, and keep it free of holes larger than 0.6 in.
Ensure that the flow line of the finished pipe does not vary more than 0.1 ft from the specified grade.

572.3.7.2 Construction Joints
At the end of a day's placement, or when placement operations are interrupted for more than 30 min, form a construction joint. At construction joints, bevel the pipe walls downward at an approximate 45° angle, and leave rough. Embed 1/2-inch reinforcing bars that are 24 in long into the ends of the pipe walls. Space the reinforcing bars at 12 in on center for pipes with diameters 42 in and smaller, and at 18 in on center for pipes with diameters larger than 42 in.
Before placing concrete, clean Deleterious Material from construction joints and moisten them.

572.3.7.3 Cover and Backfill
Ensure that the cover, measured from the top of the pipe to the bottom of thesurfacing, is not less than 24 in. Do not place backfill on pipes until the concrete has developed a compressive strength of at least 2,500 psi.

572.3.7.4 Temperature
Refer to Section 511.3.3, "Temperature and Weather Limitations."

572.3.7.5 Curing and Protecting Concrete
Place polyethylene film in accordance with ASTM C 171 (except provide a 0.0015-inch nominal thickness) on the exposed top surface of the pipe immediately after casting the pipe. Immediately cover the film with up to 3 in of moist soil to hold the film in place and protect the pipe. Maintain a humid atmosphere within the pipe, evidenced by condensation on the interior surface, for at least 7 Days after placement. However, do not exceed the maximum period of 24 h for removing forms and making repairs. Keep the ends covered except when conducting work on the inside of the pipe. Leave other openings open so that the inside of the pipe can cure effectively.

572.3.8 Inspection and Repair of Pipe
After removing the forms, make required repairs. Repair the offsets and indentations of the following size:
1. Larger than 0.25 in, for pipes with internal diameters of 42 in or less;
2. Larger than 0.38 in, for pipes with internal diameters from greater than 42 in to less than 72 in;
3. Larger than 1/2 in, for pipes with internal diameters of 72 in and greater.
Repair defects not extending through the pipe wall and less than 2 ft², as directed by the Project Manager. Repair holes cut in the pipe, as directed by the Project Manager.

572.3.8.1 Crack Repairs
Perform interior crack repairs after backfilling.
Clean and fill transverse cracks with a width of 0.05 in or more with an elastomeric compound approved by the Project Manager. Ensure that the elastomeric compound penetrates into the crack at least 0.37 in.
The Department defines a longitudinal crack as a crack generally oriented within 30° of the pipe alignment. The Department may reject pipes with the following longitudinal cracks:
1. A crack that has caused a surface fault within the pipe with a displacement greater than 0.08 in;
2. A crack with a width greater than 0.0005 times the outside diameter of the pipe, that can be penetrated by a standard machinist gauge leaf in accordance with AASHTO T 280; or
3. A crack with a width greater than 0.05 in, that can be penetrated by a standard machinist gauge leaf in accordance with AASHTO T 280.
The Project Manager may allow pipes with longitudinal cracks to remain in place. In such a case, repair the cracks by full-depth epoxy grouting.

572.3.8.2 **Rejection of Pipe**

The Department may reject a pipe for any of the following conditions:

1. Rock pockets, blisters, voids, fractures, porous concrete or similar defects that extend through the pipe wall or exceed 2 ft² (pipe may be rejected for 1 ft on each side beyond the limits of the defects);
2. The pipe is damaged during construction; or
3. Contractor does not repair other cracks and defects as directed by the Project Manager.

Replace rejected sections of pipe at no additional cost to the Department. Make the finished surface of the concrete pipe equivalent to a wood float surface, substantially free of fractures, cracks, and roughness.

572.3.8.3 **Verification of Wall Thickness**

If requested by the Project Manager, drill four ¾ in diameter holes at approximately 20-foot intervals, in the walls of the pipe to verify thickness. Drill one hole in the top, one hole in the bottom, and one hole in each side of the pipe, as directed by the Project Manager. If a deficient wall thickness exists, drill enough additional holes to determine the nature and extent of the deficient thickness.

572.4 **METHOD OF MEASUREMENT**

The Department will include branch connections, elbows, collars, and tees in the length measurement for the pipe.

572.5 **BASIS OF PAYMENT**

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast-in-Place Concrete Pipe</td>
<td>Foot</td>
</tr>
</tbody>
</table>

572.5.1 **Work Included in Payment**

Excavation, disposal of unsuitable material, select backfill Material, placement and compaction of select backfill shall be included in the Bid Item Unit Price for each relevant pay item.
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SECTION 601: REMOVAL OF STRUCTURES AND OBSTRUCTIONS

601.1 DESCRIPTION
This Work consists of removing and salvaging, or disposing of buildings, fences, Structures, utility lines, pavement in its entirety or partially to neat cut or saw cut lines, and other obstructions.

This Work also includes salvaging specified materials and backfilling the resulting trenches, holes, and pits.

The Contractor shall repair salvageable items that are damaged during removal, whether designated for removal in the Contract or by the Project Manager, at no additional cost to the Department.

601.2 MATERIALS—Vacant

601.3 CONSTRUCTION REQUIREMENTS

601.3.1 General
If the Contract identifies material for salvage, remove the material and return to the Department in a transportable condition. Store this material in accordance with the Contract.

Notify the Project Manager in writing of disposal details for material not identified as salvage.

Destroy unusable, non-hazardous combustible material. Dispose of non-hazardous, non-combustible material. If the Contractor disposes of this material outside the Right of Way, provide the Project Manager with a copy of the written permission from the property owner.

Backfill holes created by Structure removal. If the hole is within the Roadway Prism, compact in accordance with Section 203.3.5, “Embankments,” and Section 203.3.7, “Moisture and Density Control.” Break up concrete aprons or surfacing before burying to allow water to drain.

Provide a list of removals to the Project Manager at the preconstruction conference, with the following information for each:
1. A percent of the pay item amount; and
2. A monetary value.

601.3.2 Removal of Bridges, Culverts, and Other Drainage Structures
Remove existing Structures in a streambed down to the stream bottom. Remove existing Structures outside the stream to 1 ft below the ground surface. Remove more of the existing Structure if necessary to accommodate a new Structure.

If dismantling a steel or wood Bridge, minimize damage to the removed material if identified as salvageable, match-mark the steel members (unless otherwise approved by the Project Manager), and store salvaged material in accordance with Section 601.3.1, “Construction Requirements, General.”

If removed concrete is specified for use as riprap in the Contract, crush and stockpile as directed by the Project Manager.

601.3.3 Removal of Pipe
Minimize damage while removing existing pipe. If the Project Manager identifies existing pipe as reusable, store the reusable pipe, minimizing loss or damage.

601.3.4 Removal of Pavement, Sidewalks, Curbs, and Gutters
Break concrete items including pavement, Sidewalks, curbs, and gutters, and dispose of them in accordance with Section 601.3.1, “Construction Requirements, General.”

If approved by the Project Manager, recycle existing ballast, Base Course, gravel; asphalt Material, and other surfacing Materials in accordance with Section 107.14.7, “Disposal of Removed Asphalt Pavement Material.” The Contractor is responsible for disposing of excess material in accordance with Section 601.3.1, “Construction Requirements, General.”

601.3.4 Removal of Fence
Salvage fence materials, unless otherwise specified in the Contract. Place barbed wire into single-strand rolls. Minimize damage when pulling posts.
601.3.6 Hauling and Stockpiling Salvageable Material
If the Contract requires the Contractor to haul and stockpile salvageable material, load, haul, unload, and stockpile the materials in accordance with the Contract. Minimize damage to the material.
Place the salvageable material on blocks or other approved materials and maintain the stockpile area, as directed by the Project Manager.

601.3.5 Demolition
If the Contract requires demolition, remove the existing Structures and restore to the existing surface.
Before beginning demolition, coordinate disconnection of utility services with the appropriate utility owner.
Immediately repair broken or damaged utilities, at no additional cost to the Department.

601.4 METHOD OF MEASUREMENT—Vacant

601.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of Structures and Obstructions</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>Removal of Surfacing</td>
<td>Lump Sum or Square Yard</td>
</tr>
<tr>
<td>Demolition</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>

The Department will make partial payments based on the percent complete of each item on the list of removals provided to the Project Manager at the preconstruction conference.
The Department will not make additional payment for minor removals not specified in the Contract.

601.5.1 Work Included in Payment
1. No direct payment will be made for filling cavities left by structure removal, and the work shall be considered incidental to the applicable items;
2. No direct payment will be made for loading, hauling, unloading, and satisfactorily stockpiling salvageable material and the work shall be considered incidental to the applicable items;
3. Saw cutting when designated on contract.
602.1 DESCRIPTION
This Work consists of providing and placing riprap, gabions, revetment mattresses, sacked concrete revetment, concrete block revetment, wrapped rock faces, and other systems on the Embankment slopes and the sides and bottoms of channels, drain outlets, ditches, and other such locations.

602.2 MATERIALS
Unless otherwise specified in the Contract, provide slope protection structures as follows:
1. Hexagonal double-twisted wire mesh riprap, gabions, and revetment mattresses; or
2. Welded wire mesh gabions, revetment mattresses, and wrapped rock faces.

Provide galvanized slope protection items in accordance with ASTM A 641. If specified in the Contract, coat galvanized items with PVC in accordance with Section 602.2.2.2.9, “PVC Coating.”

Provide double-twisted riprap, gabions, and revetment mattresses in accordance with ASTM A 975. Provide welded wire mesh gabions, revetment mattresses, and wrapped rock faces in accordance with ASTM A 974.

602.2.1 Classifications
The Department will classify riprap and gabions in accordance with Table 602.2.1:1, “Riprap Classifications and Gabion Requirements.”

Provide riprap with at least 80% of the stones meeting the specified size requirements. Use stones less than the minimum dimensions to fill voids. For riprap Class A, wrapped rock faces, and gabions, do not use stones smaller than the mesh openings.

Table 602.2.1:1
Riprap Classifications and Gabion Requirements

<table>
<thead>
<tr>
<th>CLASS</th>
<th>DESCRIPTION</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Minimum dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Wire enclosed riprap</td>
<td>1/6</td>
<td>2/3</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>Non-enclosed riprap</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>Non-enclosed riprap</td>
<td>2</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>D</td>
<td>Derrick stone</td>
<td>14</td>
<td>27</td>
<td>12</td>
</tr>
<tr>
<td>E</td>
<td>Grouted riprap</td>
<td>1/3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>F</td>
<td>Grouted riprap</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>G</td>
<td>Rock plating</td>
<td>—</td>
<td>—</td>
<td>4–8</td>
</tr>
<tr>
<td>N/A</td>
<td>Wrapped rock facing</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>N/A</td>
<td>Gabions</td>
<td>—</td>
<td>—</td>
<td>4–8</td>
</tr>
</tbody>
</table>

*Minimum size in the least dimension.
*Class B and C stone — at least two Fractured Faces.
*70% to 80% of the stone — at least 4 in but not more than 8 in in the smallest dimension. 30 to 20% of the stone — no larger than 4 in in any dimension.

602.2.2 Riprap, Gabions, and Revetment Mattresses

602.2.2.1 Stone for Riprap, Gabions, Revetment Mattresses, and Rock Faces
Except for Class G riprap, provide rocks or rough quarry stone with no more than 60% wear, in accordance with AASHTO T 96. Provide stone with a soundness loss of no more than 21, in accordance with AASHTO T 104 using a magnesium sulfate solution with a five-cycle test duration.

Provide stone for riprap, gabions, revetment mattresses, and rockfaces in accordance with Section 602.2.1, “Classifications.”

602.2.2.2 Wire Mesh
Provide non-raveling, double-twisted wire mesh forming hexagons for riprap, gabions, and revetment mattresses in accordance with Section 602.2.2.3, “Pull-Apart Test.” Provide non-raveling welded wire mesh for gabions, wrapped rock faces, and revetment mattresses forming squares or rectangles in accordance with ASTM A 974, Section 7, Material Properties, except that the strength requirement for mattress joints is 900 lb per foot instead of 600 lb per
602.2.2.2.1 Wire
Provide soft temper wire with a Class 3 zinc coating for constructing wire mesh in accordance with ASTM A 641. Provide 0.120-inch diameter wire for gabions and riprap; and 0.087-inch diameter wire for revetment mattresses and wrapped rock faces.

602.2.2.2 Mesh Openings
Ensure that mesh openings are uniform and hexagonal. Make mesh openings for riprap and double-twisted gabions approximately 3 1/4 in × 4 3/4 in, and for double-twisted revetment mattresses approximately 2 1/2 in × 3 1/4 in. Make mesh openings for welded wire mesh gabions approximately 3 in × 3 in, and for welded wire mesh revetment mattresses and wrapped rock faces approximately 1 1/2 in × 3 in.

602.2.2.2.3 Selvedges
Mechanically selvedge the edges of double-twisted gabions, revetment mattresses, and wrapped rock face, including, end panels and diaphragms. Use a selvedge wire with a diameter of at least 0.150 in.

602.2.2.2.4 Lacing and Tie Wire
Provide lacing wire for double-twisted gabions, revetment mattresses, and wrapped rock faces with a diameter of at least 0.087 in. Provide tie wire for double-twisted gabions and revetment mattresses with a diameter of at least 0.087 in. Provide tie wire for riprap with a diameter of at least 0.120 in. Provide lacing and tie wire with the same tensile strength and coating as the mesh wire.

602.2.2.2.5 Spiral Binders
Provide spiral binders for welded wire mesh gabions, revetment mattresses, and wrapped rock faces, of the same wire quality as the mesh wire with a diameter of at least 0.106 in. Unless otherwise approved, provide spiral binders with a maximum inside diameter of 2 1/2 in and with a maximum pitch of 3 in.

602.2.2.2.6 Alternate Fasteners
The Contractor may use alternative fasteners, such as ring fasteners, with double-twisted wire mesh, and welded wire mesh riprap, gabions, revetment mattresses, and wrapped rock faces, if approved by the Project Manager. Provide wire for alternative fasteners in accordance with Section 602.2.2.2.5, “Spiral Binders.”

602.2.2.2.7 Minimum Strength of Fasteners
Use fasteners that provide a minimum strength of 1,400 lb per foot for gabion baskets, and 900 lb per foot for revetment mattresses and wrapped rock faces.

602.2.2.2.8 Approval of Alternative Fasteners
Use a certified Laboratory to test alternative fasteners in accordance with Section 602.2.2.3, “Pull-Apart Test.” At least 60 Days before using alternative fasteners, submit CTRs to the Project Manager verifying that the fasteners meet the pull-apart test requirements.

602.2.2.2.9 PVC Coating
Provide PVC coating with an average thickness of 0.0216 in and a minimum thickness of 0.0150 in per side. Apply PVC coating over the galvanizing.
Coat the galvanized wire with extruded or fusion bonded PVC Material. Unless otherwise specified, use a gray or green colored coating. Use a PVC coating that meets the following requirements:

1. Specific gravity of from 1.20 to 1.40, if tested in accordance with ASTM D 792;
2. Abrasion resistance of less than 12% weight loss, if tested in accordance with ASTM D 1242-95A, Method B at 200 cycles, CSI-A Abrader Tape, 80 grit;
3. Brittleness temperature no higher than 15° F, if tested in accordance with ASTM D 746;
4. Tensile strength no less than 2,980 psi for extruded coating, if tested in accordance with ASTM D 412; and no less than 2,275 psi for fusion bonded coating, if tested in accordance with ASTM D 638;
5. Modulus of elasticity no less than 2,700 psi at 100% strain for extruded coating, if tested in accordance with ASTM D 412; and no less than 1,980 psi at 100% strain for fusion bonded coating, if tested in accordance with ASTM D 638;
6. Ultraviolet light exposure for a test period of no less than 3,000 h, using apparatus Type E at 145 °F, if tested in accordance with ASTM G 152;
7. Salt spray test for a test period of no less than 3,000 h, if tested in accordance with ASTM B 117.

602.2.2.3 Pull-Apart Test
602.2.2.3.1 Sample Preparation

Prepare two identical rectangular panels along a selvedge wire, each about 10 1/2 mesh-openings wide. Attach the two panels along the two selvedge wires using the proposed fastener system. If the Contractor uses alternative fasteners to join two individual gabion baskets, the Contractor shall include two additional selvedge wires (each mechanically wrapped with mesh wires) so that each fastener contains two selvedges and two mesh wires.

602.2.2.3.2 Test Procedures

Mount the joined test panels in a loading machine with grips or clamps that secure the panels uniformly along the full width. Use grips or clamps designed to transmit only tension forces. Apply the load at a uniform rate of 50.7 lb per second until failure occurs. The Department will define failure as a drop in strength under continuous loading or, when an opening between two joined selvedge wires exceeds 2 in. The minimum allowable strength at failure is 1,400 lb per foot for joined gabions; and 900 lb per foot for joined revetment mattresses and wrapped rock face panels.

602.2.2.4 Certification

Submit a certificate, to the Project Manager, stating that the following proposed items meet the requirements of this specification before their use:

1. Wire mesh;
2. Gabion baskets;
3. Lacing wire;
4. Tie wire; and
5. Approved alternative fastener systems.

602.2.2.5 Stakes

Use steel railroad rails, standard weight galvanized steel pipe, or steel angles for riprap stakes. Use railroad rails with a unit weight of at least 30 lb per yard. Use standard weight galvanized steel pipe with a minimum outside diameter of 4 in. Use steel angles that are at least 4 × 4 × 3/8 in.

602.2.2.6 Grout

Provide portland cement, aggregate, and water for grout in accordance with Section 509, “Portland Cement Concrete Mix Designs.”

602.2.2.7 Material

Provide geotextile (filter fabric) Class 1 as per section 604 “Soil and Drainage Geotextiles”

602.2.3 Sacked Concrete Revetment

Provide sacked concrete revetment from a vendor on the Department’s Approved Products List. Provide bags of concrete that weigh from 60 lb to 80 lb each, dry weight, and
contain from 0.018 yd³ to 0.025 yd³ of concrete. Ensure each bag contains one of the following mixes:
1. One part cement to three parts sand;
2. A mix design in accordance with the Contract; or
3. A mix design approved by the State Materials Bureau.

Provide a concrete mix capable of attaining a minimum compressive strength of 3,500 psi after 28 Days, unless otherwise specified in the Contract. Keep the sacked concrete in dry storage until application.

602.2.3.1 Packaging
Use permeable, biodegradable sacks made of jute, cotton, or scrim-reinforced paper that are capable of holding the sand-cement mix without significant leakage and allowing sufficient water to hydrate the concrete mix.

Provide non-asphaltic, three-layer laminated, polyester-fiber-scrim-reinforced paper sacks. Perforate each of the three layers and offset the perforations to prevent cement leakage.

Use only one type and size of sack throughout the project, unless otherwise specified in the Contract.

602.3 CONSTRUCTION REQUIREMENTS

602.3.1 General Placement Requirements
Place riprap stones forming a continuous blanket in accordance with the Contract. Unless otherwise specified, construct rock plating using riprap Class G to minimum thickness of 12 in. Place stones with the long axis parallel to the toe of the slope, with a stable bearing upon the underlying soil or stones.

Place large stones as close together as possible. Use smaller stones to fill the areas between the larger stones, except when the Contract requires Class E or F (grouted) riprap. Ensure that the finished riprap surface varies no more than 3 in from the specified slope; and derrick stone riprap varies no more than 8 in from the specified slope.

Unless otherwise specified, place the riprap foundation course in a trench excavated to 24 in below the toe of the slope of the Embankment or side of channel.

Place a layer of Class 1 geotextile filter fabric between the slope and erosion protection structures, and the backfill Material.

602.3.1.1 Grouted Riprap Placement
Fill riprap voids with grout to the full riprap thickness. After placing grout, sweep the riprap surface with a stiff broom.

Protect grout from freezing for at least four Days after placement.

Cure grouted riprap placed in hot, dry weather in accordance with Section 511.3.9, “Curing.”

602.3.1.2 Proportioning and Mixing Grout
Use grout that consists of one part portland cement and three parts fine aggregate (by
602.3.1.3 Class A Riprap Placement
Enclose Class A riprap with wire mesh drawn tightly on all sides. The Contractor may connect wire mesh using approved fasteners or lacing wire. Weave adjacent edges at least once with double loops of lacing wire that is as strong and flexible as the mesh.
Provide continuous lacing as far as possible that passes through each mesh opening. Where splicing is necessary, overlap the lacing at least 12 in.
Space galvanized wire ties connecting top and bottom mesh layers approximately 24 in on centers. Anchor the ties to the bottom wire-fabric layer. Extend the ties through the rock layer and secure to the top wire-fabric layer. Anchor wire-enclosed riprap to slopes with steel stakes driven into the Embankment. Space stakes in accordance with the Contract.

602.3.1.4 Placement of Geotextile
Place Class 1 non-woven geotextile (filter fabric) between the riprap or revetment mattresses and the supporting soil. Ensure that the fabric is in accordance with Section 604, “Soil and Drainage Geotextiles.”

602.3.2 Sacked Concrete Revetment Placement
Place sacked concrete revetment within ± 0.2 ft of the specified grade and slope, or as directed by the Project Manager.
Place the foundation course in a trench excavated to 24 in below the toe of the slope of the Embankment or side of channel. Stagger the sack ends and steel staple anchors of succeeding courses.
Tamp each row of sacks, round out the bags, eliminate wrinkles, minimize voids, and prepare an even surface for the next row.
Obtain the Project Manager’s approval of the compaction method prior to backfill and compact soil behind each row of sacks before placing the next row. Do not place large stones and jagged objects adjacent to the bags.
Anchor the sacks with steel staples without damaging the sacks.
After placing the sacks, wet thoroughly and keep moist for at least three Days.

602.3.3 Concrete Block Revetment Placement
Construct concrete block revetment systems in accordance with the manufacturer’s recommendations and the Contract.
Remove slope obstructions, and fill voids with approved Material or grade slopes before placing concrete blocks.

602.3.4 Gabions
Supply gabions within ± 5% of the manufacturer’s stated sizes.

602.3.4.1 Assembly of Gabion Baskets
Fabricate gabions for individual assembly at the construction site.
If a gabion is greater than 1 1/2 times as long as it is wide, divide the gabion into cells using diaphragms of the same wire mesh as the body of the gabion. Create cells that are no longer than the gabion is wide and anchor diaphragms to the base section of the gabion.
Selvedges or bind perimeter edges so the joints are as strong as the gabion body.
Assemble perimeter edges using approved fasteners or lacing wire. Place fasteners in each mesh opening. Secure lacing wire by double looping through every other mesh opening.
Assemble gabions using one of the following:
1. Double looped lacing twice; or
2. Connect with approved fasteners and double looped lacing once.

602.3.4.2 Foundation Preparation
Level and compact the top 6 in of the gabion foundation to at least 95% of maximum density in accordance with AASHTO T 99, and to field densities in accordance with AASHTO T 310.

602.3.4.3 Placement of Gabion Baskets
Set assembled, empty baskets into the specified positions and wire each unit to adjacent units along the top and vertical edges before placing stone.
602.3.4.4 Placement of Gabion Stone
Place stone in equal layers of from 9 in to 12 in. Minimize local deformations by not filling a gabion more than 12 in higher than an adjacent gabion. Hand place stone at exposed surfaces.

Provide cross-connecting wires on gabions with cells 18 in or higher. Place cross-connecting wires directly above each layer of stone. Equally space and tightly tie two connecting wires in each direction for each layer through two mesh openings at opposite faces of each gabion cell.

Maintain alignment while filling gabions (minimizing voids and bulges, and finishing to a neat square appearance).

After filling, bend the lid over and tightly bind to the perimeters and diaphragms in accordance with Section 602.3.4.1, “Assembly of Gabion Baskets.”

602.3.4.5 Gabion Marking
Mark each gabion in an identifiable manner that clearly indicates its size.

602.3.4.6 Placement of Geotextile
Install Class 1 non-woven geotextile (filter fabric) between gabion baskets and supporting soil, and between gabion baskets and backfill.

602.3.5 Placement of Wrapped Rock Faces
Place wrapped rock faces within ± 0.2 ft of the specified grade and slope.
Place the foundation course 18 in below the toe of the slope of the Embankment or side of channel.
Place each level of welded wire forms with biaxial geogrid embedded in the rock face in accordance with the Contract, and tensioned with anchor pins to remove slack. Lap the geogrid a minimum of 12 in at the edges of adjacent panels. Tamp the welded wire form face to eliminate wrinkles, minimize voids, and finish to an even surface.
Backfill and compact behind each welded wire form level before placing the next row. Obtain the Project Manager's approval of the compaction method.

602.4 METHOD OF MEASUREMENT
The Department will measure Riprap Class-and Sacked Concrete Revetment ___ based on the specified thickness and accepted surface area.

The Department will measure Concrete Block Revetment and Wrapped Rockfacing based on the accepted surface area.

The Department will measure Gabions and Revetment Mattresses based on the specified basket dimensions.

602.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
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<tr>
<td>Riprap Class G</td>
<td>Square Yard</td>
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<tr>
<td>Sacked Concrete Revetment</td>
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<tr>
<td>Concrete Block Revetment</td>
<td>Square Yard</td>
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<tr>
<td>Gabions</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Revetment Mattresses</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Wrapped Rockfacing</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

602.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:
- Excavation, backfilling and disposal of material required for the placement of slope and erosion protection structures;
- Dewatering;
- Stakes and steel staples, drainage geotextile(s).
603.1 DESCRIPTION
This Work consists of constructing, inspecting, and maintaining erosion and sediment control facilities for the discharge of storm water associated with construction activity.

603.1.1 Storm Water Pollution Prevention Plan
The Storm Water Pollution Prevention Plan (SWPPP) contains an information sheet and the following forms:
1. Notice of Intent (NOI);
2. Storm Water Program;
3. Storm Water Management;
4. NPDES General Construction Storm Water Permit Checklist, and
5. Contractor Certification for NPDES General Permit for Storm Water Discharges from Construction Sites;
The information sheet provides the following:
6. A site description;
7. NOI inputs;
8. Drainage parameters;
9. Runoff, discharge, and volume calculations; and
10. General notes.
The information sheet is included in the Plans. For more information on SWPPP, see Section 603.1.1.2, “Department Responsibilities.” The NPDES General Permit, issued by the EPA requires an SWPPP and submittal of NOI for construction projects with 1 acre or more of earth disturbance. The Department will not require an SWPPP or an NOI if the Contractor will disturb less than 1 acre of earth and the project is not located in the vicinity of perennial streams.

603.1.1.1 Temporary Erosion and Sediment Control Plan
The Temporary Erosion and Sediment Control Plan (TESCP) depicts the location, type, and length of temporary erosion control measures, off-site flows, discharge locations, and flow paths within the Right of Way on plan and profile sheets. For more details on TESCP, see Section 603.1.1.2, “Department Responsibilities.” The Department will prepare the TESCP and include it in the Plans. The TESCP will define erosion and sediment control measures that are a part of the Work. Construct the control facilities and maintain them until project completion. The Contractor shall prepare a TESCP based on the Contractor’s construction phasing and schedule. Define erosion and sediment control measures, locations of control facilities, and placement and removal dates, by phase or major construction activity. Update the TESCP to reflect field modifications of control measures and modify the Department’s TESCP, as necessary. The Department will consider the TESCP as part of the project SWPPP.

603.1.1.2 Department Responsibilities
The Department will prepare and include in the Plans a TESCP, a Re-vegetation/Erosion Control Plan, and a SWPPP information sheet. Use the TESCP to estimate quantities.
The TESCP sheets will include the following:
1. Site maps;
2. Drainage patterns;
3. Discharge locations;
4. Approximate slopes;
5. Areas of soil disturbance;
6. Major controls locations;
7. Structural practices;
8. Surface waters (including wetlands);
9. Conditions before and after construction;
10. Right of Way lines;
11. Easements;
12. Existing and new structures;
13. Existing and proposed Roadway grades; and
14. Detours;
The Re-vegetation/Erosion Control Plan sheet will provide a description and timing...
of final stabilization practices.

The SWPPP information sheet will include the following information:
1. Nature of the activity;
2. Proposed construction phasing;
3. Total site area;
4. Total disturbed area;
5. Runoff coefficient for pre/post construction;
6. Receiving waters;
7. Latitude and longitude of the site;
8. Estimate of likelihood of discharge;
9. Endangered species or critical habitat;
10. Part I.B.3.e.(2) of the NPDES General Permit; and
11. Basic drainage and site information required for SWPPP development;

Submit the SWPPP to the Project Manager for approval.

603.1.1.3 Contractor Responsibilities

Before disturbing any soil, submit to the Project Manager an SWPPP based on the planned construction phasing and schedule. Prepare amendments to the SWPPP as Work progresses or as phasing or scheduling changes are made. Specifically define control measures for each construction phase, comply with provisions of the NPDES General Permit, and include at least the following items or activities:

1. TESCP;
2. The dates and locations of planned and actual clearing and grubbing activities, earthwork activities, and construction of permanent erosion control features;
3. A description of the when, where, and why of permanent best management practices;
4. A description of the when, where, and why of control practices used to divert flows from exposed soils;
5. A description of construction waste materials stored on site and controls used to minimize pollution from these materials; and

Include proposed methods for minimizing or eliminating pollution of streams, lakes, reservoirs, canals, and other water impoundments from storm water discharge associated with construction activities. Obtain information needed to develop or modify the SWPPP from the Plans, or from the Project Manager within 7 Days of a request. Do not start earth-disturbing activities until 7 Days after the NOI has been posted on the EPA’s website as active.

Develop the SWPPP using a combination of structural, non-structural, and vegetative best management practices (BMPs) to control erosion and sedimentation and manage storm water. Refer to the recommendations in the current version of the Department’s National Pollutant Discharge Elimination System Manual: Storm Water Management Guidelines for Construction and Industrial Activities.

Provide a signed, certified statement that states the terms and conditions of the NPDES General Permit are fully understood. Include a statement of intent to fully implement the SWPPP as proposed or modified at the pre-construction meeting in the certification.

Maintain the SWPPP in accordance with the NPDES General Permit until the project is completed.

603.1.2 Retention of Records

Retain and maintain SWPPP changes as required by the NPDES General Permit. Include copies of the permit language and inspection and maintenance reports in the SWPPP. Prepare inspection and maintenance reports from commencement of earthwork activities to project completion. Deliver the SWPPP to the Project Manager at project completion. Ensure that these records are available to the public at all times.

603.1.3 Notice of Intent (NOI)

Provide an NOI to the Project Manager that meets the NPDES General Permit requirements for discharge of storm water associated with construction activities.

The Department and the Contractor will prepare and submit separate NOIs to the EPA, designating the status of owner/operator. Do not begin earth-disturbing activities until 7 Days after the NOIs are listed on the EPA website as “active.” The EPA will post NOI approvals on their website. The Contractor shall submit a copy of the Contractor’s NOI to the Project Manager.
603.1.4 Notice to Termination (NOT)
Prepare and submit a NOT to the EPA within 30 Days after project completion, indicating that the operator of the project has changed to NMDOT. Provide a copy of the submittal to the Project Manager.

603.1.5 Off-Site Pollution Prevention Plan
Prepare and submit an SWPPP and NOI, if required, to appropriate agencies for Work performed outside the project Right of Way. The Contractor is responsible for filing the NOT for the off-site locations. Comply with NPDES requirements for off-site locations. Provide a copy of each submittal to the Project Manager.

603.1.6 Liquidated Damages
Failure to comply with the NPDES program may result in EPA citations.
If the Contractor does the following, the Department will assess liquidated damages in accordance with Table 603.1.6:1, “Liquidated Damages Schedule;”
1. Fails to maintain temporary erosion control measures in accordance with Section 603.3.6, “Erosion Control Inspection and Maintenance;”
2. Fails to document inspection and maintenance activities; or
3. Fails to document (in a timely manner) field changes of erosion control measures as directed in writing by the Project Manager.

<table>
<thead>
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<th>Total Original Contract Amount ($)</th>
<th>Charge per Calendar Day ($)</th>
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<td>1,500</td>
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<tr>
<td>&gt;10,000,000</td>
<td>2,000</td>
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</tbody>
</table>

The Project Manager will keep a schedule of noncompliance that the Department will use to calculate liquidated damages. The Department will assess liquidated damages until the Project Manager issues a written notice of compliance to the Contractor.
If the Contractor’s failure to adhere to the NPDES General Permit requirements results in a fine assessed against the Department, reimburse the Department within 10 Days of the assessment. If the Contractor does not reimburse the Department within the 10 Days, the Department may pay the fine assessed and withhold the fine amount from the Contractor’s next partial payment.

603.2 MATERIALS
603.2.1 General
Provide Materials for erosion and sediment control measures that consist of siltation fences, socks, rock, riprap, soil retention blankets, or other acceptable measures approved by the Project Manager.

603.2.2 Slope Drains
Provide Materials for slope drains that consist of pipe, flexible pipe, and riprap. The Project Manager may approve the use of other Materials.

603.2.2.1 Pipe
See Section 570, “Pipe Culverts” for approved types of pipe.

603.2.3 Geotextiles
603.2.3.1 Drainage Geotextiles
Provide drainage geotextiles (Class B drainage applications) for silt fence in accordance with Section 604, “Soil and Drainage Geotextiles,” unless otherwise specified in the Contract.

603.2.3.2 Soil Retention Blanket
Provide a soil retention blanket from the Department’s Approved Products List, or as
603.2.4 Riprap
   Provide riprap and rock plating in accordance with Section 602, “Slope and Erosion Protection Structures.”

603.2.5 Temporary Soil Stabilant
   Provide a temporary soil stabilant from the Department’s Approved Products List, or as specified in the Contract and approved by the Project Manager.
   Ensure that the soil stabilant contains an anti-foaming agent and color additive to assist in its uniform application and disappears from the surface within 36 hours after application.

603.2.6 Mulch Socks or Composted Mulch Socks
   Core Material (Mulch): See Section 632, “Seeding” for mulch and composted mulch specifications.
   Core Material (woodchips): The Material must be 100% untreated wood chip and free of inorganic debris, such as plastic, glass, metal, etc. Manufacturer shall certify that the material is free of noxious weeds.
   Woodchip size shall not be smaller than 1 inch and shall not exceed 3 inches in diameter; shavings shall not be more than 5% of the total mass.
   Containment Mesh: Furnish containment mesh 100% biodegradable, photodegradable such as burlap, twine, UV photodegradable plastic, polyester, or other acceptable Material as directed by the Project Manager. The mesh should not exceed 1/2 in in diameter.
   Furnish biodegradable or photodegradable containment mesh when the socks will remain in place as part of the permanent or temporary vegetative plan. The containment mesh shall be greater than 9 inches in height after being packed; the containment mesh shall be densely packed so that the socks do not deform. The Project Manager will determine the maximum allowable height for containment mesh.

603.3 CONSTRUCTION REQUIREMENTS

603.3.1 General
   Apply appropriate erosion and sediment control measures for construction activities, as approved by the Project Manager.
   Install temporary erosion and sediment control features and maintain until permanent erosion measures are in place and operational, as directed by the Project Manager.
   Incorporate permanent erosion and sediment control measures, such as riprap pads or other forms of energy dissipaters at the outlets of Structures, into the project at the earliest practical time, as directed by the Project Manager.

603.3.2 Contractor’s Operations
   Keep construction activity to a minimum within the project Right of Way, adjacent to the project, to prevent damage to vegetation. Repair damage or disturbance to areas, not necessary for construction of the project, at no additional cost to the Department.
   Keep construction areas in an orderly condition and promptly dispose of refuse and discarded materials.
   As directed by the Project Manager, provide erosion and sediment control measures necessary to correct negligent or improper installation, at no additional cost to the Department.

603.3.2.1 Sequence of Operations
   Before Work begins, the Project Manager and the Contractor will conduct a site inspection to review the planned erosion control protections. Use the TESCP for this review.
   If the Contract specifies Culvert protection to remain in place after completion of the Work, install the Culvert protection after the completion of Culvert placement.

   If the Contractor begins earth-disturbing work before the following the Department will assess liquidated damages in accordance with Section 603.1.6, “Liquidated Damages”:
   1. Project Manager acceptance of the SWPPP;
   2. Submission of the NOI, or
   3. Placing erosion control measures.
   Coordinate the placement and maintenance of the temporary and permanent erosion and sediment control measures shown in the SWPPP.
603.3.2.2 Watercourse Protection
Provide filtration or settling basins to treat water used to wash aggregate or water used for similar operations. Locate and construct waste disposal areas and haul roads to prevent sediment from entering streams and water impoundment areas, or leaving the project. Do not operate mechanized Equipment in perennial streams, unless otherwise specified in the Contract. Use temporary bridges or other crossing Structures constructed of non-erodable Material, where frequent stream crossings are necessary. Clear false work, piling, debris, and other obstructions placed during construction from streambeds, arroyos, and watercourses as soon as possible. Do not allow waste from haul truck cleaning to drain into watercourses.

603.3.3 Temporary Soil Stabilant Application
Apply temporary soil stabilant to exposed areas not being worked. Begin stabilization within 14 Days after Work ceases, unless construction resumes within 21 Days after Work ceases. Follow the manufacturer’s recommendations for storage and application of the soil stabilant. Maintain the rate of application recommended by the manufacturer. If the soil stabilant does not produce the required results, the Project Manager and the Department’s Landscape Architect may modify the manufacturer’s application rate. Reply stabilant to areas of continued erosion and Contractor activity within four weeks after the initial application at no additional cost to the Department, as directed by the Project Manager.

603.3.4 Mulch Socks or Composted Mulch Socks
Install the socks near the downstream perimeter of the disturbed area as shown on the SWPPP to intercept sediment from sheet flow, in the ditch as check dams, or as inlet protection as directed by the Project Manager. Close contact between the earth and sock should be maintained by removing rocks, debris and dirt clods. The socks will be interlocked or overlapped at the ends. Anchoring should be adequate to prevent displacement during design rain events and to prevent flow under the socks. The anchors will be 2 in by 2 in wooden stakes or as approved by the Project Manager. Socks used as check dams or placed in areas where the flow is more concentrated will be staked.

603.3.5 Earthwork Operations
Protect slopes as excavation or Embankment construction progresses. Maintain and protect the earthwork in Roadway sections through all construction stages to prevent silt from leaving the construction limits. Provide temporary slope drain facilities that can collect runoff and carry it to the slope bottoms. Use drain Materials capable of length change as earthwork operations progress.

603.3.6 Erosion Control Inspection and Maintenance
Inspect and maintain the temporary erosion control installation during the project. Inspect and maintain installations at least once every 14 Days and within 24 hours of a ½ in or greater rainfall event. Maintenance work includes, but is not limited to, repair of damaged installations, removal of trapped sediment, and cleaning of any silt fence. Remove accumulated silt when the control installation becomes 50% filled. Inspect disturbed areas, Material storage areas, discharge locations, and structural control measures. Inspect vehicle entrances and exits for material being tracked off-site. Document each inspection on the PPP Inspection and Maintenance Report form provided by the Department. Submit the inspection report signed by a NPDES-trained and qualified person to the Project Manager within 24 hours after the inspection. Include copies in the Contractor’s SWPPP. Install a rain gauge at the project site to track rainfall amounts for the inspection schedule.

Designate the person responsible for the SWPPP on the qualification form provided by the Department, and sign. Ensure that the person is familiar with the project SWPPP and document the responsible person’s experience and training on the qualification form. Include it with the SWPPP. The Project Manager will assign a qualified Department representative (with qualification form) experienced and trained in implementing BMPs.
Repair damaged erosion and sediment control installations within three Days of an inspection or following notification by the Project Manager that repairs are required.

If a damaged erosion control installation could result in sediment discharge into a live stream, water impoundment, or other body of water, initiate repairs within 24 hours or sooner, as necessary or as directed by the Project Manager.

Maintain erosion and sediment control installations specified to remain following completion of the Work until the project is completed.

Dispose of erosion and sediment control installations in accordance with the Contract or as directed by the Project Manager.

603.3.7 Removal of Control Installations

Remove temporary erosion and sediment control installations and features from the project area when no longer required, unless otherwise specified in the Contract or directed by the Project Manager. After removing temporary erosion control installations, restore ground lines, cover, and features as closely as possible to original condition.

Removed sediment may be deposited at locations within the Right of Way, if approved by the Project Manager. Where removed sediment is deposited in previously undisturbed areas, the Contractor shall reseed those areas at no additional cost to the Department.

603.4 METHOD OF MEASUREMENT

The Department will measure check dams along the crest of the dam.

603.4.1 SWPPP Plan Preparation Allowance

The Department will reimburse the cost to modify the Department's TESC, used to prepare the SWPPP and to maintain the BMPs under pay item SWPPP Management.

603.5 BASIS OF PAYMENT

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<th>Pay Item</th>
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<td>Linear Foot</td>
</tr>
<tr>
<td>Composted Mulch Socks</td>
<td>Linear Foot</td>
</tr>
</tbody>
</table>

**SWPPP Management** includes SWPPP preparation, inspection, and maintenance of erosion and sediment control measures, preparation of inspection reports, updating and/or modifying, maintaining, and retaining the SWPPP and other related records.

603.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the above item(s) and will not be measured or paid for separately:

A. Cleaning and maintenance of the TESC measures;
B. Posts, hardware, and appurtenances of the temporary erosion and sediment control measures;
C. Riprap for pipe slope drains and sediment traps;
D. Excavation and disposal of sediment deposits;
E. Removal and disposal of temporary erosion and sediment control measures, if required;
F. Subsequent applications of temporary soil stabilant due to unsatisfactory results; and
G. Removal and replacement of the measure at the same location due to construction activities.
SECTION 604: SOIL AND DRAINAGE GEOTEXTILES

604.1 DESCRIPTION
This Work consists of providing and installing geotextiles.

604.2 MATERIALS
604.2.1 Classifications
Use the class of geotextile in accordance with Table 604.2.1:1, “Cross Reference of Old Classes to New Classes of Geotextiles.”

<table>
<thead>
<tr>
<th>Geotextile</th>
<th>Old class</th>
<th>New class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsurface drainage</td>
<td>A or B</td>
<td>2 or 3</td>
</tr>
<tr>
<td>Sediment control</td>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>Erosion control</td>
<td>C or D</td>
<td>1 or 2</td>
</tr>
<tr>
<td>Separation</td>
<td>C or D</td>
<td>2 or 3</td>
</tr>
<tr>
<td>Stabilization</td>
<td>None</td>
<td>1</td>
</tr>
</tbody>
</table>

The Department specifies Class 1 for more severe or harsh installation conditions where there is a great potential for geotextile damage and specifies Class 2 and 3 for less severe conditions.

604.2.2 Subsurface Drainage Geotextiles
The Department prohibits the use of woven slit film geotextiles or geotextiles made from yarns of a flat, tape-like character.

Provide Class 2 geotextiles for drain system installations that require use of very coarse, sharp angular aggregate with a 1-inch-diameter or greater, or require a depth of trench greater than 6 ft.

Provide Class 3 geotextiles for general underdrain installations that require smooth graded surfaces having no sharp angular projections and fine aggregate.

604.2.3 Erosion Control Geotextiles
The Department prohibits the use of woven slit film geotextiles or geotextiles made from yarns of a flat tape-like character. If the Contractor uses a woven monofilament geotextile, the Contractor shall provide a Class 2 geotextile, otherwise the Contractor shall provide a Class 1 geotextile.

604.2.4 Separation Geotextiles
Provide separation geotextiles that are of woven or non-woven Material.

Use a Class 2 separator for Pavement Structures constructed over soils with an R-value greater than 20 to separate dissimilar Materials where water seepage is allowable. Use Class 2 geotextiles where installation requires a depth of trench greater than 10 ft, where stone drop height is to be more than zero, or where there is no sand cushion protection. The Department requires field trials where stone drop height exceeds 3 ft or where individual stone weight exceeds 250 lb.

Use Class 3 geotextiles to prevent mixing of a Subgrade soil and an aggregate cover Material (Subbase, base, select Embankment, etc), to separate dissimilar Materials where water seepage is allowable. Do not use Class 3 geotextiles under pavement. The Contractor may also use Class 3 geotextiles in Structures or under conditions where the geotextile is protected by a sand cushion or by "0 drop height" placement of stone.

Use Table 604.2.4:1, "Required Class of Separator Geotextile and Cover Thickness for R-values Greater Than or Equal to 20," to determine the class of separator geotextile and the required minimum thickness.

Table 604.2.4:1

<table>
<thead>
<tr>
<th>Geotextile</th>
<th>Old class</th>
<th>New class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgrade</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Aggregate</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Subbase</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Base</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Select Embankment</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Use Table 604.2.4:1, "Required Class of Separator Geotextile and Cover Thickness for R-values Greater Than or Equal to 20," to determine the class of separator geotextile and the required minimum thickness.
Table 604.2.4:1
Required Class of Separator Geotextile and Cover Thickness for R-values Greater Than or Equal to 20

<table>
<thead>
<tr>
<th>Required minimum cover thickness, compacted</th>
<th>Required class of geotextile</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 in</td>
<td>2</td>
</tr>
<tr>
<td>12 in</td>
<td>3</td>
</tr>
</tbody>
</table>

Do not use aggregate larger than 1 in.

604.2.5 Stabilization Geotextiles

Provide stabilization geotextile in wet, saturated conditions to provide separation, filtration, and also reinforcement. Use stabilization geotextiles for Pavement Structures constructed over soils with R-values from 10 to 20. The Contractor may provide stabilization geotextiles made of woven or non-woven Material.

The Contractor may use stabilization geotextiles in applications that require a design by a licensed professional engineer. Obtain Department approval of these designs.

604.2.6 Certification

For each class of geotextile fabric, provide a certificate from the manufacturer stating that the geotextile meets the physical and chemical requirements in accordance with AASHTO M 288, and that geotextile fabric meets R-value requirements for the respective application.

Include in the certification the product name, chemical composition of the filaments or yarns, or other relevant information to fully describe the geotextile.

Submit the certification to the Project Manager before geotextile placement.

R-values corresponding to California bearing ratio (CBR) used in AASHTO M 288 are presented in Table 604.2.6:1, “CBR Values Used in AASHTO M 288 and Corresponding R-values.”

Table 604.2.6:1
CBR Values Used in AASHTO M 288 and Corresponding R-values

<table>
<thead>
<tr>
<th>Soil strength (CBR)</th>
<th>Corresponding R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
</tbody>
</table>

604.3 CONSTRUCTION REQUIREMENTS

604.3.1 Geotextile Packaging, Storage, and Handling

Use geotextile rolls wrapped with a Material to protect the geotextile, including the ends of the roll, from damage.

Cover and elevate geotextile rolls during storage to protect them from the following:
1. Site construction damage (tearing, excessive mud, wet cement, or epoxy);
2. Precipitation;
3. Extended ultraviolet radiation including direct sunlight;
4. Chemicals that are strong acids or strong bases;
5. Flames including welding sparks; and
6. Temperatures above 160 °F and below -22 °F.

604.3.2 Geotextile Exposure After Placement

Do not expose geotextiles to the elements after placement for more than 14 Days, unless otherwise directed by the Project Manager.

604.3.3 Site Preparation

Prepare the installation site by clearing and grading the area and preparing a firm, smooth surface on which to place the geotextiles. Remove sharp objects and large stones and cut trees and shrubs flush with the smooth surface.

Ensure correct orientation (roll direction). Place geotextiles as smoothly as possible on the prepared surface; pull tight, align, and anchor such that the geotextile is free of wrinkles.
and does not show evidence of holes, tears, or rips before placing cover Material on the geotextile. Before placing cover Material, hold geotextiles in place by pins, staples, or piles of fill or rock as required by fill placement procedures. On curves, fold or cut geotextiles to conform to the curve.

The Department will not allow vehicles directly on the geotextile, but will allow vehicles after the Contractor places at least 6 in of cover Material on the geotextile. Do not allow vehicles to turn on the cover Material until at least two lifts of cover Material have been placed.

604.3.4 Backfill

Obtain approval from the Project Manager before beginning backfill operations. Do not end dump backfill directly onto exposed geotextile. Backfill by end dumping onto previously spread backfill and then pushing the dumped backfill over the exposed geotextile. On Subgrades having an R-value less than 10, dump and spread the Material placed on the geotextile to minimize the potential of a localized Subgrade failure.

Backfill in layers from 6 in to 8 in deep (uncompacted) unless otherwise specified in the Contract. After placement, compact each lift to 95% of maximum density in accordance with AASHTO T 99, Method C. Compact the top lift in accordance with Section 207, “Subgrade Preparation.” The Contractor may use vibratory compaction Equipment on initial layers of Material, if approved by the Project Manager.

Repair ruts occurring during construction by filling with additional Material and compacting to the specified density to maintain an even backfill surface and the minimum lift thickness over the geotextile.

Obtain the Project Manager’s approval of geotextile placement before covering.

604.3.5 Subsurface Drainage Geotextiles

Place geotextiles in accordance with Section 605, “Drains,” where specified. Use subsurface drainage geotextiles against soil in an underground drainage system or in an edgedrain to allow for long-term passage of water into a subsurface drain system while retaining the in situ soil. The primary function of the geotextile in subsurface drainage applications is filtration.

Provide one soil sample to the Department for testing to confirm the applicable apparent opening size based on the percent of in situ soil passing the No. 200 sieve and cohesiveness (Pl).

Compact the aggregate with vibratory Equipment to a minimum compaction of 95% of maximum density in accordance with AASHTO T 99. If a higher compactive effort is necessary, substitute a geotextile suited for more severe installation conditions.

604.3.6 Sediment Control Geotextiles

Place geotextiles in accordance with Section 603, “Temporary Erosion and Sediment Control,” where necessary.

Place and maintain sediment control geotextiles as a temporary control measure to prevent eroded soil from being transported off the construction site to rivers, streams, and impoundments and to prevent damage to private property from storm water runoff.

604.3.7 Erosion Control Geotextiles

Place geotextiles in accordance with Section 602, “Slope and Erosion Protection Structures,” where necessary.

Use erosion control geotextiles between erosion control Structures (rip-rap and gabions) and the in situ soil to prevent soil loss resulting in excessive scour and to mitigate hydraulic uplift pressures that may cause instability of an erosion control structure.

604.3.8 Separation/Stabilization Geotextiles

Use separation/stabilization geotextiles as a semi-permeable separator to prevent mixing of a Subgrade soil and sub-base or base Material.

Fold, overlap, sew, or join adjacent geotextile rolls in accordance with Table 604.3.8.1, “Minimum Overlap Requirements for Separation/Stabilization Geotextiles,” unless manufacturer’s recommendations or the Contract are more stringent.
Table 604.3.8:1
Minimum Overlap Requirements for Separation/Stabilization Geotextiles

<table>
<thead>
<tr>
<th>Soil strength R-value</th>
<th>Un-sewn seams overlap (in)</th>
<th>Sewn seams overlap (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>—</td>
<td>9</td>
</tr>
<tr>
<td>10–15</td>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>15–20</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>&gt;20</td>
<td>24</td>
<td>—</td>
</tr>
</tbody>
</table>

Ensure that both factory and field sewn or sealed seams meet or exceed the strength requirements as required by the manufacturer.

604.3.9 Repair of Damaged Geotextiles

To repair subsurface drainage, erosion control, and sediment control geotextiles, clear the damaged area and repair in accordance with the manufacturer’s recommendations. Obtain the Project Manager’s approval of repairs.

To repair separation/stabilization geotextiles, clear the damaged area plus an additional 3 ft around the damaged area and repair in accordance with Table 604.3.8:1, “Minimum Overlap Requirements for Separation/Stabilization Geotextiles,” unless manufacturer’s recommendations or the Contract are more stringent. Replace removed cover material and compact to the specified density.

604.4 METHOD OF MEASUREMENT

The Department will only measure the area of one layer at geotextile overlaps.

604.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotextile Class</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

Payment for achieving Subgrade preparation in accordance with Section 207, “Subgrade preparation” will be paid as Subgrade Preparation.

604.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: Repair of damaged geotextile fabric as a result of the Contractor’s negligence, improper shipping, handling, packaging, or storing. Geotextile packaging, storage and handling. Overlaps, anchoring, splicing and seam assemblies.
605.1 DESCRIPTION
This Work consists of constructing underdrains, french drains, vertical drains, and drain outlets.

605.1.1 Definitions
Drain Outlet Lateral. A drain outlet lateral is a non-perforated pipe placed in an unlined, backfilled trench;
French Drain. A french drain is a non-vertical, rectangular, prism-shaped, subterranean water-collector drainage system consisting of open-graded granular Material wrapped in geotextile fabric (“drainage blanket”) and a perforated collector pipe at the drainage blanket's lowest elevation;
Underdrain. An underdrain is a collector drainage system typically located under pavement sections. An underdrain system consists of a perforated collector pipe placed in a geotextile-lined, shallow, narrow trench that is then backfilled with untreated, open-graded Base Course;
Vertical Drain. A vertical drain is a vertical, rectangular, prism-shaped, subterranean, water-collector drainage system consisting of open-graded granular Material wrapped in geotextile fabric.

605.2 MATERIALS
605.2.1 Pipe
605.2.1.1 Polyvinyl Chloride Pipe
Provide PVC pipe in accordance with the following:
1. ASTM D 1785;
2. ASTM D 2464;
3. ASTM D 2467; and
4. ASTM D 2564.
Provide perforations and slots in accordance with AASHTO M 175, except provide perforations with a diameter of 0.19 in, unless otherwise specified in the Contract.

605.2.1.2 Polyethylene Pipe
Provide polyethylene pipe in accordance with AASHTO M 252, AASHTO M 294, and ASTM D 3350.

605.2.1.3 Metal Pipe
Provide metal pipe in accordance with Section 570, “Pipe Culverts.”

605.2.2 Drainage Geotextiles
Provide drainage geotextiles for underdrains in accordance with Section 604, “Soil and Drainage Geotextiles.”

605.2.3 Granular Materials
Provide granular backfill in accordance with Section 304, “Base Course,” for open graded Base Course, or as specified in the Contract.

605.2.4 Hardware Screen
Provide galvanized steel or stainless steel hardware screen for drain outlets with 1 in nominal mesh openings. Provide galvanized connecting hardware.

605.2.5 Precast Headwall
Provide precast headwall with hardware screen as per Contract.

605.3 CONSTRUCTION REQUIREMENTS
605.3.1 Placement of Drainage Geotextiles
Place drainage geotextiles in accordance with Section 604, “Soil and Drainage Geotextiles.”
Connect and maintain overlaps of geotextiles so that the drainage geotextile covers the drain for the entire length and has no breaks or holes.
605.3.2 Placement of Pipe
Place perforated pipe with the perforations down, unless otherwise specified in the Contract. Join pipe sections securely with the appropriate couplings, fittings, or bands as recommended by the manufacturer for the specific application.
Place non-perforated pipe with the bell-end upgrade. Close upgrade ends with concrete plugs to prevent entry of soil materials.

605.3.3 Placement of Open-Graded Backfill
After the Department inspects and approves the pipe installation, place granular Material in layers no more than 12 in thick and compact after placement of each layer with a steel-wheeled, self-propelled roller that will provide good consolidation without excessive breakage of the aggregate, to the satisfaction of the Project Manager. Do not displace pipe or geotextile.

605.3.4 Placement of Impermeable Material
If the Contract requires the Contractor to place an impermeable Material around the drain system, the Project Manager must approve the Material.
Place the impermeable Material in no more that 6 in layers of loose thickness. Compact each layer of impermeable Material to at least 95% of maximum density in accordance with AASHTO T 99.

605.3.5 Outlet Laterals
Place non-perforated pipe in the unlined trench with ends firmly joined as recommended by the manufacturer for the specific application.
After the Department inspects and approves the pipe installation, backfill the trench with approved Material in layers and compact in accordance with Section 206.3.1, "Construction Requirements, General."

605.3.6 Exposed Drain Outlets
Provide hardware screens for openings of exposed drain outlets. Mechanically secure the screen along the circumference of the outlet without damaging the drain. Provide PreCast concrete headwall with hardware screen when specified in the Contract.

605.4 METHOD OF MEASUREMENT—Vacant

605.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underdrains</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Vertical Drains</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>French Drains</td>
<td>Linear Foot</td>
</tr>
</tbody>
</table>

The Department will pay for excavation in accordance with Section 206, "Excavation and Backfill for Culverts and Minor Structures."

605.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: All open-graded aggregate, geotextiles, pipe, precast concrete headwall with hardware screen (rodent shield), hardware, and compaction.
606.1 DESCRIPTION
This Work consists of constructing metal barrier and end treatments, and concrete wall barrier (CWB).

606.2 MATERIALS

606.2.1 Metal Barrier Elements

The types of metal barrier are as follows:
1. W-beam metal barrier;
2. Thrie beam metal barrier;
3. W-beam weathering metal barrier; and
4. Thrie beam weathering metal barrier.


606.2.1.1 Rail Elements

606.2.1.1.1 Galvanized Metal Barrier
Provide W-beam and thrie beam rail elements with a corrugated beam in accordance with AASHTO M 180, Type II, Class A.
Galvanize steel rail elements before or after fabrication in accordance with AASHTO M 180 if necessary.
Provide wire rope or wire cable and required fittings in accordance with AASHTO M 30 for the specified diameter and strength class.

606.2.1.1.2 Weathering Metal Barrier
Provide W-beam and thrie beam Materials for corrosion-resistant “weathering” metal barrier in accordance with AASHTO M 180, Type IV, Class A, and ASTM A 606 Type IV, and ensure they have a corrosion resistance at least four times that of plain carbon steel.

606.2.1.2 Fasteners
Unless otherwise specified, galvanize fasteners in accordance with AASHTO M 111 or ASTM A 153. Galvanize after fabrication.
 Provide bolts in accordance with ASTM A 307 and nuts in accordance with ASTM A 563, Grade A or better.
 Provide fasteners for weathering metal barrier in accordance with AASHTO M 180 for Type IV beams.

606.2.1.3 Posts

606.2.1.3.1 Wood Posts and Wood Blocks
Provide wood posts and wood blocks that are southern yellow pine, western larch, ponderosa pine, douglas fir, or lodgepole pine and that are either rough sawn (unplaned) or S4S with nominal dimensions specified and with a stress grade of at least 1,200 psi.
The size tolerance of rough-sawn blocks in the direction of the bolt holes will be within ± 1/4 in of specified dimensions. Only use one combination of post and block for any one continuous length of barrier.
Use straight posts, without defects, that do not vary more than 1 in from a straight line connecting both ends.
Perform cutting, framing, routing, and boring before applying preservative treatment to the timber. Use pressure treated wood posts and blocks with petroleum-pentachlorophenol consisting of a maximum of 95% by weight of petroleum oil and a minimum of 5% by weight of pentachlorophenol, with ammoniacal copper arsenite, or with chromated copper arsenate. Use the empty-cell process for petroleum-pentachlorophenol treatment. Retain a pentachlorophenol amount of at least 0.3 lb of dry salt per cubic foot of wood. Perform treatment with ammoniacal copper arsenite or chromated copper arsenate in accordance with AWPA C14.
Provide wood preservatives in accordance with AASHTO M 133.
606.2.1.3.2 Structural Shape Posts and Blocks

- Provide structural shape posts in accordance with ASTM A 36 and galvanize them in accordance with ASTM A 123. Do not perform punching, drilling, or cutting after galvanizing.
- Provide blocks with metal barriers in accordance with NCHRP Report 350.
- Provide plastic blocks in accordance with the Department’s Approved Products List.
- Ensure Suppliers of plastic blocks proposed for inclusion on the Department's Approved Products List submit certification to the Project Manager for approval by the Traffic Services Engineer.

606.2.2 CWB

- The types of CWB are as follows:
  1. Slip-formed CWB;
  2. Cast-in-place CWB; and
  3. Precast CWB.
- Use Class A concrete in accordance with Section 509, “Portland Cement Concrete Mix Designs.” Provide reinforcing steel in accordance with Section 540, “Steel Reinforcement.”
- Provide preformed asphalt joint filler in accordance with AASHTO M 213. Provide penetrating water repellent in accordance with Section 532, “Penetrating Water Repellent Treatment.”

606.2.2.1 CWB Steel Access Panel

- Provide and install CWB steel access panels in accordance with the Plans or as directed by the Project Manager.
- Contour the steel access panel to the shape of and flush with the CWB. The Department will not allow the steel access panel to compromise the structural integrity and performance of the CWB assembly. Provide steel in accordance with AASHTO M 270, Grade 36. Coat the steel access panel in accordance with Section 545, “Protective Coating of Miscellaneous Structural Steel.”

606.2.3 Materials Certification

- Provide MTRs, and other test reports of the metal and the coating, to the Project Manager, certifying that the Materials and fabrication are in accordance with these specifications. Fabrication shall be done by an identifiable source.

606.2.4 Metal Barrier End Treatments

- The types of end treatments are as follows:
  1. Metal Barrier End Treatment-Type B;
  2. Metal Barrier End Treatment-Departure End: Type 1, Type 2 (See Table 606.2.4.1, “Metal Barrier End Treatments”), Type A (Turndown), or Type D (Buried in backslope); and
  3. Metal Barrier End Treatment-Approach End: Type 1, Type 2, or Type D.
- Limit the use of metal barrier end treatment Type B to curved guardrail installations on low-volume, low-speed Roadways in accordance with the Contract.
- Suppliers of metal barrier end treatments proposed for inclusion on the Department’s Approved Products List shall submit certification for approval by the Traffic Services Engineer.
- The manufacturer will sign and notarize the certification stating that the Materials have met the testing requirements in accordance with NCHRP Report 350.
- Provide the Project Manager with the manufacturer’s certificates, literature, and shop drawings before fabrication and installation of the terminal and its transition.
- Provide metal barrier end treatments for Types 1 and 2 in accordance with Table 606.2.4.1, “Metal Barrier End Treatments.”
TABLE 606.2.4:1
Metal Barrier End Treatments

<table>
<thead>
<tr>
<th>Type</th>
<th>End treatment system</th>
<th>System length (ft)</th>
<th># of posts</th>
<th>Begin length of need</th>
<th>Acceptable offset or flare</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SKT 350</td>
<td>50</td>
<td>8</td>
<td>POST</td>
<td>25:1</td>
<td>Road Systems</td>
</tr>
<tr>
<td></td>
<td>ET Plus</td>
<td>50</td>
<td>8</td>
<td>POST</td>
<td>25:1</td>
<td>Trinity</td>
</tr>
<tr>
<td>1</td>
<td>50 ft</td>
<td>50</td>
<td>8</td>
<td>POST</td>
<td>25:1</td>
<td>Trinity</td>
</tr>
<tr>
<td>2</td>
<td>ET Plus</td>
<td>37.5</td>
<td>7</td>
<td>POST</td>
<td>25:1</td>
<td>Industries</td>
</tr>
<tr>
<td></td>
<td>FLEAT</td>
<td>37.5</td>
<td>7</td>
<td>POST</td>
<td>Varies:</td>
<td>Road Systems</td>
</tr>
</tbody>
</table>

Use the 50 ft length systems (Type 1) on the Roadways with a speed of 65 mph or greater, or as specified in the Contract or directed by the District Traffic Engineer. Use the 37.5 ft length systems (Type 2) on other Roadways, or as specified in the Contract or directed by the District Traffic Engineer via the Project Manager.

Cover the entire face of the impact head with one continuous piece of Type VII reflective yellow sheeting with 3 in strips of black tape, spaced 2 3/4 in apart, and sloping downward at a 45° angle toward the side of the guardrail on which traffic is to pass, unless otherwise directed by the District Traffic Engineer via the Project Manager.

606.2.5 Member Identification and Marking

Ensure the manufacturer permanently stamps the specific type of metal barrier end treatment at each location to correspond with those shown on the shop drawings provided to the Project Manager, so that each is readily identifiable in the field.

606.2.6 Reflective Barrier Delineators

Provide amber-colored reflective barrier delineators for median barriers and white reflectors for shoulder-side barriers in accordance with the Contract and Section 703, “Traffic Markers.”

Place reflective barrier delineators back to back on median barriers.

606.3 CONSTRUCTION REQUIREMENTS

During construction, prevent exposed metal or concrete barrier ends from creating a hazard to the traveling public.

606.3.1 Metal Barrier Installation

Position steel parts stored in transit, in open cars or trucks, or outside in yards or at job sites to allow free drainage and air circulation. Handle fabricated steel parts to avoid gouges, scratches, and dents.

Keep the steel clean of Deleterious Material. If the Contract specifies a weathering metal barrier, the Department will not consider natural oxidation (mill scale) to be Deleterious Material and will not require galvanizing, blast cleaning, or pickling of weathering metal barrier to remove the mill scale.

Draw bolts tight (except adjustment bolts). Use bolts that are long enough to extend beyond the nuts.

606.3.1.1 Posts

Set posts plumb, in hand-dug or mechanically made holes, or by driving. If upward vertical adjustment of posts is necessary, remove and reinstall the post.

When driving, avoid battering or distorting the posts. The Department will allow the Contractor to drive steel posts through the asphalt surfacing. The Contractor shall not drive wooden posts through asphalt surfacing, unless the Contractor precuts or drills guide holes through the asphalt Material.

Perform post drilling and driving that does not cause bulging, distressing, or other disturbance of the asphalt surface.

Backfill and compact postholes with acceptable Material, such as Base Course or cold mix, placed in layers, to within 2 in of the HMA grade. Fill, compact, and crown the remaining
depth of the hole with asphalt Material or cold mix. Crown shall not exceed 2 in. The Contractor may use concrete instead of asphalt surfacing Material, at no additional cost to the Department and if approved by the Project Manager. Should bulging or other distress of the asphalt surfacing occur when driving steel posts, remove and reinstall these posts using guide holes drilled through the asphalt surfacing. Make the guide holes with a maximum diameter in accordance with Table 606.3.1.1:1, “Required Guide Hole Diameter.”

Table 606.3.1.1:1

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round wood</td>
<td>Diameter of post</td>
</tr>
<tr>
<td>Square wood</td>
<td>Dimension of side</td>
</tr>
<tr>
<td>Steel shape</td>
<td>Dimension of least side</td>
</tr>
</tbody>
</table>

After precutting or drilling the guide holes, if bulging or other distress of the asphalt surfacing occurs or if posts cannot be driven to the specified depths, cease the driving, remove the posts, and extend the guide holes as necessary.

606.3.1.2 Metal Rail Installation

Erect smooth and continuous rail elements. Overlap rails in the same direction as the traffic flow of the nearest lane. The Department will only allow such drilling or cutting that is necessary for special connections and for sampling in the field.

Shop-fabricate curved rails having a radius of 150 ft or less to the appropriate curvature specified in the Plans.

606.3.1.3 Repair of Damaged Coating

If the galvanizing of metal barrier or appurtenances is damaged, repair the coating by galvanizing or by coating with two coats of zinc dust-zinc oxide paint in accordance with Federal Specification TT-P-641 or Military Specification ML-P-21035.

606.3.2 Concrete Wall Barrier

Use cast in place, precast, or slip formed permanent CWB. Ensure that precast CWB units are the same length and design.

The Contractor is responsible for damage to precast CWB occurring during the Work. The Project Manager may reject or accept the damaged precast CWB. If the Project Manager rejects precast CWB because of damage, replace or repair at no additional cost to the Department.

606.3.2.1 Concrete Wall Barrier Fabrication

Fabricate CWB in accordance with Section 510, “Portland Cement Concrete,” and Section 511, “Concrete Structures.”

Construct temporary precast CWB in accordance with the Plans.

Construct permanent CWB in accordance with the Plans. Ensure that the top of the completed barrier does not deviate from the Plans more than ± 0.19 in. Give the CWB a Class 2, Rubbed Surface Finish, or Class 4, Special Surface Finish, in accordance with Section 511.3.8, “Finishing.”

If the manufacturer requires sandblasting, do not displace mortar used in the surface finish from the bubble pockets, pits, depressions, and honeycombs.

Cure CWB in accordance with Section 511.3.9, “Curing.”

Treat the entire exposed surfaces of CWB with penetrating water-repellent treatment in accordance with Section 532, “Penetrating Water Repellent Treatment.”

When called for in the Contract, apply penetrating water repellent first, then the Special Surface Finish. The Department will not require fly ash in the PCC used to fabricate temporary traffic control CWB.

606.3.2.2 Concrete Wall Barrier Joint Treatment

When sawing transverse weakened-plane joints, perform the sawing after the concrete has hardened enough to prevent raveling, crumbling, or shape deformation. Saw control joints at 10 ft intervals. After completing the sawing operations, clean the sawed area of debris.
Make a construction joint after the day’s permanent placement operations and at locations when concrete placement is interrupted for 30 min or more.

**Section 606: Metal and Concrete Wall Barrier**

**606.3.2.3 Concrete Wall Barrier Installation**
Construct footings and foundations, and prepare the Subgrade as necessary, before placing the CWB.
Construct vertically offset (atypical) CWB as specified in the Plans.

**606.3.2.3.1 Temporary Concrete Wall Barrier Requirements**
Precast temporary CWB as specified in the Plans. Do not intermix CWB of different designs. Set temporary CWB in accordance with the Contract and the approved traffic control plan. Provide necessary loading, hauling, and unloading at designated sites.
The Contractor shall reset the CWB during construction, as required by the Contract.
After completing the project, remove, load, haul, unload, and stockpile the State-retained or State-provided CWB at the locations required in the Contract or as directed by the Project Manager.
Ensure that State-retained CWB, State-provided CWB, and Contractor-retained temporary CWB are in accordance with Section 606.3.2, “Concrete Wall Barrier.”

**606.3.2.3.2 Temporary Concrete Wall Barrier (State-Retained Concrete Wall Barrier)**
If the Contract specifies State-retained CWB, provide new CWB. Temporary CWB (State-retained CWB), including shop drawings and connecting hardware, as approved by the Project Manager, will become the property of the Department upon completion of the project.
Remove and dispose of state retained CWB that is not, in the opinion of the Project Manager, in satisfactory condition at or before final stockpile location.

**606.3.2.3.3 State-Provided Concrete Wall Barrier**
If the Contract specifies State-provided CWB, load, haul, and unload State-provided CWB from origins to destinations.
State-provided CWB will remain the property of the Department upon completion of the project.
If using State-provided CWB, provide connecting hardware for the CWB assembly, if missing from the CWB units.

**606.3.2.3.4 Temporary Concrete Wall Barrier (Contractor-Retained Concrete Wall Barrier)**
If the Contract specifies Contractor-retained temporary CWB, provide new or used CWB. Contractor-retained temporary CWB will remain the property of the Contractor upon completion of the project.
Provide connecting hardware for the CWB assembly.

**606.3.3 Metal Barrier End Treatment**
Fabricate and install metal barrier end treatment systems in accordance with the manufacturer’s recommendations and approved shop drawings.
Install posts in accordance with Section 606.3.1.1, “Posts,” with the following exceptions:
1. Set metal barrier end treatment breakaway posts plumb in hand-dug or mechanically made holes, and do not drive them;
2. Backfill postholes with existing materials or Materials such as Base Course or cold mix;
3. Backfill postholes in 6 in lifts and rod each lift to within 2 in of the HMA grade;
4. Fill and crown the remaining depth of the hole with asphalt Material or cold mix and compact. Do not crown more than 2 in above HMA grade; and
5. The Contractor may use concrete instead of asphalt to fill the remaining depth of the hole to match the existing concrete Roadway surfacing.
Ensure that foundation tubes do not project more than 4 in above the ground.
Immediately repair traffic damage to barrier components.
Ensure that the manufacturer provides on-site assistance when installing metal barrier end treatments for the first time. Provide manufacturer certification of the installation to the Department.
606.3.4 Embankment Grading Requirements
Compact the Embankment Material to 95% of maximum density.
Unless otherwise specified in the Contract, include the cost and placement of the Embankment Material and 1 1/2 in of asphalt Material for the 10:1 slope in the Bid Item Unit Price for the metal barrier pay item.

606.4 METHOD OF MEASUREMENT
606.4.1 Metal Barrier Measurement
The Department will measure the metal barrier installation along the face of the railing from end to end, including the W-beam portion of the end treatment for Types B and D end treatment systems.

The Department will include the 25 ft section of metal barrier in the measurement of type A end treatment systems.

The Department will include the 50 ft section of metal barrier in the measurement for Type 1 end treatment systems; and the 37.5 ft section of metal barrier in the measurement for Type 2 end treatment systems.

The Department will measure the metal barrier thrie beam to W-beam transitions as thrie beam. Doubled beams will be counted as singles.

606.4.2 CWB Measurement
The Department will measure the CWB along the centerline of the barrier.

606.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
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<tr>
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<tr>
<td>Metal Barrier End Treatment</td>
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<tr>
<td>Weathering Metal Barrier Thrie Beam</td>
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<tr>
<td>Concrete Wall Barrier</td>
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<td>Temporary Concrete Wall Barrier</td>
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<tr>
<td>Concrete Wall Barrier (Half Section)</td>
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</tr>
</tbody>
</table>

606.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:

A. All loading, hauling, unloading, stockpiling, or disposal;
B. Footings, foundations, and subgrade preparation;
C. Reflective sheeting and reflectors installed on metal barrier and impact head of end treatment;
D. All connecting hardware;
E. Reflective barrier delineators installed on permanent and temporary CWB;
F. Curing of CWB and application of penetrating water-repellent treatment;
G. Backfilling and compacting of holes created by removal and installation of posts;
H. Patching material at posts;
I. Connection pins for temporary CWB;
J. Concrete wall barrier access panel;
K. Reinforcing Steel;
L. Double thrie beam section at thrie beam to barrier railing transition;
M. Metal barrier end treatment posts, sleeves, rail and impact head;
N. Embankment material and 1 ½ in layer of bituminous material for the 1:10 (10:1) slope.
SECTION 607: FENCE

607.1 DESCRIPTION
This Work consists of constructing fence and gates.

607.2 MATERIALS
607.2.1 Certification
Submit independent testing Laboratory certification to the Project Manager that indicates the fencing Materials meet these specifications. The Department may inspect the manufacturing methods at manufacturing plants and may obtain Material samples for testing and may base acceptance on the quality of manufacturing lots.

607.2.2 Barbed Wire and Woven Wire Fence
607.2.2.1 Wire
Provide wire and wire components with at least a Class 1 zinc coating in accordance with ASTM A 121 or ASTM A 116, unless otherwise specified in the Contract. Instead of Class 1 coating, the Contractor may coat the wire with aluminum alloy covering at least 0.3 oz per square foot of wire surface.

607.2.2.1.1 Barbed Wire
Provide barbed wire and barbs in accordance with ASTM A 121. Provide composite barbed wire strands that consist of two coated wires with diameters of 0.099 in. Provide round barbs that have a coated diameter of 0.08 in, with either two-point barbs spaced 4 in apart or four-point barbs spaced 5 in apart. Provide stays for barbed wire fences in accordance with ASTM A 116, with a coated diameter of at least 0.142 in and with lengths and spacing in accordance with the Contract.

607.2.2.1.2 Woven Wire
Provide woven wire in accordance with ASTM A 116, Design Number 832-6-11, unless otherwise specified in the Contract.

607.2.2.1.3 Post Fasteners
Provide coated staples with a diameter of at least 0.148 in and a length of at least 1 1/2 in; use for fastening fence wire to wood posts.

607.2.2.1.4 Brace Wire
Provide coated brace wire with a diameter of at least 0.148 in; use for constructing braces and intermediate braces with wood posts.

607.2.2.1.5 Tie Wire
Provide coated tie wire for fastening barbed or woven wire to steel posts with a diameter of at least 0.099 in. The Contractor may use wire fasteners or metal clamps with thicknesses of 0.12 in or greater instead of tie wires, if approved by the Project Manager.

607.2.2.2 Posts
Provide metal or wood corner, brace, intermediate brace gate, and line posts of the specified type, size, and length in accordance with the Contract.

607.2.2.2.1 Metal Posts
Provide metal posts and braces of rail, billet, or commercial-grade steel in accordance with ASTM A 702 or ASTM F 1083 for galvanized, standard weight pipe. Provide C-section posts in accordance with ASTM A 1011. Galvanize steel posts in accordance with AASHTO M 181 for Grade 1 steel and provide a topcoating specified for Grade 2 steel, or an equivalent or better coating, from the Department’s Approved Products List. Coat edges and damaged areas of posts in accordance with ASTM A 780. Use posts of the same coating and color.
Provide posts that weigh no less than 95% of the specified weight; and are of the specified length +2 in, -1 in. Provide line posts with a minimum weight of 1.33 lb per foot, not including anchor plates. The Contractor may provide I-beam, T-beam, U-beam, Y-bar, or C-section line posts. Provide
provide anchor plates with an area of at least 18 in\(^2\) and that weigh at least 0.67 lb. Clamp, weld, or rivet anchor plates to the post section to prevent displacement when driving the posts.

### 607.2.2.2.2 Wood Posts

Provide wood posts cut from live southern yellow pine, lodgepole pine, or ponderosa pine trees. Provide straight posts that are free of decay and other defects, bark-free, trimmed smooth of knots and projections, and with both ends sawed off perpendicular to the centerline.

Provide an average nominal diameter at the top of each post of at least 6 in. Ensure the circumference of corner, brace, intermediate brace, and gate posts is at least 19 in, measured 6 in below the top of the post.

The Contractor may provide line posts with a slight crook in one direction, but the post may not vary more than 1 1/2 in from a straight line connecting both ends of the post. Ensure the average nominal diameter of the top of each line post is at least 3 in. Ensure the circumference of line posts is at least 9 in, measured 6 in below the top of the post.

Provide coast region douglas fir, or New Mexico red spruce or fir braces for wood posts.

### 607.2.2.2.2.1 Preservative Treatment of Wood Posts

Provide wood posts pressure treated with pentachlorophenol in accordance with Section 550.2.2, “Preservatives and Treatment Methods,” with a minimum retention of 0.3 lb per cubic foot.

### 607.2.2.3 Gates

For fence constructed with woven wire and barbed wire, the Contractor shall provide tubular steel or steel panel frame gates. Provide gates with woven wire or chain link fabric filler, if specified in the Contract or directed by the Project Manager.

If providing barbed wire gates, use the same Materials as for the barbed wire fence.

Provide frame tube and panel Materials for gates in accordance with AASHTO M 181, unless otherwise specified in the Contract.

Galvanize gates in accordance with Section 607.2.2.2.1, “Metal Posts,” or coat in accordance with Section 545, “Protective Coating of Miscellaneous Structural Steel.” Use “Interstate Green” as the finished color coating, except for galvanized gates and unless otherwise specified in the Contract.

### 607.2.2.4 Fittings

Provide fittings, hardware, and appurtenances for fences and gates that are of commercial-quality steel, malleable iron, or wrought iron, and galvanized in accordance with ASTM A 153.

### 607.2.3 Chain Link Fence

#### 607.2.3.1 Posts

Provide posts that are tubular steel, H-column, or C-section (for line posts). Provide either Grade 1 or Grade 2 steel posts in accordance with AASHTO M 181. Provide Grade 1 tubular posts, braces, and top rails in accordance with ASTM F 1083 for galvanized, standard weight pipe. Provide Grade 2 steel posts in accordance with ASTM A 1011 or ASTM A 653.

Provide C-section line posts in accordance with ASTM A 1011. Provide H-column posts in accordance with ASTM A 36.

Provide pipe with minimum wall thickness as specified in the Contract. Ensure that the product of the yield strength and section modulus of the pipe is in accordance with ASTM F 1083.

Provide posts that securely hold tension wires in position without vertical movement.

#### 607.2.3.2 Fittings

Provide fittings in accordance with Section 607.2.2.4, “Fittings.”

Provide stainless steel straps and seals in accordance with ASTM A 176.

Provide coated tension wires that are galvanized coil spring steel wire of commercial quality with a diameter of 0.148 in. Provide galvanized ferrules for tension take-up in accordance with ASTM A 1011.

Provide pull cable and tension truss rods with diameters of at least 3/8 in, with drop-
forged turnbuckles or other approved tension devices.

The Project Manager will determine the uniformity of the coating by visual inspection. The Department may make other inspections and tests at the manufacturer’s plant, before shipment.

607.2.3.3 Tie Wires and Fasteners
Provide galvanized, coated tie wires for fastening chain link fabric to posts and rails with a diameter of at least 0.148 in. The Contractor may provide galvanized steel or non-corrosive metal bands or fasteners instead of tie wires, as recommended by the manufacturer.

607.2.3.4 Compression Braces
Provide compression braces that meet the same requirements as top rails in accordance with Section 607.2.3.1, “Posts.”

607.2.3.5 Chain Link Fabric
Provide chain link fabric in accordance with AASHTO M 181, with a Class C coating or better. Provide galvanized, coated wire with a diameter of 0.148 in. Provide 2-inch mesh fabric. Measure the mesh size as the distance between the wires forming parallel sides of the mesh.

607.2.3.6 Gates
Provide double drive, single drive, or single walk gates. Provide galvanized steel pipe gate frames in accordance with ASTM F 1083 and ASTM A 123.

607.2.3.7 Vinyl-Coated Chain Link Fence
If providing PVC coated chain link fabric, use vinyl-coated fabric, posts, and hardware in accordance with AASHTO M 181 for Class A PVC coating. Continuously bond the vinyl coating (do not spray or dip) over the galvanized steel wire by the extrusion bonding process under pressure.

Ensure the vinyl coating resists damage from prolonged exposure to dilute solutions of common mineral acids, sea water, and dilute solutions of salts and alkali.

Galvanize using the electrolytic process before coating with PVC.

Provide wire that was vinyl-coated before weaving and is free and flexible at the joints.

607.2.4 Post and Cable Barrier
607.2.4.1 Cable
Provide wire cable in accordance with AASHTO M 30. Provide cable of Type I, Class A, 0.75 in diameter rope, unless otherwise specified in the Contract.

607.2.4.2 Hardware and Fittings
Provide galvanized or cadmium plated parts, hardware, and fittings. Galvanize in accordance with AASHTO M 232. Provide cadmium plating in accordance with ASTM B 766, for Class 12, Type III. Provide bolts in accordance with ASTM A 307 and nuts in accordance with ASTM A 563.

Provide externally threaded fittings such as end tie rods, anchor rods, and splicing rods, that transmit direct tensile stress, having a minimum tensile strength of 75,000 psi.

Provide internally threaded fittings such as turnbuckles, cable sockets, and nuts capable of withstanding a proof load that is 85% of the proof load requirements for nuts, as specified in accordance with ASTM A 563, Table 3.

Provide cable splices and connections that withstand a proof load equal to the tensile strength required of the attached wire rope cable.

Provide steel rectangular plate washers and cable clamps with a minimum tensile strength of 60,000 psi. Provide plain washers of ferrous metal in accordance with ANSI B 18.22.1, Type A.
607.2.4.3 Round Wood Posts

- Provide round wood posts from one of the following species:
  1. Northern White Cedar;
  2. White Pine;
  3. Jack Pine;
  4. Red (Norway) Pine;
  5. Southern Yellow Pine;

- Provide posts from live trees that are stacked and properly seasoned. Peel the entire length of each post, closely trim knots, saw both ends square, and shave the entire length of the post to the white.

- Provide posts with a top diameter after shaving of 4 in − 1/2 in, +1 1/4 in.

- Ensure posts are free of sap rot, woodpecker holes, plugged holes, ant-eaten areas, and hollow knots extending to center of the post. Do not allow butt rot to exceed 5% of the butt area. Provide posts with sound tops, however, the Department will allow one pipe rot not exceeding a diameter of 3/8 in on a cedar post. Provide posts that do not have excessive checking. Ensure that the posts do not have short kinks or more than one one-way sweep exceeding 2 in, however, the post may have a winding twist.

- The Department will not allow posts exhibiting both the maximum crook and maximum butt rot, and will not allow more than 10% of the posts specified in the Contract to contain the maximum crook or butt rot.

- The Department may reject posts with other defects that give the post an unsightly appearance or impair its durability or strength. Complete debarking, trimming, and sizing operations before treatment.

607.2.4.4 Preservative Treatment of Posts for Post and Cable Barrier

- Provide pressure treated wood posts with pentachlorophenol in accordance with Section 550.2.2, “Preservatives and Treatment Methods,” with a minimum retention of 0.4 lb per cubic foot.

607.2.5 Snow Fence

- Provide snow fence of 1/2 in × 1 1/2 in wooden pickets spaced 3 1/2 in on center and woven between five cables. Each cable will consist of at least two strands of galvanized steel wire with diameters of 0.099 in or larger.

- Provide wooden pickets that are at least 48 in long and treated or painted in accordance with the manufacturer’s recommendations.

- Provide wire, braces, attachments, and fittings in accordance with ASTM A 116 and applicable requirements of Section 607.2.2, “Barbed Wire and Woven Wire Fence.”

607.2.6 Concrete

- Provide Class A concrete bearing blocks and anchors in accordance with Section 510, “Portland Cement Concrete.” The Contractor may provide a prepackaged, pre-blended cementitious Material to which the Contractor only adds water at the site.

607.3 CONSTRUCTION REQUIREMENTS

607.3.1 General

- Clear the fence lines of trees, bush, stumps, logs, weeds, existing fences, and other obstructions that may interfere with fence construction, unless the Project Manager requires certain trees to remain in place. Dispose of removed material in accordance with Section 601, “Removal of Structures and Obstructions.”

- If the Contractor is to embed posts, braces, or anchors in concrete, the Contractor shall install temporary guys or bracing to hold the posts in position until the concrete sets. Unless otherwise specified, do not install Materials on posts and do not strain posts, braces, or anchors set in concrete until 7 Days after concrete placement, or until the concrete has reached a compressive strength of 2,500 psi, whichever occurs first. Crown the concrete at the top of the foundation to shed water.

- Only cut the tops of posts as approved by the Project Manager. Apply protective coating to cut posts in accordance with Section 607.3.8, “Repair of Damaged Coating on Pull Cables and Tension Wires.” Firmly attach wire and fencing to the posts and braces. Tightly stretch wire and install it at the required elevations. Place fence wire on the field side of the posts, except on the inside
At each location where an electric transmission, distribution, or secondary line crosses new fence, provide and install a ground connection in accordance with the NEC®. Build new fences adjacent to existing fence before removing existing fences. When removing and rebuilding fences, maintain the security of livestock and protect adjacent properties and the traveling public. Remove the existing fence or unused Materials and neatly roll it up in single strand rolls. Remove the fence posts without damaging them and place the posts with the rolls of wire within the Right of Way for property owners to salvage, unless otherwise directed by the Project Manager. If the property owners do not pick the fence up within the allotted time, dispose of the fence as directed by the Project Manager.

607.3.2 Barbed Wire and Woven Wire Fence
Set posts plumb and in accordance with the Plans. The Contractor may drive metal line posts. Excavate for footings and anchors in accordance with the Plans or as directed by the Project Manager. Place post hole backfill in thin layers and compact each layer. Attach Right of Way fences to Roadway Structures, in accordance with the Plans.

607.3.2.1 Fence Tensioning
Stretch fence wire with a mechanical stretcher or other similar device. Do not allow the length between pull posts to exceed 990 ft for barbed wire, and 660 ft for woven wire.

607.3.2.2 Braces and Corner Posts
Place intermediate braces at intervals of 990 ft or less and at every fence grade-change, such as edges of arroyos, bottoms and tops of hills, and as directed by the Project Manager. Maintain the required distance between the bottom wire and the ground. Space intermediate braces evenly between corner and gateposts or cattle guards. Place a corner post and brace at the intersection of cross fences and the Right of Way fence. Stretch the wires and firmly attach them to the corner posts.

607.3.3 Chain Link Fence
Install braces, tension rods, cables, hardware, and appurtenances in accordance with the manufacturer’s recommendations and the Contract.

Do not attach chain link fabric to posts until the concrete footings have reached a compressive strength of 2,500 psi, or until 3 Days after concrete placement, whichever occurs first.

After permanently positioning posts, setting anchorages firmly, and drawing tension wires and pull cables tight with turnbuckles or other approved tension devices, secure the tension wires to the posts with tension bands and tie wires. Secure the chain link fabric at one end and stretch away from the secured end. Stretch the fabric with a mechanical stretcher or other device approved by the Project Manager.

607.3.3.1 Chain Link Fence Post Placement
Set posts plumb in concrete footings. Space chain link fence posts at intervals of 10 ft or less. Measure the intervals from center to center of posts. Pull posts are line posts braced to adjacent line posts. Position pull posts at intervals of 500 ft or less. Provide end posts with an outside diameter of at least 2.875 in. Brace end posts in the same way as corner posts.

607.3.3.2 Chain Link Security Fence
Use chain link security fence in accordance with Section 607.3.3, “Chain Link Fence.” Supply security appurtenances on gates for access.

607.3.4 Post and Cable Barrier

607.3.4.1 Post Placement
The Department will allow a depth of post embedment that is greater than specified in the Contract if the finished top of the post meets the required elevation. Compact the bottom of the holes to provide a stable foundation. Set the posts plumb with the front faces in a neat uniform line and with full contact on the foundation surface. Backfill holes with granular Material and compact in layers so the posts maintain the specified position and alignment. Instead of setting posts in previously dug holes and backfilling, the Contractor may drive the posts, except if the Contract specifies bearing blocks. Only drive if there is adequate lateral stability and as long as the Shoulders and adjacent slopes are not damaged from the
driving operations.

Remove posts that do not meet the requirements or are damaged below cutoff during driving, and replace with sound posts. If upward vertical adjustment of posts is necessary, remove and reinstall them.

The Contractor may cut off the tops of posts to the elevation specified in the Contract. Round the tops of round posts to an approximate domed hemispherical shape centered on the axis of the post. After cutting off treated posts, apply two coats of pentachlorophenol preservative to the cut surfaces.

607.3.4.2 Setting of Anchors, Cable, and Fittings for Post and Cable Barrier

If a bolt projects more than 1 in from the nut, cut off 1/2 in and burr. Paint the ends of cut-off bolts with aluminum paint. Bore holes for cable supports after the posts are set. Place end and intermediate anchorages and bearing blocks in accordance with the Contract.

Excavate trenches for anchor blocks to their neat lines. Perform excavation for anchor rod installation without excessively disturbing the earth between the block and the anchored posts. Excavate holes for bearing blocks to their neat lines, then place and level the block with anchor rods in place on undisturbed soil. Place backfill Material and compact in layers. Do not apply final tension to the anchor assembly until after completing the backfilling.

After completing the anchor assemblies, properly adjust and securely fasten the cables, draw the cables tight, then loosen them to meet Contract requirements for the applicable temperature range.

Use 3 in wide reflective sheeting in accordance with Section 701.2.2.1, “Retroreflective Sheetling,” Silver White No. 2. Mount the sheeting on flexible aluminum alloy. Fix the sheeting to each end post and at maximum intervals of 100 ft on intermediate posts, with a minimum of three strips per installation. Completely wrap the reflective strips around each post before installing the post plate washers.

607.3.5 Snow Fence

Construct snow fence in accordance with the manufacturer’s recommendations and the Contract.

607.3.6 Pedestrian/Bicycle Railing

Construct pedestrian and bicycle railing in accordance with the Contract or as directed by the Project Manager.

607.3.7 Removing and Rebuilding Fence

Remove and rebuild existing fences in accordance with the Contract or as directed by the Project Manager. Construct new fences in the same or better condition than the original fence.

Salvage Materials from removed fences and incorporate into the rebuilt fences. If the Project Manager determines that some Materials are not reusable, replace those Materials as necessary and in accordance with Section 109.5, “Payment for Changes, Differing Site Conditions, and Extra Work.”

Firmly reset posts to the staked alignment. Use the same spacing of the posts and the same number of wires strung and stapled to the posts as the original fence. Use new staples to fasten the wires to the posts.

607.3.8 Repair of Damaged Coating on Pull Cables and Tension Wires

The Contractor may repair pull cables and tension wires that exhibit minor damage to the zinc coating by wire-brushing the damaged area and removing loose, cracked, or weld-burned zinc coating. Paint the cleaned area with two coats of zinc oxide-zinc dust paint in accordance with Federal Specification TT-P-641 or Military Specification MIL-P-21035 or with an equivalent coating approved by the Project Manager. Make repairs and provide repair Materials at no additional cost to the Department.

607.3.9 Gates

Fabricate and construct gates, and stile and post wire traps in accordance with the Contract.

607.3.9.1 Remove and Reset Gate

Remove and reset existing gates in accordance with the Contract or as directed by the
607.4 **METHOD OF MEASUREMENT**

The Department will measure fences and watergap gates along the top from outside to outside of end posts for each continuous run of fence or watergap gate.

607.5 **BASIS OF PAYMENT**

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<th>Pay Item</th>
<th>Pay Unit</th>
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<tr>
<td>Chain Link Gate, ___ ft Span by ___ ft Rise</td>
<td>Each</td>
</tr>
<tr>
<td>Pipe Gate ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Water Gap Gate</td>
<td>Each</td>
</tr>
<tr>
<td>Turnstile Gate ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Remove and Reset _____ Gate</td>
<td>Each</td>
</tr>
<tr>
<td>Stile and Post Wire Trap</td>
<td>Each</td>
</tr>
</tbody>
</table>

607.5.1 **Work Included in Payment**

The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: clearing and grubbing, grading, excavation, backfill, disposal of surplus material, concrete, fasteners, galvanizing, coating repairs and all additional bracing required for grade changes.
SECTION 608: SIDEWALKS, DRIVE PADS, AND CONCRETE MEDIAN PAVEMENT

608.1 DESCRIPTION
This Work consists of constructing Sidewalks, drive pads, detectable warning surfaces, and concrete median pavement in accordance with these Standard Specifications and the Americans with Disabilities Act of 1990 (42 U.S.C. § 12101 et seq.).

608.2 MATERIALS
608.2.1 Concrete
Provide Class A or Class F concrete in accordance with Section 510, “Portland Cement Concrete.”

608.2.2 Joint Fillers
Provide preformed expansion joint filler in accordance with AASHTO M 33 or AASHTO M 153.

608.2.2.1 Silicone Joint Sealant and Backer Rod
Provide silicone joint sealant and backer rod (bondbreaker) from the Department’s Approved Products List and in accordance with Section 452, “Sealing and Resealing Concrete Pavement Joints.”

608.2.3 Bed Course Material
Provide bed course Material that consists of cinders, sand, gravel, crushed stone, or other granular aggregate, with 100% passing a 1/2 in sieve and not more than 12% passing the No. 200 sieve, or Base Course as per Section 304, “Base Course.”

608.2.4 Detectable Warning Surfaces
608.2.4.1 General
Obtain a list of approved Suppliers from the Department’s Approved Products List. Contact the Department’s Office of Affirmative Action to propose alternative Suppliers. Stamped or imprinted concrete systems will not be allowed.

608.2.4.2 Color Contrast
Provide a light colored Material on a dark surface or a dark colored Material on a light surface to contrast with adjacent walking surfaces.
Use a uniform color over the entire surface that is homogenous throughout the thickness of the Material, as approved by the Project Manager.
Should a concern arise over the color contrast, the Contractor will coordinate with the Environmental Program Manager (through the Project Manager) for color contrast guidance. Allow a minimum of 30 Days for coordination with the Environmental Program Manager.

608.2.4.3 Contractor Submittals
Submit certification to the Project Manager before proposed installation describing the following:
1. The detectable warning surface Material and name of approved Supplier;
2. All associated Materials used, including bonding Material and color used for color contrast requirements;
3. Installation procedure as per manufacturer's recommendations;
4. A detailed time element regarding application to new concrete;
5. Submit a 12 in × 12 in sample of the detectable warning surface on concrete substrate showing the color contrast developed for the project;
6. Certified test results indicating compliance with manufacturer recommendations.

608.3 CONSTRUCTION REQUIREMENTS
608.3.1 Excavation and Backfill
Perform excavation or backfill to the required depth of elevation and to a width that will allow the installation and bracing of the forms. Remove soft and yielding Material and replace with the specified bed course Material. Shape and compact the foundation to a firm, even surface.
608.3.2 Bed Course Placement
Compact existing ground under bed course to 95% of maximum density in accordance with Section 203.3.7, "Moisture and Density Control."
Place at least 4 in of bed course Material. Compact bed course Material to a density of at least 90% of maximum density. Compact bed course Material for drive pads to a density of at least 95% of maximum density. Perform compaction in accordance with Section 303.3.2, "Mixing and Placing."

608.3.3 Forms
Use wood or metal forms that extend the full depth of the concrete. Ensure forms are straight, free of warps, and strong enough to resist the concrete pressure without deforming. Brace and stake forms so they remain in both horizontal and vertical alignment until their removal. Treat the forms with form release oil to prevent damage to the concrete when removing the forms. Use flexible forms in curved sections so that the top surface of the forms produces a smooth, continuous arc.

608.3.4 Placing Concrete
Moisten the foundation immediately before placing the concrete. Remove excess water remaining on the foundation. Proportion, mix, and place the concrete in accordance with the requirements for the specified concrete. Use cast-in-place or slip formed concrete. Ensure the surface of the patterned concrete pavement matches the finish grades. Consolidate the concrete placed in the forms by vibration or other acceptable methods.

608.3.5 Finishing
Finish the surface with a float. Do not plaster or re-temper the surface with water. Give the top surfaces of the slabs a transverse broomed finish after floating, unless otherwise specified in the Contract. Use an edging tool with a 1/2 in radius on the outside edges of the slab and joints.

608.3.5.1 Colored and Patterned Median Pavement Application
Apply the color to the mix at the concrete plant in accordance with the manufacturer’s recommendations.
While concrete is still in the plastic state, apply the imprinting tools to make the desired patterned surface.
Submit a sample panel at least 2 ft × 2 ft, showing color and texture, to the Project Manager for approval before starting Work on the patterned concrete pavement. Use the approved sample panel as a standard for the installation of patterned concrete pavement.

608.3.5.2 Joints
Fill the expansion joints with pre-molded expansion joint filler. Also, fill sealed expansion joints with a backer rod and silicone joint sealant at the specified intervals.
Divide sidewalks, drive pads, and concrete median pavement into sections with contraction joints formed with a scoring tool to create rounded edges. Create contraction joints that are approximately 0.125 in wide and extend into the concrete at least one-third the depth of the Sidewalk, drive pad, or concrete median pavement. The Department will not require contraction joints in patterned concrete median pavement.
Construct expansion joints that extend into and through the Sidewalk around manholes, pipe inlets, utility poles, or other miscellaneous Structures. Install a pre-molded expansion joint filler to completely fill the joint.
Install expansion joint filler 0.75 in thick between concrete sidewalks and fixed Structures, such as buildings or bridges. Ensure the expansion joint filler extends the full depth of the Sidewalk.

608.3.6 Curing
Cure concrete in accordance with Section 511.3.9, "Curing."

608.3.7 Surface Tolerance
Do not allow the surface of concrete sidewalks and median pavement to deviate more than 1/4 in (in any direction), if tested with a 10 ft straightedge. Correct deviations at no additional cost to the Department. The Project Manager must approve the correction method.
608.3.8 Detectable Warning Surface
608.3.8.1 Installation Requirements
Install detectable warning surfaces per the manufacturer’s recommendations and provide manufacturer’s assistance for proper installation when necessary.
Provide the Project Manager the manufacturer’s certification stating that the Contractor is certified to install the detectable warning surfaces.

608.3.8.2 Tile Cutting
Provide detectable warning surfaces cut along the flat surface. Cutting along the raised (dome) surface is prohibited.

608.3.8.3 Cleanup
Leave a neat, clean work area without any contamination. Remove and dispose all waste and excess Material in an environmentally acceptable manner.

608.3.8.4 Warranties
Submit all warranty material to the Project Manager after acceptance of the Work.

608.4 METHOD OF MEASUREMENT—Vacant

608.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Sidewalk ___ in</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Drive Pad ___ in</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Concrete Median Pavement ___ in</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Concrete Median Pavement ___ in (Colored)</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Concrete Median Pavement ___ in (Colored and Patterned)</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

608.5.1 Work Included in Payment
The following Work and items will be considered incidental to the main items:
1. Excavation, backfill, compaction, expansion joint, coloring, and other related items and appurtenances;
2. Bedding Material;
3. All labor, manufacturer field assistance, Materials, Equipment, submittals, repairs, cleanup, and all guarantees and warranties;
4. Detectable warning surface.
SECTION 609: CURB AND GUTTER

609.1 DESCRIPTION
This Work consists of constructing asphalt or concrete curb, concrete gutter, and concrete curb-and-gutter combinations.

609.2 MATERIALS
609.2.1 Concrete
Construct PCC curb and gutter with Class A or Class F concrete in accordance with Section 510, “Portland Cement Concrete.” Provide Class A concrete if the concrete is being cast directly into forms and Class F if the concrete is being slip-formed.

609.2.2 Joint Fillers
Provide preformed expansion joint filler in accordance with AASHTO M 33 or AASHTO M 153.

609.2.2.1 Silicone Joint Sealant and Backer Rod
Provide silicone joint sealant and backer rod (bondbreaker) in accordance with Section 452, “Sealing and Resealing Concrete Pavement Joints.”

609.2.3 Bed Course Material
Provide bed course Material that consists of cinders, sand, gravel, crushed stone, or other granular aggregate, with 100% passing a 1/2 in sieve and not more than 12% passing the No. 200 sieve. Alternatively, Base Course as per Section 304, “Base Course” may be used.

609.2.4 Asphalt Material
Provide asphalt Material for curbing in accordance with Section 423, “Hot-Mix Asphalt — Superpave (QLA & Non-QLA),” and as approved by the Project Manager.

609.3 CONSTRUCTION REQUIREMENTS
609.3.1 Foundation
Place concrete curb and gutter on an approved foundation in accordance with Section 203, “Excavation, Borrow, and Embankment;” Section 207, “Subgrade Preparation;” and Section 304, “Base Course.” Prepare the foundation by excavating or constructing Embankment to the specified Subgrade.

609.3.1.1 Excavation
If required, excavate to the specified depth and compact the base for the curb and gutter in accordance with Section 207, “Subgrade Preparation.” Remove soft and unacceptable Material to 2 ft below the specified Subgrade and replace with Material having at least the minimum specified design R-value in accordance with Section 203, “Excavation, Borrow, and Embankment,” and Section 207, “Subgrade Preparation.”

609.3.1.2 Bed Course Placement
For existing ground under bed course, compact the thickness shown in the Contract to 95% of maximum density in accordance with Section 203.3.7, “Moisture and Density Control.” Compact bed course Material to a density of at least 96% of maximum density in accordance with Section 303.3.2, “Mixing and Placing.”

609.3.2 Cast-in-Place Concrete Curb and Gutter
609.3.2.1 Forms
Use wood or metal forms that are straight and free of warps, and constructed to permit the inspection of grade or alignment.
Ensure forms extend the entire depth of the curb and gutter. Brace and secure the forms sufficiently to prevent deflections during concrete placement.
Use flexible forms in curved sections so that the top surface of the forms will produce a smooth, continuous arc.
Treat forms with form release oil to prevent damage to the concrete during form removal.
Form the slope of the gutter to match the Roadway cross slope.
609.3.2 Mixing and Placing

Thoroughly moisten the bed course immediately before placing the concrete. Do not allow standing water on the bed course.

Proportion, mix, and place concrete in accordance with Section 451, “Portland Cement Concrete Pavement,” Section 510, “Portland Cement Concrete,” and Section 511, “Concrete Structures,” for the specified class of concrete.

Consolidate the placed concrete in the forms using vibration or other acceptable methods.

Finish the surface with a float. Do not plaster or re-temper the surface with water. Unless otherwise specified, give the top surfaces of the concrete a transverse broomed finish after floating.

Use an edging tool with a 1/4 in radius on the outside edges of the curb and gutter and joints.

Leave forms in place until the concrete has set sufficiently to allow removal without damaging the curb and gutter.

609.3.3 Slip-Formed Concrete Curb and Gutter

The Contractor may place curb and gutter using a slip-form machine (except on Structures) if the finished curb and gutter is true to line and grade, and the concrete is dense and of the specified surface texture.

Construct curb and gutter using a slip-form machine in accordance with Section 451, “Portland Cement Concrete Pavement.”

Ensure that the top and face of the finished curb and gutter are true and straight, and the top surface is of uniform width and free from humps, sags, and other irregularities.

Use concrete of a consistency that will maintain the shape of the curb and gutter section without support after slip forming.

Ensure that the forming portion of the slip-form machine is readily adjustable vertically during the forward motion of the machine, to provide a variable height of curb and gutter grade, if necessary.

The Contractor shall attach a grade line gauge or pointer to the slip-form machine so that the Contractor can make a continual comparison between the curb and gutter grades indicated by the gauge or pointer and the offset guidelines.

Feed concrete to the slip-form machine at a uniform rate. Operate the slip-form machine under sufficient uniform restraint from forward motion to produce a well-compacted mass of concrete that is free of surface pits with diameters larger than 0.19 in, and that requires no further finishing, other than light brushing with a wet brush. Do not finish with a brush application of grout.

609.3.4 Joints

Construct curb and gutter in sections with uniform lengths of 30 ft. Separate sections by open joints, 1/8 in wide, except at expansion joints. Construct contraction joints at intervals of 5 ft.

Form expansion joints at the intervals in accordance with the Contract, using the preformed expansion joint filler with a thickness of 3/4 in.

Construct transverse weakened plane and expansion joints at right angles to the line of the concrete curb and gutter.

The Contractor may construct expansion joints by sawing through the concrete curb and gutter section to its full depth. Ensure that the width of the cut accepts the joint filler with a snug fit.

Complete the operations of sawing and inserting the joint filler before curing the concrete. At the conclusion of the curing period, check the filler in each joint for tightness. Mortar in place and cure loose filler in joints.

If constructing the curb and gutter adjacent to or on concrete pavement, locate expansion joints opposite to or at expansion joints in the pavement.

609.3.5 Curing

Cure concrete in accordance with Section 511.3.9, “Curing.”

609.3.6 Backfilling

After the concrete attains a compressive strength of 2,500 psi, fill the spaces in back of
the curb to the specified elevation with Embankment Material, and compact in accordance with Section 203.3.7, "Moisture and Density Control," unless otherwise specified in the Contract.

609.3.7 Asphalt Curbing
If constructing asphalt curbing on an asphalt surface, place the curb after cleaning the surface and applying a tack coat of asphalt Material.
- The Project Manager will determine the tack coat application rate.
- Construct asphalt curbing using a paver with curbing attachments.

609.4 METHOD OF MEASUREMENT
- The Department will measure curb along the front face of the section.
- The Department will measure gutter and curb-and-gutter combinations along the flowline of the gutter.

609.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Curb ___ in</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Bituminous Curb</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Header Curb</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Concrete Sloped Curb and Gutter ___ in × ___ in</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Concrete Vertical Curb and Gutter Type _______ ___ in × ___ in</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Standard Curb and Gutter</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Concrete Valley Gutter ___ in × ___ in</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Concrete Laydown Curb ___ in</td>
<td>Linear Foot</td>
</tr>
</tbody>
</table>

609.5.1 Work Included in Payment
The Work Included in payment will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: Excavation, borrow, bed course, compaction and embankment, for foundation of curb and gutter, expansion joint material (including silicone joint sealant and backer rod), coloring, and other related items and appurtenances, and backfilling behind curb.
610.1 DESCRIPTION
This Work consists of constructing precast concrete cattle guards or steel frame cattle guards.

610.2 MATERIALS
610.2.1 General
Provide cattle guards and grids in accordance with the Contract. Provide individual cattle guards with grids of identical type having the same shapes, dimensions, and weight of the steel members.
Use steel frame cattle guards as an alternate to precast concrete cattle guards at turnouts or at other locations in accordance with the Contract.
If the Contract specifies precast concrete cattle guards, the Department will not allow substitutions.

610.2.2 Precast Concrete Cattle Guards
Use Class AA concrete in accordance with Section 510, “Portland Cement Concrete.”
The Department will reject cattle guards with cracks, chips, spalls, or honeycombed or patched areas in excess of 30 in²; or those that fail to meet the minimum strength requirements.
Provide precast concrete cattle guards from approved manufacturers listed on the Department’s Approved Products List.

610.2.3 Steel Frame Cattle Guards
Provide steel frame cattle guards from approved manufacturers listed on the Department’s Approved Products List.

610.2.4 Reinforcing Steel
Use Grade 60 reinforcing steel deformed bars in accordance with Section 540, “Steel Reinforcement.”
Provide welded wire fabric in accordance with AASHTO M 55.

610.2.5 Cattle Guard Grids and Hardware
Provide traffic grill units, warning devices, bolts, tie bolts washers, hardware, and other Materials in accordance with Section 541, “Steel Structures.”
Provide grid units in accordance with AASHTO M 183.
Provide aluminum members in warning devices in accordance with the ASTM specifications listed in Table 610.2.5:1, “Aluminum Members Warning Devices Standards.”

<table>
<thead>
<tr>
<th>Description</th>
<th>ASTM</th>
<th>Alloy</th>
<th>Temper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubing</td>
<td>B 429</td>
<td>6061</td>
<td>T-6</td>
</tr>
<tr>
<td>Fence angle</td>
<td>B 221</td>
<td>6061</td>
<td>T-6</td>
</tr>
<tr>
<td>Base plate</td>
<td>B 209</td>
<td>6061</td>
<td>T-6</td>
</tr>
</tbody>
</table>

610.3 CONSTRUCTION REQUIREMENTS
610.3.1 Concrete Footings and Foundations
Excavate or build with Embankment, level, and compact foundations for cattle guards before installing the cattle guard. Excavate wide enough to compact and test material adjacent to the cattle guard, or backfill with flowable fill at no extra cost to the Department.
Finish uneven foundation surfaces to ensure full bearing of cattle guard units. Compact Subgrade foundations in accordance with Section 207, “Subgrade Preparation.”
If the Contractor finds unstable material in footing foundations, the Contractor shall stabilize, or remove and replace with Material approved by the Project Manager.
Place a 3 in thick bedding of fine aggregate over the Subgrade and compact it to at least 95% of the maximum density in accordance with AASHTO T 99. Place the cattle guard unit on the fine aggregate bedding.
Finish the tops of concrete footings so that stringer-bearing surfaces receive the full bearing under each stringer.
610.3.2 Placement Requirements
Place the concrete cattle guards in accordance with Section 511, “Concrete Structures.”
The Contractor may splice reinforcing bars over 30 ft long using a minimum 24-bar-
diameter lap.
Chamfer exposed edges of concrete 3/4 in.
The Contractor may use used steel members that are free of bends and in good
condition, as approved by the Project Manager.
Fabricate grids so that the bottoms of the stringers are in a plane surface.

610.3.3 Protective Coating
Provide cattle guards with a protective coating in accordance with Section 545,
“Protective Coating of Miscellaneous Structural Steel.”
Stripe warning devices with two coats of black coating Material in accordance with the
Contract.

610.3.4 Backfill
Perform the excavation, placement, and compaction of select backfill in accordance with
Section 206, “Excavation and Backfill for Culverts and Minor Structures.”

610.4 METHOD OF MEASUREMENT—Vacant

610.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle Guard (___ ft)</td>
<td>Each</td>
</tr>
</tbody>
</table>

610.5.1 Substitutions
The Department will not adjust the bid price for weights of rails greater than the specified
minimum.

610.5.2 Work Included in Payment
The following work and items, except when otherwise specified, will be considered as
included in the payment for the main items, complete in place as detailed in the contract, and
will not be measured or paid for separately. Subgrade preparation, excavation, replacement of
unstable subgrade, placement and compaction of select backfill, all steel reinforcement
(including welded wire fabric), all structural steel, bearing pads, all connecting hardware and
associated components, all warning devices, all field painting, and all appurtenances
necessary to complete the work.
613.1 DESCRIPTION
This Work consists of removing unsuitable material from within and around concrete box Culverts, concrete Culverts, corrugated metal Culverts, storm drains, catch basins, inlets, and outlets.

613.2 MATERIALS—Vacant

613.3 CONSTRUCTION REQUIREMENTS
Before beginning Structure extension work, clean the existing Structures that will remain operational.
Remove materials on the roads and streets that accumulate during the performance of the Work.
Clean ditch lines within the Right of Way to prevent ponding and ensure proper drainage.

613.3.1 Equipment
If using a mechanical jet rodding machine in cleaning operations, provide water necessary to complete the Work.

613.3.2 Disposal Requirements
Haul the debris and unsuitable material to an environmentally suitable disposal site.
Obtain the permits and clearances from the appropriate regulatory agencies in accordance with Section 107, “Legal Relations, Environmental Requirements, and Responsibility to the Public.”
Notify the Project Manager in writing of the details of disposal operations.
Do not place rock waste, vegetative debris, or any other debris in wetland areas or areas that may impact endangered species or archaeological resources. Obtain an archaeological survey and environmental clearance for approval of the disposal sites.

613.3.3 Traffic Control Requirements
Provide, install, and maintain traffic control devices necessary to protect the Work and the safety of the public.

613.3.4 Final Acceptance
Clean the project site before the final project acceptance.

613.4 METHOD OF MEASUREMENT
The Department will only measure Cleaning Culverts and Drainage Structures if specified as a pay item in the Contract.

613.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning Culverts and Drainage Structures</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>

613.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:
A. Water for cleaning;
B. Furnishing, installing and maintaining traffic control devices;
C. Hauling and disposal of waste and debris;
D. Cleaning of ditch lines within right of way.
614.1 DESCRIPTION
This Work consists of providing and installing pipe for encasing utility lines.

614.2 MATERIALS
614.2.1 Galvanized Steel Pipe
Provide galvanized steel pipe in accordance with ASTM F 1083 for galvanized standard weight pipe.

614.2.2 Corrugated Steel Pipe
Provide corrugated steel pipe in accordance with AASHTO M 36 and Section 570, “Pipe Culverts.”

614.2.3 Polyvinyl Chloride Pipe
Provide polyvinyl chloride pipe in accordance with Section 570, “Pipe Culverts.”

614.3 CONSTRUCTION REQUIREMENTS
Obtain Project Manager approval of the installation method before beginning the Work.
Dig trenches for laying pipe in accordance with Section 660.3.1.1, “Trench Widths.”
Connect the pipe sections in accordance with the manufacturer's recommendations.
Backfill the trenches in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures.”

614.4 METHOD OF MEASUREMENT—Vacant

614.5 BASIS OF PAYMENT
Pay Item Pay Unit
Pipe Casing Linear Foot
617.1 DESCRIPTION.
Perform vibration monitoring and video taping in and around all engineered structures, sensitive features and construction areas as indicated in the Contract and as determined by the vibration risk survey, or as directed by the Project Manager. Sensitive features may include archaeological sites, historical features, utilities, and historic structures, watercourses and other areas subject to damage or erosion.
Perform vibration monitoring and video taping to determine if potentially damaging vibrations to engineered structures and sensitive features are created as a result of construction activity.

617.2 MATERIALS – Vacant

617.3 CONSTRUCTION REQUIREMENTS

617.3.1 General

617.3.1.1 Vibration monitoring consists of the following:
1. Vibration risk survey of all sensitive features within the influence zone of construction activity to determine size and locations of any existing cracks and other defects in any sensitive features;
2. Use of a seismograph, by a qualified vibration specialist, to monitor vibration levels;
3. Immediate notification of the Project Manager, if visual inspection or seismograph readings indicate that damage to any sensitive feature is occurring due to vibrations.

617.3.1.2 Video taping consists of the following:
1. Video tape in both directions along the roadway corridor and along roadways to be constructed or reconstructed. Insure that these video tapes pick up existing utilities within the corridor as well as existing drainage patterns. The maximum speed of camera movement shall not exceed 4 ft/s;
2. Pre-construction video taping for each area on the project shall take place not more than fourteen (14) days prior to beginning construction in that area or as directed by the Project Manager;
3. During all video taping, provide an audio explanation of significant features observed during taping;
4. Any notification of any damage or any concerns/remedies resulting from construction activities shall be immediately relayed to the Project Manager;
5. Video tape building structure front and side views, including close-ups of each view, for any features or facilities that may be affected by construction. Where cracks exist on building structures place a scale next to the crack and video tape to show existing crack size. Such building features may include, but are not limited to, all buildings, fences and landscaping adjacent to the project limits.
6. Video tape the construction area immediately following rainfall over the area to ascertain drainage patterns. This video taping shall take place before commencing construction when possible.
7. Video taping equipment and operator shall be onsite within ½ h at the Project Manager’s request.
8. The video viewing system and the appropriate video tapes shall be available for meetings as scheduled, and at the request of the Project Manager.
9. The quality of the visual and audio portions of the video tapes, and the method of indexing of locations on the tapes, shall be acceptable to the Project Manager. Tapes or portions of tapes deemed defective or substandard shall be re-taped.

617.3.2 Condition Survey of Engineered Structures and Sensitive Features
Conduct a vibration risk survey of any sensitive features within the influence zone of construction activity.
1. Submit to the Project Manager, a report documenting conditions of all potentially affected sensitive features within the survey influence zone or as shown in the Contract;
2. Include the following information from the survey, for each sensitive feature:
   2.1 The age, foundation, and above-ground Structure type or sensitive feature;
   2.2 Provisions for water drainage from roof and around foundation exterior;
2.3 The age, type, and condition of any sensitive utility;
2.4 Documentation (in the form of drawing, photographs, or videotape) of the size and location of all cracks, and the type and location of all structural defects.

617.3.3 Equipment
617.3.3.1 Seismograph Equipment
   Provide seismograph(s) with self-triggering unit(s), approved by the Project Manager, and capable of recording three mutually perpendicular components of ground motion time histories, in terms of velocity. In the case of monitoring blast vibrations, provide additional capability for recording of airblast levels. Provide unit(s) capable of reporting the frequency as well as the peak values for all vibration time histories.

617.3.3.2 Video Camera Equipment
   1. Furnish at least one video camera and appurtenances for the duration of the project. The equipment shall be capable of producing a color picture when the tape is viewed, equipped with audio capabilities; and equipped with a zoom lens.
   2. Furnish at least one video tape viewing system and appurtenances for the duration of the project. The equipment shall be capable of reproducing a color picture with audio on a television screen; and capable of slow motion, stop for viewing of single picture image, and reverse controls.
   3. Supply a sufficient number of two-hour videotapes to videotape the entire construction area and adjacent areas before construction commences, and as required or directed by the Project Manager during and after construction. Each videotape shall be titled, catalogued, dated, sequenced in chronological order, and cross-referenced. A copy of each two-hour videotape shall be submitted to the Project Manager. This copy shall also be titled, catalogued, dated, sequenced, and cross-referenced; and will remain the property of the Department upon acceptance by the Project Manager.

617.3.4 Seismograph Location and Usage
   Place seismographs outside the sensitive features closest to the construction activity as determined by the vibration risk survey or approved by the Project Manager. The transducer(s) shall be placed between the construction and the sensitive features and coupled to the ground.

617.3.5 Frequency of Vibration Monitoring
   For all construction activity other than blasting, perform monitoring at least two times during peak construction when construction activity is occurring near the sensitive features, and at the Project Manager’s request.

617.3.6 Qualification for Vibration Monitoring
   Provide a qualified specialist competent to perform the Work and analyze the results of vibration monitoring. Department approved specialist are on file with the Department’s Geotechnical Section.

617.3.7 Prior Experience
   Submit the following written documentation of prior experience to the Project Manager:
   1. Copies of reports including analysis and conclusions for at least three previous projects similar in scope to this project;
   2. Resumes for all personnel involved in this Work;

617.3.8 Analysis of Vibration Monitoring
   Submit to the Project Manager eight copies of a comprehensive report for each sensitive feature. Each report shall include a discussion of:
   1. Site conditions and description, including a site map drawn to scale showing the location of the sensitive feature and the location of the construction activity;
   2. Field procedures and Equipment used, including the seismograph manufacturer, model and unit serial number;
   3. The name of the seismograph operator;
   4. A hard copy of all ground vibration time histories, in units of velocity;
   5. A record summary of the maximum value of ground vibration in any one of three
directions measured (longitudinal, radial, or vertical), the frequency associated with the maximum value, in unit of hertz, and the measured distance between the seismograph and the construction activity;

6. Analysis of results with conclusions and recommendations;
In the case of blasting, the report shall also include:

7. A hard copy of the airblast time history, in units of decibels and pounds per square inch (psi), the maximum value of airblast, in decibels, and the peak airblast frequency in hertz;
8. The maximum charge weight of explosive used per 8 millisecond time delay;
9. The scaled distance factor used for design;
10. A plot of the ground motion velocity plotted against frequency for the maximum values recorded on a graph similar to that shown in Figure 617.3.8:1.
Submit any additional inclusions to the report(s) at the direction and request of the Project Manager.

617.3.9 Safe Vibration Levels for Blasting
Base safe levels of the maximum ground motions and air blast in accordance with nationally recognized standards specified by the U.S. Bureau of Mines 30 CFR Parts 715 and 817.

617.4 METHOD OF MEASUREMENT
Vibration Monitoring will be measured as a lump sum unit.
Vibration Risk Survey will be measured as a lump sum unit.

617.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration Monitoring</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>Vibration Risk Survey</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>Video Taping</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>

![Graph of Blast Vibration Frequency vs. Maximum Particle Velocity](image-url)
618.1 DESCRIPTION
This Work consists of providing traffic control management in accordance with the Contract and the MUTCD, including supervision of personnel and the installation, inspection, and maintenance of traffic control devices on the project.

618.2 REQUIREMENTS
The Contractor may assign more than one traffic control supervisor (TCS) to provide traffic control management for the project.

If assigning more than one TCS to provide traffic control management, submit to the Project Manager a weekly schedule identifying who shall be in charge of providing traffic control management each Day.

Provide the TCS with a set of traffic control plans and a current copy of the MUTCD. The TCS shall possess these at all times.

If using a subcontractor to provide traffic control management, ensure that the TCS is in accordance with the Contract.

The Contractor may assign one or more traffic control technician (TCT) to assist the TCS in inspection and maintenance of traffic control devices.

618.2.1 Certification
Before commencing Work that requires traffic control management, submit to the Project Manager a copy of the “Work Zone Safety Supervisor” certificate for the TCS (wallet size card) issued by the American Traffic Safety Services Association (ATSSA), the Associated Contractors of New Mexico (ACNM), or an agency or firm approved by the Department.

The Department will accept the TCS certification by ATSSA, ACNM, or any agency or firm only if the following requirements are met:

1. Successful completion of a Department-approved work-zone traffic control course;
2. Passing a written examination on a work-zone traffic control course;
3. At least one year of full-time field experience, verified by the agency or firm, in work-zone traffic control; the Department may verify the experience at its discretion.

The TCT must only satisfy requirements 1 and 2, above.

Before commencing work that requires flagger traffic control, submit a copy of the “Flagger Training” certificate (wallet sized card) issued by ATSSA, ACNM, FHWA, or an agency or firm approved by the Department.

618.2.1.1 Re-certification
Renew the TCS’s certification every four years through the ATSSA, ACNM, or a Department-approved agency or firm.

Re-certify in the fourth year, before the expiration date of the current certification.

Flaggers must obtain refresher training which meets the requirements of ATSSA, ACNM, FHWA, or agency or firm approved by the Department prior to the fourth anniversary date shown on the current certificate.

618.2.2 Duties
The TCS’s only responsibility is traffic control management. The Department may allow exceptions to this rule if the project is small and requires limited traffic control. The Project Manager and the District Traffic Engineer will determine approval of the exception at the preconstruction conference.

The TCS’s primary duties include the following:

1. Providing management and supervision services at the project site;
2. Preparing revisions requested by the Contractor to the traffic control plan in the Contract and submitting the new traffic control plan, in CAD format or hand drafted on a 12 in × 18 in piece of 20-pound paper using current drafting standards, to the Project Manager for approval by the District Traffic Engineer. Complex traffic control plans require development by a registered professional engineer prior to submittal to the project manager;
3. Coordinating the flagging and signing personnel training;
4. Supervising the flagging and signing personnel;
5. Coordinating traffic control operations for the duration of the Contract, including those of subcontractors, utility companies, and Suppliers, to ensure that traffic
control is in place and fully operational before the commencement of Work. When dealing with utility companies, the TCS shall coordinate concurrent utility traffic control with other construction traffic control to avoid conflicts;

6. Coordinating, in writing, project activities with the appropriate individual traffic control, law enforcement, and fire control agencies;

7. Preparing and submitting statements concerning road closures, delays, and other project activities to the news media, as necessary. Before submittal to the news media, the Contractor shall submit news releases to the Project Manager for review and approval;

8. Notifying the Project Manager of accidents related to the project traffic control;

9. Recording time and date of accident notification in accordance with Section 618.2.2.1, “Traffic Control Diary;”

10. Attending the preconstruction conference;

11. Maintaining, cleaning, and replacing traffic control devices in use per the current traffic control plan during working and non-working hours.

618.2.2.1 Traffic Control Diary

The TCS shall maintain a project traffic control diary in a bound book. Obtain the diary from the ACNM.

The TCS shall keep the traffic control diary current each day and sign each daily entry. The TCS shall make entries in ink, in a format approved by the Project Manager, without erasures or white-outs. The TCS shall strike out unacceptable entries and replace with acceptable ones. The TCS may use photographs to supplement the written text.

Ensure that the traffic control diary is available for inspection by the Project Manager at all times and submit a copy of the diary to the Project Manager at the end of each week.

The traffic control diary will become the property of the Department at the completion of the project. If the Contractor fails to submit the diary, the Department may withhold final payment until it is submitted.

618.2.2.2 Inspection of Traffic Control

The TCS shall inspect traffic control devices every day that traffic control devices are in use. The TCS shall provide for the immediate cleaning, repair, or replacement of traffic control devices that are not functioning as required to ensure the safety of the motorists and construction personnel.

The TCS shall conduct inspections of the traffic control devices at the beginning and end of each day that traffic control devices are in use, and as scheduled or directed by the Project Manager during the work day.

The TCS shall inspect the traffic control devices during working and non-working hours on a schedule approved in writing by the Project Manager.

The TCS shall inspect traffic control devices that are in use for longer than 7 Days at least once a week during nighttime periods.

618.2.3 Availability of TCS

Provide traffic control management under the supervision and direction of the TCS on a 24-hour-per-day basis throughout the duration of the project.

The TCS shall be on the project whenever Work is in progress, and available by telephone to be on the project within 1 hour at all other times.

The provisions for availability of the TCS will also apply during times of Partial or full project Suspension.

618.3 COMPLIANCE

618.3.1 Failure to Comply

If the Contractor fails to comply with the approved traffic control plan or fails to immediately correct unsafe traffic conditions after written notification of the problem, the Project Manager may suspend all or part of the Contractor’s operations.

If the Contractor does not take appropriate action to correct the problem, the Department may proceed with the corrective action and charge the Contractor for the additional cost incurred by the Department.

If the Department suspends the Contractor’s operations, the Department will include the period necessary to correct these unsafe conditions and traffic control deficiencies in the normal assessment of Contract Time.
The Department will not relieve the Contractor of the responsibility to provide traffic control safety to the traveling public, if the Department fully or Partially Suspends the project.

If the Department suspends the project due to the Contractor’s failure to comply with this Section, or the Contract is in liquidated damages, the Contractor shall continue to provide traffic control management, at no additional cost to the Department.

If the Contractor requests full or Partial Suspensions, the Contractor shall perform the additional traffic control management at no additional cost to the Department.

618.3.2 Project Manager Modifications

The Project Manager may change requirements for handling and controlling traffic during construction, with the approval of the District Traffic Engineer, due to actual field conditions. The Project Manager will make these changes and provide written notice to the Contractor.

618.4 METHOD OF MEASUREMENT—Vacant

### 618.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Control Management</td>
<td>Lump Sum</td>
</tr>
<tr>
<td>Traffic Control Management</td>
<td>Calendar Day</td>
</tr>
</tbody>
</table>

### 618.5.1 Partial Payments

If the Department pays for Traffic Control Management by the lump sum, the Department will make monthly partial payments for Traffic Control Management based on the rate of progress of the project, less previous partial payments for this item. The Department will calculate partial payments in accordance with the following equation:

\[
P = \left( \frac{A \times L}{B} \right) - C
\]

where

- \( P \) is the partial payment
- \( L \) is the Total Bid Amount for Traffic Control Management
- \( A \) is the number of days charged the Contractor toward completion of the project
- \( B \) is the Contract Time
- \( C \) is the total amount of previous partial payments for this item

The Department will negotiate payment for additional traffic control management resulting from an increase in Work beyond the scope of the project. Do not start Work until agreement on payment for additional Traffic Control Management.

For normal increases in Contract Items resulting in extensions of the Contract Time, the Department will increase the original lump sum amount based on the ratio of actual additional days used to the original Contract Time.
619.1 DESCRIPTION
This Work consists of providing, installing, and repairing headgates, flapgates, and appurtenances, and, if specified, constructing irrigation ditches.

619.2 MATERIALS
Provide headgates, flapgates, and appurtenances in accordance with the Contract. Provide reinforcement for concrete headwalls in accordance with Section 540, “Steel Reinforcement,” and concrete in accordance with Section 510, “Portland Cement Concrete,” and Section 511, “Concrete Structures.”

619.3 CONSTRUCTION REQUIREMENTS
Construct irrigation ditches in accordance with Section 203, “Excavation, Borrow, and Embankment.”
Install headgates and flapgates in accordance with the Plans.
Compact backfill in contact with the Structure to prevent leakage of water and erosion.

619.3.1 Protective Coating
Provide headgates and flapgates with a protective coating in accordance with the manufacturer’s recommendations. If headgates and flapgates are uncoated, coat non-contact surfaces in accordance with Section 545, “Protective Coating of Miscellaneous Structural Steel.”

619.4 METHOD OF MEASUREMENT—Vacant

619.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Headgate Type _____: ___ in</td>
<td>Each</td>
</tr>
<tr>
<td>Flapgate ___ in</td>
<td>Each</td>
</tr>
</tbody>
</table>

619.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately: protective coating of headgates and flapgates, concrete, and steel reinforcement.
SECTION 620: SELECTIVE/NON-SELECTIVE HERBICIDE APPLICATION

620.1 DESCRIPTION
This Work consists of providing and applying herbicide. Store, handle, mix, and apply all herbicide in accordance with the manufacturer’s label and NMDA rules and regulations.

620.2 MATERIALS
Provide herbicide in accordance with the Contract.

620.3 CONSTRUCTION REQUIREMENTS

620.3.1 Handling, Mixing, and Loading Herbicides
Keep livestock, pets, and persons away from mixing and loading areas. When mixing herbicide, provide a well-ventilated mixing area away from perennial or ephemeral waterways to avoid contamination. Do not mix or load herbicides at night. Follow the instructions and warnings on the manufacturer’s labels during mixing, loading, and application of herbicides, to protect against spills, splash, and wind-drift. Wear personal protective equipment in accordance with the manufacturer's label.

620.3.2 Storage of Herbicides
Store herbicides in accordance with the applicable manufacturer’s label and other rules and regulations.

620.3.3 Labeling Information
The Department will designate chemicals proposed for treatment. Provide the following information to the Department 14 Days before using the chemicals:
1. Appropriate specimen labels;
2. MSDSs;
3. Technical bulletins;
4. Toxicity ratings; and
5. EPA registration numbers.

620.3.4 Laws and Regulations
Strictly adhere to laws regulating the storage, handling, mixing, loading, transporting, spill and accident reporting, and use of herbicides.

620.3.4.1 Minor Spills
Isolate the spill area and keep unauthorized personnel away. Use soil, sawdust, or other absorbent material to soak up the spill. Place contaminated material into a leak-proof container and dispose of in accordance with applicable laws and regulations.

620.3.4.2 Major Spills
Keep unauthorized personnel away, confine the area, and administer first aid if needed. Notify the Chemical Transportation Emergency Center (Chemtrec), the local fire department and police, and state herbicide authorities for assistance. If a major spill occurs on a state Highway, county Road, or city Street, the Contractor is responsible for notifying the affected state and local agencies. If food or water is contaminated, notify state or federal food and drug authorities and regional, state, and federal air quality or water pollution authorities.

620.3.5 Certification of Applicators
The Department will only allow the Contractor to apply herbicides under the direct supervision of an appropriately licensed and certified applicator. The Department requires the Contractor or its subcontractor to be licensed in New Mexico as a commercial applicator in accordance with NMDA requirements, and certified in appropriate applications. The Department will verify proper training and testing for competency in the safe and effective handling and use of herbicides. Provide proof of license through the NMDA to the Project Manager 14 Days before the application of the herbicide.

620.3.6 Safety Guidelines
Adhere to the safety guidelines on the Manufacturer’s label regarding the following:
1. Potential hazards to humans, domestic animals, and the environment;
2. Physical and chemical hazards such as fire, explosion, or chemical reactions to other products; and
3. Herbicide use, misuse, storage, and disposal.

Do not apply herbicide on frozen ground. Do not spray along and across irrigation ditches where damage to private property could occur. If within the limits of a town or city, spray in accordance with local ordinances. Do not spray if the wind speed exceeds 10 mph, unless stated otherwise on the chemical label.

Apply herbicide to both sides of the Roadway to control noxious weeds, as directed by the Department. The Department will specify the spray width and exact beginning and ending points at the time of application.

The Department reserves the right to reject Equipment on the basis of suitability and safety to the environment, the traveling public, the Contractor’s employees, and Department employees. Provide Equipment in accordance with OSHA, the U.S. Department of Transportation, and the NMDA.

Ensure that each spray truck is properly licensed and carries the appropriate plaques as required by state law.

620.3.7 Records and Documentation

Supply a current copy of the license and applicator’s certification to the Project Manager for verification by the Department’s Roadside Vegetation Management Unit. Keep a daily record of the herbicide application showing the following information:

1. Date of application;
2. Types and application rates of herbicides applied;
3. Time of day of application;
4. Air temperature;
5. Wind velocity;
6. Area covered;
7. Location of areas treated; and
8. Equipment calibration information.

The Department will verify the Contractor’s daily record. Submit copies of the records to the Project Manager within 14 Days of the spraying.

620.3.8 Equipment

620.3.8.1 Equipment Calibration

Calibrate the Equipment to apply the proper amount of liquid per unit area in accordance with the chemical manufacturer’s label before introducing chemicals into the Equipment. Recalibrate the Equipment in accordance with manufacturers recommendations and as required by the Project Manager.

620.3.8.2 Hand-Held Spray Applicators

The Department will allow the Contractor to use backpack or hand-held power Equipment in inaccessible areas, including cracks in medians or islands, around guardrail posts, and signposts. Use hand-held applicators as directed by the Project Manager.

620.3.8.3 Broadcast Sprayers

Apply herbicides with Equipment that has a spray bar with sufficient width and number of nozzles to provide uniform application rates in accordance with the manufacturer’s label. Ensure the spray bar is adjustable to varying widths and heights to properly distribute the herbicide, to minimize drift, and to apply herbicides to specified areas only.

620.3.8.4 Boomless Sprayers

Do not use boomless spraying Equipment for herbicide application, unless otherwise specified in the Contract or directed by the Project Manager. If specified or directed, ensure that boom sprayers are capable of applying the herbicide to widths in accordance with the Plans and at rates in accordance with the manufacturer’s label. Use a drift control agent with boom sprayers in accordance with the manufacturer’s recommendations.

620.3.8.5 Sprayer Parts

620.3.8.5.1 Tanks

Use tanks for herbicide applications with large openings for easy filling and cleaning and that have a gauge to show the liquid level. The Contractor shall equip tanks with a shut-off
620.3.8.5.2 Agitators
Equip spray equipment with hydraulic jet agitators of sufficient size and number to keep the chemical adequately agitated in accordance with the manufacturer's label.

620.3.8.5.3 Strainers
Equip herbicide sprayers with strainers to prevent clogging of spray nozzles and to protect the working parts of the sprayer. Clean strainers at least daily, or as specified, and replace if damaged.

620.3.8.5.4 Pressure Gauges
Equip sprayers with a pressure regulator to control the pressure and the quantity of herbicide liquid delivered by the nozzles, and protect other sprayer parts from damage due to excessive pressure.

620.3.8.5.5 Pumps
Use spraying equipment with a pump capable of supplying the required volume to the spray nozzles. Ensure that pump parts resist corrosion and abrasion if using abrasive materials such as wettable powders. Use spraying equipment with gaskets, plunger caps, and impellers that resist swelling and chemical breakdown caused by liquid herbicides.

620.3.8.5.6 Nozzles
Use nozzles of the design and type that provide the proper spray pattern and uniformly distribute the herbicide mixture over the specified areas. Use nozzles composed of the following major components:
1. Nozzle body;
2. Cap;
3. Filter; and
4. Tip or orifice plate.
Check nozzles for clogging, as necessary, and maintain them to ensure proper operation of the sprayer. Use drift-control spot-spraying nozzles.

620.3.8.5.7 Hoses and Fittings
Use hoses in accordance with the following:
1. Made of neoprene, rubber, or plastic material having a burst strength greater than the maximum operating pressure;
2. Resistant to oil and other solvents present in herbicides; and
3. Weather resistant;
Do not use PVC hoses or fittings.

620.3.8.6 Cleaning of Equipment
Ensure that sprayers are in good condition and have no leaks while standing, mixing, or spraying. Do not leave spraying equipment at the application site. Clean the spraying equipment before arrival at the site. Rinse mixing equipment into the sprayer tank after each use and before topping off the tank. Do not clean the equipment at the site.

620.3.9 Disposal
620.3.9.1 Disposal of Excess Herbicides
When calibrating the equipment, do not allow chemical solutions to accumulate. Unmixed concentrated chemicals remain the property of the Contractor. Exercise care with unmixed concentrated chemicals, including those in unopened containers.

620.3.9.2 Disposal of Containers
Dispose of empty containers in accordance with NMEDA guidelines.

620.3.10 Samples and Inspection
Provide tank samples at the request of the Department. The Department reserves the right to inspect the tank mix and equipment before, during, or after the spraying process. Quality assurance inspections are required before any payment.
620.4 METHOD OF MEASUREMENT
The Department will measure Selective/Non-Selective Herbicide Application in square feet parallel to the ground surface divided by 43,560.

620.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
<td>Selective/Non-Selective Herbicide Application</td>
<td>Acre</td>
</tr>
</tbody>
</table>
SECTION 621: MOBILIZATION

621.1 DESCRIPTION
This Work consists of preparatory work, preliminary operations, movement of personnel, equipment, supplies, and incidentals to the project site, and establishment of offices, buildings, and other facilities necessary for the project, before beginning Work on the project.

621.2 MATERIALS—Vacant

621.3 CONSTRUCTION REQUIREMENTS—Vacant

621.4 METHOD OF MEASUREMENT
621.4.1 Payment Procedures
If the Contractor's Bid Item Price for mobilization is equal to or less than 10% of the Total Original Contract Amount less mobilization, the Department will pay the Contractor using the following procedure:

1. If the Contractor has performed Work representing less than 5% of the Total Original Contract Amount less mobilization, the Department will pay 25% of the mobilization bid amount;
2. If the Contractor has performed Work representing from 5% to less than 10% of the Total Original Contract Amount less mobilization, the Department will pay 50% of the Bid Item Price for mobilization; and
3. If the Contractor has performed Work representing 10% or more of the Total Original Contract Amount less mobilization, the Department will pay 100% of the Bid Item Price for mobilization.

If the Contractor's Bid Item price for mobilization is greater than 10% of the Total Original Contract Amount less mobilization, the Department will only apply the previous payment procedure to that portion of the Contractor's Bid Item Price for mobilization equal to 10% of the Total Original Contract Amount less mobilization. The Department will pay the Contractor the remainder of the Bid Item Price for mobilization upon completion of the Work.

621.5 BASIS OF PAYMENT

<table>
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<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
<td>Mobilization</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>

The Department will not make additional payments for demobilization and remobilization due to shutdowns or suspensions of the Work, or for other mobilization activities required for satisfactory completion of the Contract.
622.1 DESCRIPTION
This Work consists of providing and equipping field laboratories, supplemental field laboratories, and field offices.

622.2 FIELD LABORATORY CONSTRUCTION REQUIREMENTS
622.2.1 General
Provide anti-theft mechanisms for digital scales.
Install a security light on the exterior portion of the field Laboratory near each exterior door.

622.2.1.1 Sanitary Facilities
Provide and maintain one chemical toilet in satisfactory condition for each field Laboratory. The Project Manager will approve the model and location of the chemical toilet.

622.2.1.2 Eye Wash Facilities
Equip each field Laboratory with one eye wash unit in accordance with ANSI Z358.1. Provide a portable unit and place it in a readily accessible location. When filled and ready for use, the unit will not weigh more than 55 lb and will have a minimum capacity of 5 gal. Treat the flushing fluid with an antibacterial additive and change it as needed.

622.2.1.3 Electrical Power Requirements
Provide at least 15 kW of electric power to Type I field laboratories and at least 35 kW of electric power to Type II field laboratories. Provide a minimum service amperage of 120 A for Type I field laboratories and 300 A for Type II field laboratories.
Provide enough electric power so that the voltage measured at the electric outlets in the field Laboratory is 100 V AC to 130 V AC, 60 Hz for the nominally rated 115 V AC outlets; and 200 V AC to 260 V AC, 60 Hz for the nominally rated 230 V AC, 60 Hz outlets. Install devices necessary to protect electronic equipment from damage, due to power surges in the main power supply line.
Label the electrical receptacles with legible information regarding voltage output.

622.2.1.4 Water Supply Requirements
Provide the laboratories with a pressurized potable water system and replenish as necessary. Use a fiberglass or stainless steel tank system equipped with an automatic shut-off valve.
Drain, flush, and refill the water system every two weeks.
Provide a device to monitor the water level in the system. Place the water system indoors and under the counter top and sufficiently insulate it to keep the water from freezing.
Use a water supply system with a separate outside water inlet and the necessary valves to connect to a pressurized municipal water supply.
Provide Type I laboratories with a 200 gal capacity water supply.
Provide Type II Laboratories with a 250 gal capacity water supply.
Provide distilled or de-mineralized water, as necessary, for testing purposes.

622.2.1.5 Heating, Ventilation, and Air Conditioning Requirements
622.2.1.5.1 Type I Field Laboratory Heating, Ventilation, and Air Conditioning (HVAC)
Provide Type I laboratories with an HVAC system capable of maintaining a temperature of 75 °F during cold weather and a temperature below 80 °F during hot weather.

622.2.1.5.2 Type II Field Laboratory HVAC
Provide Type II laboratories with a central heating and refrigerated air conditioning system, with vents on the ceiling, capable of maintaining a temperature of 75 °F during cold weather and below 80 °F during hot weather. The unit will not draw in air from the sample room.
622.2.1.5.3 Supplemental Hot-Mix Asphalt Field Laboratory

Provide HMA field Laboratory with a central heating and refrigerated air conditioning system, with vents on the ceiling, capable of maintaining a temperature of 75 °F during cold weather and below 80 °F during hot weather. The unit will not draw in air from the sample room.

622.2.1.6 Field Laboratory Placement and Maintenance Requirements

Place field laboratories and supplemental field laboratories as directed by the Project Manager. These laboratories will remain the property of the Contractor. Maintain field laboratories and supplemental field laboratories for the duration of the project. Remove these laboratories when the project is complete, unless released earlier by the Project Manager.

Place the field laboratories and supplemental field laboratories on the project in a ready-to-use condition at least one week before project field-testing is necessary. Place the field laboratories so that the distance between the bottom of the door and the ground is less than 6 in or provide an adequate ramp with a skid resistant surface.

Anchor the field laboratories in position to prevent them from overturning.

622.2.1.6.1 Supplemental Field Laboratories

Provide a supplemental field Laboratory in accordance with the Contract.

Provide a heavy-duty cabinet with sound insulation and bolts for mounting a Ro-Tap shaker.

Provide a rigid steel stand, 30 in high, capable of supporting the cabinet and Ro-Tap shaker in a stationary position while the shaker is operating.

Mount the Ro-Tap shaker at the location shown in the supplemental field Laboratory details, unless otherwise specified by the Project Manager.

622.2.1.6.2 Supplemental Hot-Mix Asphalt Field Laboratories

Provide a supplemental HMA field Laboratory in accordance with the Contract.

Use Class A concrete for the concrete slab foundation of the supplemental HMA field Laboratories; ensure that it measures 14 ft × 14 ft × 8 in. At the conclusion of the project, remove the building and foundation and restore the site to an acceptable condition at no additional cost to the Department.

Supply and install an accurately calibrated gyratory compactor for the supplemental HMA field Laboratory. Use a gyratory compactor that is a mechanical asphalt-mixture compaction device comprised of the following:

1. Reaction frame;
2. Rotating base;
3. Motor;
4. Loading system;
5. Loading ram;
6. Pressure gauge;
7. Height measuring and recordation system; and
8. Mold and base plate.

The National SuperPave Regional Center must approve the device for compaction of HMA mixtures. Transport the device by picking it up from the bottom with a forklift, and move manually on roller casters.

Provide the following items with the gyratory compactor at no additional cost to the Department:

9. Three 6-inch molds;
10. Extruder for specimen removal from mold;
11. Printer;
12. Printer cable;
13. Height standard block;
14. Serial cable;
15. Two hundred and fifty specimen paper disks;

Provide a power supply that will work on 115 V AC. A list of approved models is available from the State Materials Bureau.

The gyratory compactor will remain the property of the Contractor at the conclusion of construction.
Provide and install a binder ignition oven for the supplemental HMA field laboratory. Provide a binder ignition oven in accordance with AASHTO T 308. Supply the necessary safety equipment, including a heat reflective face shield, high temperature gloves with 14 in sleeves, and aluminized rayon or other heat reflective coat or apron. The binder ignition oven and safety equipment shall remain the property of the Contractor at the conclusion of construction.

Supply the following:
17. A fine aggregate angularity test apparatus;
18. A flat and elongated particles test caliper;
19. An asphalt mix sample divider, complete with one quick funnel insert;
20. Four sample containers; and
21. One material-handling chute.

A list of approved models of the test equipment is available from the State Materials Bureau. This test equipment shall remain the property of the Contractor after final acceptance.

622.2.1.7 Field Laboratory Computer Facilities

If the Contract specifies Type II field laboratories, provide the laboratory with a personal computer. Maintain this computer for the duration of the project. The Project Manager will approve the model and location of the personal computer. The computer equipment shall remain the property of the Contractor.

Provide computer hardware in accordance with the following requirements, or latest industry standard, or greater:
1. Microprocessor: 2.6 GHz, 800 MHz FSB; or greater;
2. Memory: Minimum of 1 gigabyte;
3. Hard disk: Minimum of 300 gigabytes of disk storage;
4. Media drives: 16x DVD ±R/±RW & 48x/32x/48x CD ±R/±RW recorder;
5. Monitor: 19-inch color graphics monitor, VGA/DVI;
6. Printer: letter-quality color laser printer, 8 pages per minute minimum;
7. 11” x 17” flatbed scanner w/600 optical dpi; and
8. Modem: 56K baud modem minimum, full duplex, auto dial/auto answer, internal or external with facsimile software. Provide computer software in accordance with the following requirements, or latest industry standards, or greater;
9. Operating System: Windows Vista Business; and

Provide a power-surge protection device and dust cover for the computer, printer, and keyboard.

622.2.1.8 Field Laboratory Facsimile Machine Facilities

If the Contract requires Type II field laboratories, provide and maintain one facsimile machine for the duration of the project. The Project Manager will approve the model and location of the equipment. The facsimile machine shall remain the property of the Contractor.

Use facsimile machine in accordance with Consolidated Committee on International Telephone and Telegraphs Group 3 (G3) standards. Provide a facsimile machine that:
1. Uses standard bond, single-sheet paper;
2. Is capable of scanning and reading legal- and letter-size documents; Compression of legal-size documents to letter size is acceptable as long as the documents are legible;
3. Is capable of holding a paper supply of at least 150 sheets;
4. Has a transmission speed of not longer than 20 s to transmit a single non-graphic page of printing;
5. Has at least two scanning densities, with a minimum low scanning density of 96 lines per 1 inch;
6. Has a modem speed of at least 9,600 bits per second with automatic baud rate adjustment (fall back);
7. Is of the desktop variety in size;
8. Has automatic switching from telephone to facsimile machine (Type 1) capabilities;
9. Has local copy function for on-site reproduction;
10. Has LCD read-out;
11. Has an automatic feeder capable of holding at least 25 sheets;

Provide a facsimile machine with the following imaging requirements:
12. Contrast and fine mode controls; and
13. A halftone minimum of 67 level gray scales; Use a facsimile machine with following transmission requirements:
14. Capability of producing activity reports with a minimum 40 transaction memory, for both successfully and unsuccessfully transmitted transactions;
15. Displays message when transactions are unsuccessfully transmitted;
16. Has coded speed dialing for a minimum of 10 locations;
17. Has manual dialing and automatic redialing (two times minimum each redialing event) features;
18. Documents memory of at least 0.5 megabyte;
19. Capability of sending a delayed transmission;
20. Capability of identifying the sending terminal when receiving transmissions; Provide a separate telephone line for connection to the facsimile machine.

622.2.1.9 Field Laboratory Utilities
Equip the field Laboratory with telephone modular jacks in each separate work area.

622.3 Field Office Construction Requirements
622.3.1 General
If the Contract specifies a field office, provide a field office complete, in place, and operational before beginning work on the project.
If the field office is a mobile trailer, ensure that it is in accordance with the Manufactured Housing Improvement Act of 2000, and Housing and Urban Development Manufactured Housing Program.
If the field office is a permanent building, ensure it is in accordance with the UBC™, the Uniform Plumbing Code™, the Uniform Mechanical Code™, and the NEC®.
Make sure the field office has convenient access to the Highway and is located within reasonable distance of the project.
Locate the field office site where telephone and cellular service is available.
Make sure the field office is clean, with electrical outlets and other accessories and appliances in good working order.
Make repairs to the field office as necessary.
Make sure the field office has sufficient parking for at least 15 vehicles. Keep the parking areas free of mud, snow, and debris.
Enclose the field office and parking lot with a chain-link security fence at least 6 ft high.
Make sure the fence has an access opening at least 16 ft wide and one or more chain-link gates at least 6 ft in height at an appropriate location to allow vehicles to pass.
Provide the fence and gates with at least two strands of barbed wire and security appurtenances at the top.

622.3.2 Field Office Architectural Requirements
Make sure the field office has at least 576 ft\(^2\) of floor area.
Provide the field office with a minimum of 50 ft\(^2\) of shelf space.
Equip the field office with:
1. At least one closet with at least 10 ft\(^2\) of floor space, and with a 24 in wide door (with lock); and
2. At least one closet with at least 15 ft\(^2\) of floor space and 20 ft\(^2\) of shelf space.
Provide the field office with at least two office spaces separate from the rest of the field office by full partition and door. Ensure that these office spaces have at least 144 ft\(^2\) of floor space each.
Ensure that the field office has sufficient overhead lighting so it requires no additional lighting.
Ensure that the field office has 18 gauge hollow core steel doors with 18-gauge steel casings on the exterior entrances.
Ensure that the field office has 34 in, 9 gauge, smooth-expanded metal grating to cover the windows for security purposes. Weld the metal grating to an angle iron frame. Bolt the whole unit through the wall to an interior metal frame. Ensure that the grating opens or can easily be removed from the interior to comply with fire safety codes.
Cover the floors with suitable floor covering such as linoleum or carpeting. Ensure that blinds or curtains cover the windows and that the walls are finished.
622.3.2.1 Field Office HVAC Requirements
Equip the field office with an HVAC system that can maintain a temperature of at least 75 °F during cold weather and less than 80 °F during hot weather.

622.3.2.2 Field Office Equipment
Equip the field office with:
1. One water cooler;
2. One 6 gal minimum capacity water heater;
3. A bathroom with lavatory and water closet;
4. One drafting table;
5. One worktable measuring approximately 30 in x 96 in;
6. Two chairs; and
7. Facsimile machine.

622.3.2.3 Field Office Utilities
Equip the field office with the following:
1. A potable water supply;
2. Adequate electrical power;
3. Other utilities required to operate the office;
4. A system for wastewater disposal in accordance with state and local requirements. Install devices necessary to protect electronic equipment from power surges in the main power supply and communication lines.

Equip the field office with telephone modular jacks in each separate work area, and provide an external telephone demarcation point.

Install a security light on the exterior portion of the field office near each exterior door.

622.3.2.4 Release of Field Office
The Department will retain possession of the field office for 90 Days after the final inspection or until released by the Project Manager, whichever occurs first.

622.4 METHOD OF MEASUREMENT—Vacant

622.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Laboratory Type I</td>
<td>Each</td>
</tr>
<tr>
<td>Field Laboratory Type II</td>
<td>Each</td>
</tr>
<tr>
<td>Supplemental Field Laboratory</td>
<td>Each</td>
</tr>
<tr>
<td>Supplemental Hot-Mix Asphalt Field Laboratory</td>
<td>Each</td>
</tr>
<tr>
<td>Supplemental Field Laboratory (Superpave)</td>
<td>Each</td>
</tr>
<tr>
<td>Field Office</td>
<td>Each</td>
</tr>
</tbody>
</table>

622.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main item(s) and will not be measured or paid for separately:
A. Hookup and furnishing of utilities and appurtenances;
B. Security fencing;
C. Parking lot;
D. Basic equipment as listed;
E. Foundations and anchoring;
F. All phone installations and monthly bills;
G. Distilled or de-mineralized water for lab testing.
623.1 DESCRIPTION
This Work consists of providing and installing drop inlets and junction boxes, and adjusting existing drop inlets.

623.2 MATERIALS
Provide Class A concrete in accordance with Section 510, “Portland Cement Concrete.”
Provide reinforcing steel in accordance with Section 540, “Steel Reinforcement.”
Provide Structural Steel in accordance with Section 541, “Steel Structures.”
Provide coatings for Structural Steel in accordance with Section 545, “Protective Coating of Miscellaneous Structural Steel.”
Provide preformed expansion joint filler in accordance with AASHTO M 213.
Provide precast units in accordance with Section 517, “Precast Concrete Structures.”

623.3 PROVIDE Dewatering Construction Requirements
Construct drop inlets in accordance with Section 511, “Concrete Structures;” Section 540, “Steel Reinforcement;” and Section 541, “Steel Structures.”
Precast the drop inlets and junction boxes or cast in place.
Raise the existing drop inlets by removing and reconstructing the top 6 in of the existing Structure. Reuse the existing grate, but provide a new frame.

623.3.1 Foundation Requirements
Compact the foundations of drop inlets and junction boxes to at least 100% of maximum density in accordance with Section 207, “Subgrade Preparation.”
Replace unstable material with structurally adequate Material before constructing new foundations.

623.3.2 Backfilling
Backfill in accordance with Section 206, “Excavation and Backfill for Culverts and Minor Structures.”

623.3.3 Coating of Structural Steel
Coat Structural Steel for drop inlets in accordance with Section 545, “Protective Coating of Miscellaneous Structural Steel.”

623.4 METHOD OF MEASUREMENT
The Department will measure reinforcing steel, concrete, and Structural Steel for drop inlet extensions in accordance with Section 540, “Steel Reinforcement;” Section 511, “Concrete Structures;” and Section 541, “Steel Structures,” respectively.

623.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Drop Inlet, Type I, ___ to ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Median Drop Inlet, Type ___</td>
<td>Each</td>
</tr>
<tr>
<td>Modified Median Drop Inlet, Type ___</td>
<td>Each</td>
</tr>
<tr>
<td>Curb Drop Inlet Type <em><strong>-</strong></em>, to ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Curb Drop Inlet Type <em><strong>-</strong></em>, over ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Drop Inlet Type <em><strong>-</strong></em>, to ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Drop Inlet Type <em><strong>-</strong></em>, over ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Transverse Drop Inlet Type <em><strong>-</strong></em>, to ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Transverse Drop Inlet Type <em><strong>-</strong></em>, over ___ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Junction Box</td>
<td>Each</td>
</tr>
</tbody>
</table>

623.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:
A. Subgrade preparation;
B. Compaction;
C. Replacement of unsuitable foundation material;
D. Excavation and backfilling for drop inlets;
E. Coating of structural steel;
F. Reinforcing steel, concrete, and structural steel (Except on Extensions);
G. Removal of the top 6 in on extensions;
H. Gravel for drain pocket and hardware cloth for the weep holes.
SECTION 624: WIRE MESH FOR SLOPE STABILIZATION

624.1 DESCRIPTION
This Work consists of Roadway slope stabilization to restrain and channel rockfall.

624.2 MATERIALS
624.2.1 Anchor Cable
Provide anchor cable with a diameter of at least 1/2 in. It shall be zinc-coated steel wire strand, common grade, Type 1 coating, in accordance with ASTM A 475.

624.2.2 Resin-Grouted Steel Bolt Systems
Provide a resin-grouted steel bolt system with the best standard products of a manufacturer regularly engaged in the production of this type of installation and of the manufacturer’s latest approved design.

Use resin-grouted steel bolts and hooked anchors with a minimum diameter of 3/4 in. Use the headed type with flash forging. Use steel bolts with the following tensile properties:
1. Minimum yield strength: 43,000 psi
2. Minimum ultimate strength: 70,000 psi

Use steel bolts and hooked anchors manufactured from any of the grades of deformed bars specified in ASTM A 615. Use steel bolts and hooked anchors specifically designed for resin grouting with lugs, vertical ribs, and deformations to provide thorough mixing of the resin and to center the steel bolts in the drilled holes.

624.2.2.1 Resin Cartridges
Provide the type of resin cartridges used in DuPont’s FASLOC A resin anchoring system designed for a 0.9 in diameter cartridge in a 1 in diameter hole with a 3/4 in bolt or anchor, or provide an approved equal.

624.2.3 Earth Anchor Systems
Use earth anchor systems with the best standard products of a manufacturer regularly engaged in the production of this type of installation and of the manufacturer’s latest approved design. Use earth anchor systems designed for the conditions encountered and as approved by the Project Manager.

624.2.4 Bearing Base Plates
Use bearing base plates that are 6 in square or 6 in diameter round plates in accordance with ASTM F 432.

624.2.5 Certification
Submit to the Project Manager for approval any manufacturer’s certificates, literature, and shop drawings at least two weeks before beginning the Work. Shop drawings will, at a minimum, include spacing, bolt/anchor length, working load, and minimum required torque.

624.2.6 Slope Stabilization Wire and Wire Mesh
Provide tie wire and wire mesh in accordance with Section 602, “Slope and Erosion Protection Structures.”

624.2.6.1 Polyvinyl Chloride Coated Wire Mesh
In addition to Section 602, “Slope and Erosion Protection Structures,” use PVC-coated wire mesh and connections in accordance with the following:
1. Extrude the PVC coating onto the wire core before weaving the coated wire;
2. Overall minimum diameter (galvanized wire core plus PVC coating) is 0.1338 in;
3. Edging wire will be a galvanized wire core, with a diameter of at least 0.1338 in (approximate U.S. gauge 10), coated with PVC, and having a minimum overall diameter of 0.1638 in; and
4. Lacing wire will be a galvanized wire core, with a diameter of at least 0.0866 in (approximate U.S. gauge 13.5), coated with PVC, and having a minimum overall diameter of 0.1166 in.

624.2.6.2 PVC Coating
Provide protective PVC coating that resists the damaging effects of natural weather
exposure or immersion in salt water, and that does not show any material difference in its
initial compound properties in accordance with Table 624.2.6.2:1, “PVC Coating Physical
Property Requirements.”

**Table 624.2.6.2:1**

<table>
<thead>
<tr>
<th>Property</th>
<th>Required value</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Property Requirements</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Specific Gravity, kg/Dm²</td>
<td>1.30–1.35</td>
<td>ASTM D 792</td>
</tr>
<tr>
<td>Durometer Hardness</td>
<td>50–60</td>
<td>ASTM D 2240</td>
</tr>
<tr>
<td>Shore D</td>
<td>—</td>
<td>ISO 868</td>
</tr>
<tr>
<td>Volatile Loss, Maximum</td>
<td>—</td>
<td>ASTM D 1203</td>
</tr>
<tr>
<td>@ 105 °C for 24 h</td>
<td>2%</td>
<td>ISO 176</td>
</tr>
<tr>
<td>@ 105 °C for 240 h</td>
<td>6%</td>
<td>ASTM D 2287</td>
</tr>
<tr>
<td>Tensile Strength, kg/cm², Minimum</td>
<td>210</td>
<td>ASTM D 412</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>200–280</td>
<td>ASTM D 412</td>
</tr>
<tr>
<td>Modulus of Elasticity, kg/cm², Minimum</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>100% of Elongation</td>
<td>190</td>
<td>ASTM D 412</td>
</tr>
<tr>
<td>Resistance to Abrasion, gm, Maximum</td>
<td>0.19</td>
<td>ASTM D 1242 – 95a</td>
</tr>
<tr>
<td>Brittleness Temperature, °C, Maximum</td>
<td>–30</td>
<td>BS 2782-104A</td>
</tr>
<tr>
<td>Cold bend temperature</td>
<td>+15</td>
<td>BS 2782-150B</td>
</tr>
<tr>
<td>Cold flex temperature</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Creeping Corrosion, mm, Maximum</td>
<td>25</td>
<td>—</td>
</tr>
</tbody>
</table>

*Penetration of corrosion of the wire core from a square cut end when the
specimen has been immerses for 2,000 h in a 50% solution of hydrochloric acid
12 Be.

624.3 CONSTRUCTION REQUIREMENTS

Prepare top and bottom of slopes by trenching.

Scale slope faces in accordance with Section 626, “Scaling of Rock Slopes,” before
installing steel bolts/anchors and draping and anchoring the wire mesh.

624.3.1 Anchor Hole Preparation

Drill bore holes for steel bolts/anchors approximately perpendicular to the rock face,
except in areas approved by the Project Manager, incline the boreholes to a maximum of 30°
off the perpendicular in order to intercept and seat the steel bolts/anchors in solid rock.

Upon completion of drilling, blow the drilled holes clean with compressed air with an
operating air pressure of at least 50 psi introduced at the back of the hole.

Use the manufacturer’s recommended hole diameter for the steel bolts/anchors.

Ensure that the clearance between the steel bolt(anchor) and borehole wall is from 1/8 in
to 3/16 in.

624.3.2 Anchor Installation

Carefully follow the manufacturer’s recommended installation procedures for steel
bolts/anchors.

During construction, the Contractor may reduce the center-to-center spacing in order to
maximize anchorage by selective bolting/anchoring in sound rock or to eliminate large voids
between the wire mesh and the slope face.

Use steel bolts/hooked anchors that are at least 6 ft long. Ensure that the steel bolts
extend at least 1 ft into sound rock.

As construction progresses, the rock conditions encountered may require the lengths of the
steel bolts/hooked anchors to be greater than the minimum length, so the Project Manager
may direct varied lengths. If using varied lengths, the Department will allow the Contractor to
use steel couplings or other methods recommended by the manufacturer.

624.3.2.1 Tensioning and Testing of Steel Bolts and Earth Anchors

Tension steel bolts and earth anchors in accordance with the manufacturer’s
recommendations. Use a minimum torque of 200 lbf•ft, unless otherwise specified.

After installation, test a randomly selected set of 10% of the bolts or anchors to confirm the
specified working load. If more than one third of these fail, test all bolts/anchors.
After replacing the failed bolts and anchors, test another randomly selected set of 10% of bolts and anchors, not including those previously tested and accepted. Repeat the procedure until obtaining the satisfactory results.
Replace unacceptable bolts and anchors at no additional cost to the Department.

624.3.3 Installation of Wire Mesh
If the Contract specifies, use PVC-coated wire mesh.
Lap the wire mesh at least 6 in and securely bind the perimeter edges of wire mesh so that the joints formed by tying the selvedges have a minimum strength equal to that of the body of the mesh.
Space ties, connectors, locking clips, or hog rings used for fastening edges 4 in apart or less. The Contractor may lace perimeter edges with binding wire by tightly looping it through every mesh opening.
Extend wire mesh down the face of the slope and anchor it to the face of the slope by resin-grouted steel bolts or anchors, as required.
Hold wire mesh in place by the bearing base plates to stretch it to the maximum and contour it to the existing surface.
Anchor the wire mesh at the bottom to contain loose debris and allow periodic maintenance and debris removal.

624.3.3.1 Alternate Anchoring Method
If specified in the Contract, anchor wire mesh using anchor cable and hooked resin-grouted steel or earth anchors.

624.3.4 Site Maintenance
Maintain the project area and keep it clear of falling rock and debris during construction and at project completion. Dispose of waste and debris at locations approved by the Project Manager.

624.4 METHOD OF MEASUREMENT—Vacant

624.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope Protection Wire Mesh</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Slope Protection Wire Mesh PVC-Coated</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Resin-Grouted Steel Bolts</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Resin-Grouted Steel Anchors</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Earth Anchors</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>Anchor Cable</td>
<td>Linear Foot</td>
</tr>
</tbody>
</table>

624.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:
A. Trenching at the top and bottom of the slope;
B. Hauling and disposal of rocks and debris; and
C. Ties, lacing wire, clips, hog rings, plates, and other appurtenances.
SECTION 626: SCALING OF ROCK SLOPES

626.1 DESCRIPTION
This Work consists of removing loose rock on the slope using hand scaling, hydraulic splitters, or blast trimming.

626.2 MATERIAL—Vacant

626.3 CONSTRUCTION REQUIREMENTS

626.3.1 Work Plan
Submit a detailed work plan for each rock slope scaling location to the Project Manager for approval by the State Geotechnical Engineer. Submit the plan to the Department at least 30 Days before beginning the rock scaling work.

Include the following in the plan:
1. The proposed construction sequence and schedule;
2. The number of rock slope scaling crews to be employed on the project;
3. A blasting plan for rock blocks requiring light blasting or trimming; and
4. A rock removal and disposal plan for rock debris generated from the rock slope scaling work, including provisions to protect adjacent facilities.

626.3.2 General
Do not use heavy power Equipment such as backhoes on the slope unless otherwise approved by the Project Manager.

626.3.3 Sequence of Operations
Begin rock slope scaling at the top of the slope and proceed downward, removing loose rock as the Work progresses.

After completing the first rock-slope scaling pass, remove rock fragments or debris that hang up on the slopes during the scaling operations.

The Project Manager will inspect the new face to determine the adequacy of the scaling operation.

626.3.4 Blasting Requirements
Blast in accordance with Section 203.3.3.1, “Blasting Requirements.”
Ensure that the blasting explosive force is sufficient to remove the loose rock without damaging the surrounding competent rock.
Load the drill holes with a sufficient amount of explosive to break the rock between the drill holes without damaging the new face.

626.3.5 Debris Removal
Dispose of the rock and debris resulting from rock slope scaling operations at a location approved by the Project Manager.

626.4 METHOD OF MEASUREMENT—Vacant

626.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scaling of Rock Slopes</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

626.5.1 Work Included in Payment
Hauling and disposal of the rock and debris, blasting, protection of facilities, and work plan will be considered as included in the payment for the scaling of rock slopes, and no separate measurement and payment will be made.
SECTION 630: GLARE SHIELDS

630.1 DESCRIPTION
This Work consists of providing and installing glare shields.

630.2 MATERIALS
Provide new Material for permanent installations or "like-new" Material for temporary installations.
Provide glare shields from the Department’s Approved Products List.
Obtain Project Manager approval of "like-new" glare shielding systems for temporary installations before installation.

630.2.1 Mounting System
Use a mounting system with an approved steel mechanical anchor bolting system.
Ensure that each anchor has a minimum 3,000 lb pullout and shear strength.

630.2.1.1 Multiple Glare Shield Blade Systems
For multiple glare shield blade systems, flush mount and internally thread the anchors to allow for removal and replacement of the base rail without damage to the anchors.
Use a base rail made of a corrosion-resistant Material or protected with a rust-inhibiting coating.

630.2.2 Glare Shield Blades
Provide glare shield blades in accordance with the following requirements:
1. Use blades of a durable impact-resistant, non-warping, and nonmetallic Material;
2. The blade Material will not deviate more than 15% in the tensile strength and elongation values evident at 70 °F if tested at -20 °F and 120 °F in accordance with ASTM D 638;
3. The blade Material will not deviate more than 15% in the tensile strength and elongation values evident at 70 °F after 2,000 h exposure if tested in accordance with ASTM D 638 and ASTM G 154.

630.3 CONSTRUCTION REQUIREMENTS
Place 4 in × 12 in Type III reflective sheeting, yellow or white as appropriate, on the blades at 50 ft intervals.

630.3.1 Glare Shield Blade Spacing
Space glare shield blades at intervals that will block the light within the glare zone, defined as the zone 22.5° left and right from the axis of headlight.
Make the spacing uniform and uninterrupted for the entire length of the installation.

630.3.2 Base Rail Construction Requirements
Ensure that base rails for multiple glare shield blade systems fit within the top edge of the concrete wall barrier, or form around the edge in a manner that fits tightly against the concrete wall barrier.
Ensure that each base rail is a continuous, single unit spanning the length of the concrete wall barrier unit.
Do not span joints between concrete wall barrier sections with the base rail units of multiple glare shield blade systems.
Secure each 10-foot base-rail unit to the concrete wall barrier with at least three anchor points, unless the Project Manager or the manufacturer requires more anchors.

630.3.2.1 Blade-to-Base Rail Mounting Requirements
Mount the glare shield blades to the base rail by a bracket assembly that allows the replacement of individual blades.
Ensure that the bracket assembly holds the blade rigidly in a fixed position and is adjustable, allowing the blades to be switched for traffic passing left-to-left or right-to-right.

630.3.3 Repair of Inadequate Glare Shielding
Replace anchors that show inadequate bonding with the concrete wall barrier. Replace incorrectly placed glare shield blades.
Incorrect placement of a glare shield blade includes the following:
1. The blades have an incorrect skew angle;
2. The blades are not vertically erect;
3. The blades have non-uniform spacing; or
4. The anchors are loose.

The Project Manager will determine which items need to be repaired or replaced. Perform the replacement or repair of inadequate glare shielding at no additional cost to the Department.

630.4 METHOD OF MEASUREMENT—Vacant

630.5 BASIS OF PAYMENT

Glare shields used for temporary construction traffic control will remain the property of the Contractor upon completion of the project.

Pay Item          Pay Unit
Individual Glare Shield Blades Each
Multiple Glare Shielding Linear Foot

630.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for glare shields and will not be measured or paid for separately:
A. Base rails, hardware, and anchoring appurtenances;
B. Relocation of glare shielding within the project;
C. Maintenance, repair and replacement; and
D. Reflective sheeting, Type III.
SECTION 631: RUMBLE STRIPS

631.1 DESCRIPTION
This Work consists of milling rumble strips into Roadway Shoulders.

631.2 MATERIALS
631.2.1 Equipment
Use a device to mill the Roadway Shoulders that is capable of producing rumble strips in accordance with the Contract.
Obtain Project Manager approval of the milling device.

631.2.2 Alignment Control
Use devices equipped with a guide in order to obtain proper alignment of the completed rumble strip.

631.3 CONSTRUCTION REQUIREMENTS
631.3.1 General
Make clearly incised grooves for the rumble strips, in accordance with the Contract.
Place rumble strips in accordance with the Plans.
Remove or obliterate the rumble strips placed at locations other than shown on the Plans and restore the pavement to the satisfaction of the Project Manager.

631.3.2 Placement
Allow the HMA Material to cure for a minimum of 48 h after compaction, before starting rumble strip work. Mill the rumble strips with one pass of the milling device.
Seal all rumble strip surfaces, including vertical surfaces, with asphalt Material.

631.4 METHOD OF MEASUREMENT
The Department will measure the rumble strips longitudinally, parallel to the Traveled Way, for each side of the Roadway the Contractor installs the rumble strips.
The Department will measure rumble strips beginning at the transverse center of the first milled strip and proceeding along the centerline of the rumble strip pattern to the transverse center of the final milled strip in the pattern. The Department will not include in the measurement breaks in the rumble strip pattern for exits, principal intersections, and other interruptions.

631.5 BASIS OF PAYMENT
Pay Item Pay Unit
Rumble Strips Linear Foot

631.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately: equipment and labor; repair of incorrectly placed rumble strips; continuous application of seal coat to completed rumble strips; and repair of damaged pavement.
SECTION 632: SEEDING

632.1 DESCRIPTION
This Work consists of seeding the areas stripped of vegetation during construction operations.

632.2 MATERIALS

632.2.1 Seed
The revegetation/erosion control Plans will specify the species, varieties or origins, and rates of seeding. The Contract will specify varieties of certified weed-free seed in accordance with New Mexico Seed Law (NMSA 1978, § 76-10-11 et seq.).

The revegetation/erosion control Plan will specify the minimum standards for each species. Provide certified seed of named varieties in accordance with the minimum standards of the appropriate seed certification agency.

632.2.1.1 Labeling and Certification
Seal and label each bag of seed in accordance with the Federal Seed Act (7 U.S.C. § 1551 et seq.) and NMDA seed labeling requirements (NMSA 1978, § 76-10-13).

Provide the following information on each bag tag for each species:
1. Variety (specify if certified);
2. Kind of seed;
3. Lot number;
4. Purity;
5. Germination;
6. Percentage crop seed, percentage inert, percentage noxious weeds, in accordance with New Mexico Seed Law (NMSA 1978, § 76-10-11 et seq.);
7. Origin;
8. Test date; and
9. Weight (in pounds) of this species or percentage of total lot.

Provide seed analysis results that are not older than 5 months for seed shipped interstate, and not older than 9 months for seed shipped intrastate.

Provide to the Project Manager documentation of seed origin and pure live seed content from a certified testing Laboratory. Calculate the pure live seed using the following equation:

\[
P_{LS} = \frac{P \times G}{100} \tag{1}
\]

where

\(P_{LS}\) is the pure live seed
\(P\) is the percent purity
\(G\) is the percent germination (including dormant seed)

The Contractor may provide premixed seeds. Provide documentation as if the Supplier sold or bagged the seeds separately.

632.2.2 Fertilizer
Provide fertilizer in accordance with the Contract (specified type and formulation) and Supplier’s certification that it is in accordance with the Contract.

632.2.3 Mulch
Provide certified weed-free core material (woodchips). The material must be 100% untreated wood chips and free of inorganic debris, such as plastic, glass, metal, etc. Manufacturer shall certify that the material is free of noxious weeds. Woodchip size shall not be smaller than 1 in and shall not exceed 3 in in diameter; shavings shall not be more than 5% of the total mass.

632.2.3.1 Hay Mulch
Use perennial native or introduced grasses of fine-stemmed varieties, unless otherwise specified in the Contract.

Provide bales of hay containing at least 65% (by weight) 10 in herbage or longer.
The Department will not accept rotten, brittle, or moldy hay, or hay containing noxious seed or plants. The Contractor may provide marsh grass or prairie hay composed of native grass of specified species. The Department will accept tall wheat grass, intermediate wheat grass, switch grass, or orchard hay, if the Contractor cuts it before seed formation.

Use marsh grass hay composed of mid and tall native, usually tough and wiry grass, and grass-like plants found in the lowland areas of the Rocky Mountain region.

Cure and harvest hay at least 60 Days before use.

632.2.3.2 Straw Mulch
Do not use rotten or moldy straw.

632.2.3.3 Wood Cellulose Mulch
Provide wood cellulose mulch that consists of a specially prepared virgin wood fiber processed to contain no growth-inhibiting or germination-inhibiting factors. Manufacture and process mulch so the wood cellulose fibers remain in uniform suspension in water under agitation and will blend with grass seed, fertilizer, and other additives to form a homogenous slurry.

Provide processed mulch Materials with the following characteristics:
1. Can form a blotter-like ground cover on application;
2. Has moisture and percolation properties; and
3. Can cover and hold grass seed in contact with the soil.

632.2.4 Soil Retention Blanket
Provide soil retention blankets in accordance with the Contract and staples in accordance with the recommendations of the soil-retention-blanket manufacturer.

632.2.5 Composted Mulch
Furnish and place composted mulch as shown on the plans and in accordance with the criteria as described below. Composted mulch provider must be registered with or permitted by the New Mexico Environment Department Solid Waste Bureau and must be in compliance with 20 NMAC 9.1.

Composted mulch is defined as the product of a controlled aerobic thermophilic biological decomposition process that meets the quality requirements in Table 632.2.5.1, “Quality Requirements for Composted Mulch.” Raw materials used in producing composted mulch may include green waste, animal manure, animal bedding, paper waste, food waste, biosolids or other non-toxic organic matter, but shall not include animal mortalities.
Table 632.3.2:1

<table>
<thead>
<tr>
<th>Material</th>
<th>Measure</th>
<th>Method</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Composted Mulches</td>
<td>Moisture*</td>
<td>Evaporative loss at 105°C</td>
<td>No more than 60%</td>
</tr>
<tr>
<td></td>
<td>Particle Size</td>
<td>Sieve</td>
<td>40% to 70% of material passes ¾ inch screen; 100% of pieces smaller than 4 inches in length and 2 inches in diameter</td>
</tr>
<tr>
<td></td>
<td>Electrical</td>
<td>Conductivity*</td>
<td>&lt;10 mmho/cm</td>
</tr>
<tr>
<td></td>
<td>pH*</td>
<td>1:5 slurry (mass basis)</td>
<td>pH 5.0 – pH 8.0</td>
</tr>
<tr>
<td></td>
<td>Organic Matter*</td>
<td>Loss on ignition at 550°C</td>
<td>25% - 70% of dry weight</td>
</tr>
<tr>
<td></td>
<td>Maturity</td>
<td>Minimum 50% germination to second set of leaves for marigold seeds in 50:50 (volume basis) mixture of ¾ inch screened composted mulch and twice-rinsed nursery sand.</td>
<td></td>
</tr>
<tr>
<td>Stability</td>
<td></td>
<td></td>
<td>Maximum core temperature of 110°F after 48 hours in 5 foot tall conical pile, with moisture adjusted to between 40% and 60%.</td>
</tr>
<tr>
<td>Debris</td>
<td></td>
<td></td>
<td>Less than 1% inorganic debris by volume, including, but not limited to, glass, plastic, stones and metal.</td>
</tr>
<tr>
<td>Composted Mulches with</td>
<td>Trace Metals*</td>
<td>HNO$_3$ digestion</td>
<td>Complies with Table 3 of 40CFR503.13</td>
</tr>
<tr>
<td>Wastewater Biosolids</td>
<td>Fecal Coliforms*</td>
<td>MPN with A-1 broth</td>
<td>&lt;1000 MPN/dry gram</td>
</tr>
</tbody>
</table>

*Tests marked with asterisks must be performed by a suitable analytical laboratory; other test may be performed by the composted mulch producer.

632.2.5.1 Acceptance
Before delivering composted mulch, provider shall furnish documentation that includes the following:
1. The raw materials, by percentage, used in the production of the delivered composted mulch;
2. Daily temperature records for at least 20% of the piles or batches used to produce the delivered composted mulch, illustrating attainment of at least 130°F for at least 7 consecutive days;
3. A laboratory analysis for criteria shown in Table 1, performed on composted mulch no more than 180 days prior to composted mulch delivery; and
4. An affidavit, signed by a responsible company representative, confirming that the composted mulch meets each requirement shown in Table 632.2.5:1, “Quality Requirements for Composted Mulch.”

The Project Manager or Landscape Architect will inspect and approve the composted mulch application during installation and upon completion of the project.

632.3 CONSTRUCTION REQUIREMENTS
632.3.1 Sampling
The Department will sample and test shipments of seed and fertilizer for compliance with the regulations and requirements of the NMDA. Make seed and fertilizer stockpiles available for sampling at least 10 weeks before the scheduled seeding activities.
The Project Manager will notify the NMDA of the seed and fertilizer delivery location and date. The NMDA will sample the shipments of seed and fertilizer. The Department will reject seed or fertilizer not in accordance with the Contract.

### 632.3.2 Seeding Classes

Provide the various classes and the Material and operations for each class in accordance with Table 632.3.2.1, "Material and Operations for Classes of Seeding."

<table>
<thead>
<tr>
<th>Table 632.3.2:1 Material and Operations for Classes of Seeding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td><strong>Seeding class</strong></td>
</tr>
<tr>
<td>Seed bed preparation</td>
</tr>
<tr>
<td>Fertilizing</td>
</tr>
<tr>
<td>Seeding</td>
</tr>
<tr>
<td>Chain harrowing or hand raking</td>
</tr>
<tr>
<td>Mulch</td>
</tr>
<tr>
<td>Mulch anchoring, mechanical</td>
</tr>
<tr>
<td>Mulch anchoring, tack</td>
</tr>
<tr>
<td>Soil retention blanket</td>
</tr>
<tr>
<td>Watering</td>
</tr>
<tr>
<td>Wood cellulose mulch</td>
</tr>
</tbody>
</table>

*Anchoring method is based on the specified mulch type.

**Key:**
- **X** = required;
- **—** = not required; and
- **(X)** = required or not, in accordance with the Contract.

The Department defines the seeding classes as follows:
1. Class A = Mulch seeding with a drill (slopes V:H, flatter than 1:4);
2. Class B = Seeding without mulch;
3. Class C = Mulch seeding with hydroseeder;
4. Class D = Seeding with soil retention blanket (slopes V:H, from 1:4 to 1:3);
5. Class E = Seeding over mulch;
6. Class H = Hydroseeding; apply seed and fertilizer in one operation (perform chain harrowing or hand raking before applying wood cellulose mulch); and
7. Class SS = Steep slope seeding (slopes steeper than 1:3 (V:H)).

### 632.3.3 Seedbed Preparation

Till the seedbed with a disc, harrow, or chiseling tools to at least 4 in deep. Uproot competitive vegetation during seedbed preparation, and uniformly work the soil to a surface free of clods, large stones, or other deleterious Material that would interfere with seeding Equipment.

Till across the slope, if practical. Do not till the seedbed if the moisture content of the soil is outside the limits recommended by the seed Supplier for planting, or the ground is in a non-tillable condition.

Do not prepare more seedbed area on which the entire seeding operation can be applied before the surface crusts or loses seed and fertilizer to erosion. If erosion or crusting occurs, perform seedbed preparation again.

### 632.3.4 Fertilizing

Apply the approved fertilizer uniformly to the prepared seedbed.

### 632.3.5 Seeding Season Limitations

Unless otherwise specified in the Contract, perform seeding between June 1 and August 31. However, the Contractor may prepare and mulch the seedbed all year. The Department will pay for seeding performed after August 31 and before June 1 at 65% of the Bid Item Unit Price. If only performing seedbed preparation and mulching, perform over-seeding and fertilizing during the next seeding season. The Department will pay for the remaining balance owed toward the Bid Item upon completion.

If the Contractor completes soil slopes before the seeding season, the Contractor shall
immediately seed the slopes after the opening of the seeding season. If the Contractor completes soil slopes during the seeding season, the Contractor shall seed the slopes during the same season.

632.3.6 Seeding Operations

Uniformly apply the seed mix at a rate in accordance with the Contract. If practical, perform the seeding operations across the slope by drilling. Do not drive vehicles or other Equipment on seeded areas.

If rainfall or some other factor prevents the Contractor from seeding to the specified depth on prepared surfaces, the Contractor shall prepare the seedbed and apply seed again, at no additional cost to the Department.

632.3.6.1 Cool-Season Dormant Seeding

If performing cool-season dormant seeding, apply a commercial fungicide to the seed in accordance with state law and the manufacturer’s recommendations. Perform cool-season dormant seeding if the soil is both tillable and not frozen.

632.3.6.2 Drill Seeding

Plant seed approximately 1/2 in deep, with a maximum depth of 1 in, unless otherwise specified in the Contract. Ensure that the distance between the drilled furrows is no more than 8 in. If the furrow openers on the drill exceed 8 in, re-drill the area.

Perform seeding with grass seeding Equipment in good working order. Ensure that the Equipment has the following:

1. Double disc openers;
2. Depth bands;
3. Drop tubes;
4. Packer wheels or drag chains;
5. Rate control attachments;
6. Seed boxers with agitators for trashy seed.

632.3.6.3 Broadcast Seeding

If specified in the Contract or where it is not practical to accomplish the seeding by drilling, mechanically broadcast the seed with a hydro mulch slurry blower or distribute the seed by hand at twice the specified seeding rate.

Perform broadcast seeding using a hydro mulch slurry blower at the highest pressure and smallest nozzle opening that will accommodate the seed.

Begin the application from the bottom of the slope and proceed up the slope. Follow with a slope harrow or hand-raking operation to loosen the soil and cover the seed. This may be done with two or three passes of a chain harrow.

632.3.6.4 Steep Slope Seeding

Perform steep slope seeding on disturbed slopes steeper than 3:1 (H:V), or as determined in the field by the Project Manager with the Landscape Architect.

632.3.6.5 Overseeding

Use overseeding that consists of Class E seeding. Perform overseeding with an overseeding drill approved by the Department.

632.3.6.6 Contractor’s Responsibility for Seeded Areas

Protect and care for seeded areas until final acceptance of the Work. Repair any damage to seeded areas caused by pedestrian or vehicular traffic at no additional cost to the Department.

632.3.7 Mulching

Do not perform mulching when wind velocity exceeds 15 mph.

Ensure that hay and straw mulch have at least 50% of fibers exceeding 10 in long on the ground after application.

Spread the mulch uniformly over the area either by hand or with a mechanical mulch spreader. If spreading by hand, tear apart the bales of mulch and fluff it before spreading.

Spread mulch for Class C seeding with a mechanical mulch spreader. Anchor or tack the mulch with an approved tackifier. Use the Materials and rate of application recommended by
Perform mechanical mulch anchoring with a tackifier when the mechanical method is impractical due to steep slopes or rocky areas and when approved by the Project Manager.

632.3.7.1 Hay Mulch

Ensure that the rate of application of hay mulch is at least 2 1/2 ton per acre of air-dry hay.

Anchor hay mulch using a crimper with flat serrated discs at least 1 in thick with dull edges, spaced no more than 9 in apart. Ensure that the disc diameter is large enough to prevent the frame of the Equipment from dragging in mulch.

Ensure that hay mulch anchoring is at least 2 in deep and do not cover it with excessive amounts of soil. Perform hay mulch anchoring across the slope where practical, with no more than two passes of the anchoring Equipment.

632.3.7.2 Straw Mulch

Ensure that the straw mulch rate of application is at least 1 1/2 ton per acre of air-dry straw.

Anchor straw mulch with an approved tackifier at the rate of application recommended by the manufacturer.

632.3.7.3 Wood Cellulose Mulch

Apply wood cellulose mulch uniformly at the approved rate.

632.3.8 Soil Retention Blankets

Ensure that soil retention blankets are at least 4 ft wide.

Prepare, fertilize, and seed necessary areas before placing the blankets.

Place the blankets in accordance with the manufacturer’s recommendations. Staple the blankets at joints, corners, and at approximately 5 ft intervals along the sides. Bury the ends and edges at least 1 ft deep to prevent undercutting by water or wind. Overlap adjacent blankets at least 4 in and then staple.

On slopes, unroll the blankets down the slope. In ditches, unroll the blankets in the direction of the flow of water.

632.3.9 Watering

If the Contract requires watering, provide one of the following temporary water delivery systems:

1. Sprinkler system;
2. Water truck with a spray boom; or
3. Another method satisfactory to distribute a uniform coverage of clean water to seeded areas.

Keep the distributed water free of oil, acid, salt, or other substances harmful to plants. The Project Manager will approve the water source before use.

When using a temporary sprinkler system, keep the pipe connections tight to avoid leakage and loss of water and to preclude the washing or erosion of growing areas. Maintain the sprinklers in proper working order during watering.

Do not drive trucks with spray systems on seeded areas. Ensure that the water force is not of a volume or pressure that will cause movement of the mulch on the ground.

Do not apply more than 1/2 in of water per hour and do not water continuously for more than 2 h.

The Project Manager may require additional applications of water.

632.3.10 Composted Mulch

Composted mulch shall be used on slope ratios up to 2:1, as directed in the plans. A maximum layer of 2 in of composted mulch shall be spread evenly over slopes previously prepared in accordance with this Section.

Composted mulch shall be applied to prepared slopes with mechanical blower, pneumatic blower, manure spreader, mechanical spreader, manual application, front-end or skid-steer loader, or other method determined in the field by the Project Manager or Landscape Architect during the pre-project conference required in the plans. Newly placed composted mulch shall be watered in within 24 hours after placement, without disrupting the composted mulch layer, by evenly applying 12,000 gallons of water per acre of treated area.
For composted mulch applications less than 2 in deep, water application shall be reduced proportionately.
If required, seeding of treated slopes shall be accomplished in accordance with this Section.

632.4  METHOD OF MEASUREMENT
The Department will measure parallel to slopes.
An acre unit is 1/2 in of water depth over one acre.

632.5  BASIS OF PAYMENT
The Department will make partial payments for seeding in accordance with Section 632.3.5, “Seeding Season Limitations.”
The Department considers seeding and fertilizing of the following areas occupied by the Contractor as incidental to this Work, for which the Department will not pay for separately:
1. Campsites;
2. Office;
3. Plant sites;
4. Equipment parking;
5. Service areas; and
6. Areas stripped of native vegetation through unnecessary or improper construction practices by the Contractor.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class __ Seeding</td>
<td>Acre</td>
</tr>
<tr>
<td>Steep Slope Seeding</td>
<td>Acre</td>
</tr>
<tr>
<td>Broadcast Seeding</td>
<td>Acre</td>
</tr>
<tr>
<td>Watering</td>
<td>Acre Unit</td>
</tr>
</tbody>
</table>

632.5.1 Work Included in Payment
The following work items will be considered as included in payment for the main items and will not be measured or paid for separately:
A. Tackifier for mulch;
B. All compost materials and related work;
C. Seeding of the areas occupied by the Contractor for campsites, office, plant sites, equipment parking, service; areas, areas stripped of native vegetation through unnecessary or improper construction practices by the Contractor, and any fertilizing.
SECTION 660: EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES

660.1 DESCRIPTION
This Work consists of performing excavation, trenching, and backfilling for underground utility lines.

660.2 MATERIALS—Vacant

660.3 CONSTRUCTION REQUIREMENTS

660.3.1 Trenching and Excavation
Grades for underground utility lines are the invert (inside bottom of the pipe) unless the Contract specifies otherwise.
During excavation, pile Material suitable for backfill in an orderly manner far enough away from the banks of the trench to avoid overloading and to prevent slides or cave-ins.
Perform grading necessary to prevent surface water from flowing into trenches or other excavations; remove water that has accumulated by pumping or with other approved methods.
Perform trenching far enough in advance of pipe laying to allow the Project Manager to make necessary grade changes. Unless otherwise specified in the Contract, begin backfilling immediately after laying pipe and keep pace with pipe-laying operations.

660.3.1.1 Trench Widths
Ensure that trenches are wide enough to properly lay, align, grade, and joint the pipe.
Dig trenches to at least 24 in wide, but in no case should they exceed 1.4 times the outside diameter of the pipe, plus 24 in, plus twice the thickness of shoring structures, at the level of the top of the pipe.
The Contractor may use excavation for concrete Structures as the outside form, if approved by the Project Manager.
If trenching is behind a curb, in lawns, or adjacent to Sidewalks or walls, ensure that the trench is not wider than the outside diameter of the pipe plus 24 in at the trench top. Provide sheeting or bracing as necessary.
The Department will consider over depth excavation not ordered by the Project Manager as unauthorized. Fill the unauthorized excavation with granular or compacted embedment Material or concrete, as directed by the Project Manager at no additional cost to the Department.

660.3.1.2 Shaping Trench Bottoms
Accurately grade trench bottoms for pipe 6 in or smaller to provide uniform bearing and support throughout the length of each section of pipe. Finish the bottom of the trench by excavating a shallow concave groove at the line of the pipe and shape it approximately to fit the pipe.
Excavate trench bottoms for larger pipe to below the grade line, as necessary, to allow the installation of granular embedment foundation Material for the pipe.
Dig bell holes and depressions for joints after grading the trench bottom so that the full length of the pipe rests on the prepared bottom. Make these depressions the length, depth, and width necessary to properly fit the particular type of joint.
Do not excavate below the specified final trench bottom elevation, unless the Contract requires granular embedment foundation Material.

660.3.1.3 Foundations
Remove wet or otherwise unstable soil, incapable of properly supporting the pipe, and backfill the trench to grade with granular embedment foundation Material or other suitable Material.
If the Contractor excavates deeper than the specified grade, the Contractor shall backfill the trench to grade with granular embedment foundation Material or other approved Material.
Thoroughly tamp the replacement foundation Material to provide a solid bed for the pipe.
The Project Manager will determine if Material from the trench is acceptable.

660.3.1.4 Rock Excavation
Remove rock that is not rippable with a rip tooth, or that occurs in masses larger than 1/2 yd³ or ledges at least 4 in thick in accordance with Section 203, “Excavation, Borrow, and Embankment.”
If the Contractor encounters solid rock during excavation, the Contractor shall excavate to a depth 6 in below the outside bottom of the pipe and backfill the trench to the proper grade. If Materials cannot be handled or compacted as earth (including rock), the Contractor shall separate them from excavated materials that the Contractor shall use as fill or Embankment Material. Dispose of rock separated from fill Material as approved by the Project Manager.

660.3.1.5 Wet Excavation Requirements
Keep trenches and other excavations free of water by bailing, pumping, or draining during construction operations. Keep water away from concrete or cement joints until the Materials attain initial set.

Provide the following, as necessary:
1. Cofferdams;
2. Pumps;
3. Drains;
4. Ditches;
5. Well points; and
6. Other means for removing water from the excavations or other parts of the Work and for preventing excavated slopes from sliding or caving.

Dewater for at least 24 h in the vicinity of concrete to allow the concrete to set properly. Dispose of water by pumping it into ditches, storm drains, or sanitary sewers in accordance with applicable regulations.

660.3.2 Bracing and Sheeting
The Department will allow the Contractor to cut trench banks on slopes to prevent sliding and caving where the increased trench width will not interfere with surface features or encroach on Right of Way limits. Slopes may not intersect vertical trench walls more than 12 in above the top of pipe.

Do not remove sheeting and bracing until sufficient backfill is in place to protect the utility Structures and the adjacent Roadway from caving damage. Leave sheeting in place if necessary and approved in writing by the Project Manager. Cut off sheeting left in place at least 1 ft below the ground surface.

660.3.3 Bedding and Backfill
Provide bedding and backfill for utilities in accordance with Section 663.1.1, "NMSSPWC Appurtenant Stipulations," except, provide compaction within 4 ft of pipe and utility appurtenances, under the Roadway Prism, to 100% maximum dry density.

If backfilling uncased pipe, do not break, chip, crush, crack, or otherwise damage the pipe. Backfill polyvinyl chloride pipe only if the pipe is 75 °F or below.

660.3.3.1 Backfill Material
Provide backfill Material that, after placement and compaction, is capable of supporting the design loads. Provide backfill Material that is free of lumps, debris, other Deleterious Materials, and sharp rocks, stones, or other objects that might damage the pipe.

660.3.3.2 Backfill Compaction Operations
Compact backfill Material placed around irregular areas with hand-operated tamping Equipment. Compact anchor loads for pipe testing and other backfill placed before the regular trench backfill.

660.3.4 Contractor’s Responsibility for Protection of Public Utilities
Repair damage to Structures, pipelines, conduits, cables, sewers, storm drains, or other utilities encountered in or adjacent to the excavation, due to the Contractor’s negligence. Use reasonable measures and precautions, including Blue Stake or One Call, to protect utilities. Locate underground utilities before excavating and provide support to protect these utilities and avoid damage or interruption in functions.

At least 7 Days before beginning excavation, provide written notification to owners of public utilities that may be affected by construction, so that the owners may make necessary arrangements. Restore or rebuild property damaged by construction operations to at least the condition that existed before the construction operations.
Get the Project Manager’s approval to relocate trench lines to avoid known obstacles. Permanently plug the dead ends left in the trench from removed abandoned pipes, conduits, or sewers.

### 660.3.4.1 House Service Connections

Do not disturb or damage existing house lateral connections to utility mains. Replace broken lateral connections with the same type pipe or better, at no additional cost to the Department.

### 660.4 METHOD OF MEASUREMENT—Vacant

### 660.5 BASIS OF PAYMENT

The Department will pay for authorized rock excavation in accordance with Section 203, “Excavation, Borrow, and Embankment.”

The Department will pay for sheeting left in place at the direction of the Project Manager at an agreed price that does not exceed the actual Material cost.
SECTION 662: MANHOLES

662.1 DESCRIPTION
This Work consists of constructing manholes. Construct manholes complete with covers, steps, fittings, and other appurtenances. This Work also includes installation of reducing cones, manhole extensions, ties to existing manholes, manhole adjustments, and manhole frame and covers.

662.1.1 NMSSPWC Appurtenant Stipulations
Adhere to the applicable requirements of the NMSSPWC, except for the procedures for method of measurement and Basis of Payment.

662.1.1.1 Terms
Substitute “Engineer,” as it appears in the applicable sections of the NMSSPWC, with “Project Manager.” The term “Owner” refers to the entity owning the affected utilities on this project.

662.1.2 Manhole Types
Use precast concrete sections to construct “Drop” and “Standard” manholes.

The Department defines “Drop” manholes as manholes that have outside pipe and fittings for dropping sewage into the lower line.

The Department defines “Standard” manholes as inside drop manholes, where the incoming line discharges directly into the manhole and does not require special fittings.

662.2 MATERIALS

662.2.1 General
Use new Materials of the best standard quality available for the intended purpose.

The Contractor may substitute Contract specified brand name Materials with generic Materials of equal quality if the Contractor provides adequate technical and descriptive data and the Project Manager approves.

662.2.1.1 Referenced Materials
Provide Materials in accordance with these Standard Specifications and the following sections of the NMSSPWC:

1. Section 106, “Cement Mortar and Grout;”
2. Section 108, “Brick;”
3. Section 123, “Reinforced Concrete Pipe;”
4. Section 124, “Reinforced Concrete Pressure Pipe;”
5. Section 128, “Concrete Cylinder Pipe;”
6. Section 130, “Gray Iron and Ductile Iron Fittings;”
7. Section 143, “Galvanizing;”
8. Section 160, “Steel Castings;”
9. Section 161, “Gray Iron Castings;” and
10. Section 162, “Aluminum Castings.”

If the above-referenced specifications and these Standard Specifications conflict, the Contractor shall use the more stringent.

662.2.1.2 Certification
Before installing an item or type of Material, provide the Project Manager with a certification that the item or type of Material meets these Standard Specifications or the referenced specifications.

662.2.2 Masonry

662.2.2.1 Concrete
Provide Materials for concrete in accordance with Section 509, “Portland Cement Concrete Mx Designs.”

662.2.2.2 Non-Shrink Mortar
Provide non-shrink mortar in accordance with Section 521, “Non-Shrink Mortar.”
662.2.3 Fine Aggregate
Provide fine aggregate that passes a No. 8 sieve, but no more than 4% passes the No. 200 sieve.

662.2.4 Precast Sections
Provide circular precast concrete in accordance with ASTM C 478, except that the minimum thickness and the reinforcement will be in accordance with the Contract.
Provide circular or horseshoe-shaped box out openings for each connecting pipe, with the surfaces grooved or roughened to improve mortar bond.

662.2.5 Gaskets
Provide rubber or mastic gasket Materials in accordance with the following:
2. Rubber that is Neoprene, or another synthetic, and 40 ± 5 hardness if, measured in accordance with ASTM D 2240 and Type A durometer.

662.2.6 Coal Tar Paint
Provide one of the following types of coal tar paint:
1. Koppers Bitumastic Super-Service Black;
2. Porter Tarmastic 103;
3. Tnemec 450 heavy Tenemecol, or;
4. An approved equal.

662.2.7 Castings
Provide castings in accordance with ASTM A 48, with asphalt varnish coating applied at the foundry.
Provide the following manhole rings and covers:
1. Neenah R-1736;
2. Clay and Bailey No. 2008;
3. McKinley ET 24 M, or
4. An approved equal.
Provide aluminum manhole steps or polypropylene-encased deformed-steel reinforcing-bar manhole steps in accordance with ASTM C 478.

662.3 CONSTRUCTION REQUIREMENTS

662.3.1 General
Make excavations, as necessary, to determine the exact location of existing utilities that affect the new construction.
Repair damage to existing utilities at no additional cost to the Department.
The Project Manager will establish the final locations for new fittings, connections, etc. in the field. The Project Manager must approve modifications to the Contract before beginning the Work.
Submit a proposed sequence of construction to the Project Manager for approval before beginning the Work.

662.3.1.1 Waste Containment and Disposal Requirements
Dispose of materials taken from sanitary sewers during cleaning operations at no additional cost to the Department.
Retrieve and dispose of sand and other debris from the sewers and secure a legal disposal site at no additional cost to the Department.
Do not discharge removed sewage or solids onto streets, ditches, catch basins, or storm drains.

662.3.2 Delivery
Do not deliver precast concrete sections to the project until representative concrete control cylinders have attained at least 80% of the specified minimum compressive strength. Inspect precast concrete sections upon delivery and do not use cracked, broken, or visibly defective units.

662.3.3 Placement Requirements
Use mortar within 40 min after mixing. Discard mortar that has begun to take on initial
set and do not mix it with additional cement or new mortar. If necessary, extend the manhole as directed by the Project Manager.

662.3.3.1 Inverts
   Ensure that the dimension of the invert section through a manhole is greater than that of the outgoing pipe. Ensure that the shape of the invert conforms exactly to the lower half of the pipe it connects. Connect side branches with as large a radius of curve as practical. Trowel inverts to a smooth, clean surface.

662.3.3.2 Precast Sections
   Provide circular precast sections with a rubber or mastic gasket to seal joints between sections. Fill the space between connecting pipes and the wall of precast sections completely with non-shrinking mortar.

662.3.4 Connections
   Make connections in a sequence and method that minimizes inconvenience to the Owner. Obtain Project Manager approval of the sequence and method before making the connections.

   To stop the flow of water to make the connection to the existing line, the Contractor shall only close existing valves in the presence of an Owner representative.

662.3.5 Manhole Frames and Covers
   Cast or finish manhole frames and covers in accordance with the Plans.

Use machined cover seats and frame seats made of tough gray iron, free of cold chutes or blow holes, and with a finish to industry standards. Produce an indentation on a rectangular edge using a hammer without flaking the metal.

   Perform the following to castings at the foundry:
   1. Hammer inspection;
   2. Thoroughly clean;
   3. Dip in asphalt or coal tar; and
   4. Oil at a temperature of from 290 °F to 310 °F.

   Use manhole frames and covers in accordance with the Contract. Cast, finish, and machine the frame and cover so that the cover fits true and even, without rocking within the frame.

   Ensure the position and spacing of the manhole step rungs are in accordance with the Contract.

662.3.6 Submittals
   Two weeks before installation, submit drawings and data regarding precast concrete sections to the Department. Submit data and drawings regarding cast-in-place manholes to the Department in accordance with Section 510, “Portland Cement Concrete,” and Section 511, “Concrete Structures.”

662.3.7 Manhole Adjustments
   Adjust manhole rings in existing paved Roadway using the following procedure:
   1. Remove the existing ring and cover;
   2. Place a 5/8 in thick (minimum) steel plate cover on the manhole opening;
   3. Salvage the existing manhole rings and manhole covers and return them to the Owner as directed;
   4. Place and compact the required surfacing;
   5. Locate the steel-plate manhole cover with a metal detector or other method approved by the Project Manager;
   6. Cut a 5 ft × 5 ft square opening in the surfacing and remove the surrounding material in accordance with the Plans (the control point of the square opening is the center of the manhole);
   7. Install a manhole ring and adjust in accordance with the Plans;
   8. Place the steel reinforcement and concrete (the Project Manager will determine the curing time allowed for the placed concrete before other Work adjacent to or over the concrete can be started); and
   9. Place and compact the required surfacing.

   The Contractor may propose an alternate method of adjusting manholes by providing the
662.3.8 Miscellaneous Manhole Construction

If specified, install reducing cones, manhole extensions, ties to existing manholes, manhole adjustments, and manhole frame and covers in accordance with the NMSPWMC.

662.4 METHOD OF MEASUREMENT

The Department will measure additional depth for adjusted manholes from the inside bottom of the manhole to the adjusted finished top of the manhole ring and compare that measurement to the Plan depth.

662.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manhole Type __, __ ft diameter ___ ft to ___ ft Depth</td>
<td>Each</td>
</tr>
<tr>
<td>Manhole Type __, __ ft diameter over ___ ft to ___ ft Depth</td>
<td>Each</td>
</tr>
<tr>
<td>Manhole Type ___</td>
<td>Each</td>
</tr>
<tr>
<td>Special Manhole Type ___</td>
<td>Each</td>
</tr>
<tr>
<td>Manhole, ___ ft diameter</td>
<td>Each</td>
</tr>
<tr>
<td>Sewer Manhole, ___ in diameter</td>
<td>Each</td>
</tr>
<tr>
<td>Drop Manhole, ___ in diameter</td>
<td>Each</td>
</tr>
<tr>
<td>__ in × ___ in Reducing Cone</td>
<td>Each</td>
</tr>
<tr>
<td>Additional Depth for Manhole</td>
<td>Vertical Foot</td>
</tr>
<tr>
<td>Additional Depth for ___ ft diameter Manholes</td>
<td>Vertical Foot</td>
</tr>
<tr>
<td>Manhole Adjustment</td>
<td>Each</td>
</tr>
<tr>
<td>Manhole Extension</td>
<td>Each</td>
</tr>
<tr>
<td>Tie to Existing Manhole</td>
<td>Each</td>
</tr>
<tr>
<td>Manhole Frame and Cover</td>
<td>Each</td>
</tr>
</tbody>
</table>
SECTION 663: UTILITY ITEMS

663.1 DESCRIPTION
This Work consists of trench excavation and backfill, and providing, installing, and connecting the specified utility items to existing utilities.

663.1.1 NMSSPWC Appurtenant Stipulations
Adhere to the applicable requirements of the NMSSPWC as referenced, added to, or modified for utility relocation and construction.

663.1.1.1 Terms
For the purposes of this section, substitute “Engineer,” as it appears in the applicable sections of the NMSSPWC, with “Project Manager.” The term “Owner” refers to the entity owning the affected utilities on this project.

663.1.1.2 Applicable Sections
The following sections of the NMSSPWC shall apply, except as modified:
1. Section 700, “Trenching and Boring for Utilities;”
2. Section 701, “Trenching, Excavation, and Backfill;”
3. Section 710, “Boring, Drilling, and Jacking;”
5. Section 801, “Installation of Water Transmission, Collector and Distribution Lines;”
6. Section 802, “Installation of Water Service Lines;”
7. Section 900, “Sanitary and Storm Sewer Facilities;”
8. Section 901, “Sanitary Sewer Collector and Interceptor Facilities;”
9. Section 905, “Sanitary Service Lines;”
10. Section 910, “Storm Sewer Pipe Installations;”
11. Section 915, “Storm Sewer Drainage Appurtenances;” and
12. Section 920, “Sanitary and Storm Sewer Manholes.”

663.1.1.3 Modifications to NMSSPWC
The sections listed above do not include references to measurement and payment; measurement and payment will be in accordance with Section 663.4, “Method of Measurement,” and Section 663.5, “Basis of Payment.”

663.1.2 Electrical
Perform Work in accordance with state and local codes and ordinances, the current edition of the NEC®, the rules and regulations of the local electrical company authority, and other authorities with jurisdiction. Whether shown on the Plans or not, make modifications required by any of the above authorities at no additional cost to the Owner or the Department.

663.2 MATERIALS
Provide the following Materials in accordance with the Contract:
1. Pumps;
2. Pipes;
3. Tubing;
4. Fittings;
5. Manual valves;
6. Reduced pressure backflow preventers;
7. Instrumentation; and
8. Miscellaneous system components.
Provide new, unused Materials of the best quality available for the purposes intended. If the Contract specifies Materials by brand names, substitute other brands of equal quality with Project Manager approval of a submittal detailing adequate technical and descriptive data.
Provide Materials in accordance with these Standard Specifications and the following sections of the NMSSPWC:
9. Section 100, “Materials;”
10. Section 101, “Portland Cement Concrete;”
11. Section 102, “Steel Reinforcement;”
12. Section 103, “Epoxy-Coated Steel Reinforcement;”
13. Section 105, “Concrete Curing Compound;”
14. Section 106, “Cement Mortar and Grout;”
15. Section 107, “Joint Filler and Sealant Material;”
17. Section 121, “Plastic Pipe (Water and Sanitary Sewer Use);”
18. Section 123, “Reinforced Concrete Pipe;”
19. Section 124, “Reinforced Concrete Pressure Pipe;”
20. Section 125, “Vitrified Clay Pipe;”
21. Section 127, “Steel Water Pipe;”
22. Section 128, “Concrete Cylinder Pipe;”
23. Section 129, “Ductile Iron Pipe;”
24. Section 130, “Gray Iron and Ductile Iron Fittings;”
25. Section 143, “Galvanizing;”
26. Section 160, “Steel Castings;”
27. Section 161, “Gray Iron Castings;”
28. Section 162, “Aluminum Castings;” and
29. Section 170, “Electronic Marker Disks.”

Provide concrete in accordance with Section 509, “Portland Cement Concrete Mix Designs.” Provide steel for reinforcement in accordance with Section 540, “Steel Reinforcement.”

663.2.1 Certification

Provide the Project Manager with a Certificate of Compliance for each required item or type of Material, before use, that indicates the item or Material is in accordance with the Contract.

663.3 CONSTRUCTION REQUIREMENTS

663.3.1 General

Excavate to determine the exact locations of existing utilities that affect the new construction. The Contractor shall repair damage to existing utilities due to Contractor negligence, at no additional cost to the Department.

The Project Manager will establish the final locations for new fittings, connections, etc. in the field. The Project Manager must approve modifications to the Contract in writing before use.

663.3.1.1 Waste Containment and Disposal Requirements

Dispose of materials taken from sanitary sewers during cleaning operations at no additional cost to the Department.

Retrieve sand and other debris from the sewers and secure a legal disposal site for it. Do not discharge removed sewage or solids onto streets or into ditches, catch basins, or storm drains.

663.3.2 Pipe Installation

The Contractor may select a Contract-specified type of pipe as approved by the Project Manager and the Owner.

Store plastic pipes out of direct sunlight until placement, and replace plastic pipes showing discoloration or deterioration with acceptable pipes, at no additional cost to the Department.

Replace sections of pipe found to be defective before or after installation with new pipes at no additional cost to the Department.

663.3.2.1 Trenching

Perform trenching and excavation for utilities in accordance with Section 660, “Excavation, Trenching and Backfilling for Utilities.”

663.3.2.2 Pipe Assembling

Perform the following before pipe assembly:
1. Clean off dirt and pipe scale;
2. Ream and remove burrs; and
3. Clear pipes and fittings of dirt, dust, and moisture.

Use manufacturer-recommended fittings to ensure leak-proof joints. Use elastomeric sealed joints in accordance with ASTM F 477 and ASTM D 3139.
Clean the interior of pipes from foreign matter before lowering into the trench and keep them clean during installation using plugs or other methods approved by the Project Manager.

663.3.2.3 Pipe Placement
Lay pipes in accordance with these Standard Specifications and the manufacturer's recommendations.

Ensure that the full length of each section of pipe rests solidly on the pipe bed including recesses to accommodate the joints. If a pipe section is disturbed after initial installation, remove and re-lay.

Do not lay pipes in water or unsuitable weather conditions. When not working on pipes, securely close open ends of pipes and fittings to prevent trench water, earth, or other Deleterious Material from entering them.

663.3.2.4 Pressurized Pipe Tests
Thoroughly flush out main line supply pipelines and test them for leaks before placing backfill and installing valves.

Firmly block the fittings at bends in the pipelines and at the ends of lines to prevent the fittings from blowing off the lines when under pressure.

Ensure that fittings and couplings are visible for inspection during the entire test period.

Test in accordance with NMSSPWC.

663.3.2.5 Bedding and Backfilling
Perform bedding and backfilling for utilities in accordance with Section 660, “Excavation, Trenching, and Backfilling for Utilities.”

663.3.3 Sequence of Construction
Submit a proposed sequence of construction to the Project Manager for approval at least 2 weeks before beginning the utility work.

Use a sequence and method for making the connections that minimizes the inconvenience to the Owner and obtain Project Manager approval before making the connections to existing lines.

To stop the flow of water to make the connection to the existing line, the Contractor shall only close existing valves in the presence of an Owner representative.

663.3.4 Fences
Preserve and protect fences in the vicinity of construction.

For the relocation of utilities, the Contractor shall install temporary gates in existing fences (if necessary), if the gates are located only on rights-of-way for the utilities or at other locations for which the Contractor has obtained permission from the Owner for such construction. Remove temporary gates and reconstruct the fence lines to original or better condition after completing utility construction.

663.3.5 Grading and Cleanup
After backfilling, grade and level the area. Reshape and grade Roadways to their original configurations, including restoration of drainage ditches and other features.

663.4 METHOD OF MEASUREMENT
The Department will measure pipes along the centerline of the pipe.

663.5 BASIS OF PAYMENT
The Department considers the Work described in this section to be included in the Special Provisions, for which the Department will not make additional payments.
SECTION 664: LANDSCAPE PLANTING

664.1 DESCRIPTION
This Work consists of providing trees, shrubs, and other Materials necessary to complete the landscape. This Work includes labor, Equipment, and the performance of operations including planting, fertilizing, watering, cleanup of planting areas, and replacement of unsatisfactory, damaged, and unacceptable planting Materials.

664.2 MATERIALS

664.2.1 Plant Materials
Provide healthy, vigorous plants of the type (species and variety) and size specified. Provide plants with normal, well-developed branch and root systems. Ensure plants are free of the following:
1. Damage from machines;
2. Sun or frost damage;
3. Insects and insect eggs; and
4. Disfiguring knots or other objectionable defects.
Provide plants that equal or exceed the minimum specified measurements. Select plant Materials for shape and branching habit; that will produce the strong, full foliage of a typical, mature specimen.

664.2.2 Inspection of Plant Materials
Provide plant Materials in accordance with state and federal laws, including the New Mexico Plant Protection Act (NMSA 1978, § 76-5-11 et seq.), for disease infestation inspection.
Inspection certificates required by law must accompany each shipment, invoice, or order of stock. On delivery, provide the certificate to the Project Manager. Provide for Department inspection at the place of origin or in a local nursery, and upon delivery to the planting location at the project.

664.2.2.1 Notification and Inspection
Submit an itemized list of the plants to the Project Manager, along with a time and location the inspection may be made, at least 7 Days in advance.
The Landscape Architect and the Project Manager will make plant inspections jointly. The Project Manager will tag the accepted plants before plants are removed from the nursery for delivery to the project.
The Project Manager and the Landscape Architect will inspect for size, vigor, representation of the species and variety, damage, condition of ball and roots, and latent defects.

664.2.3 Container Plants
Provide plants specified on the plant list as “container grown” at a reasonable stage of development for the specified container size. Provide plants grown in their containers long enough to develop good, round, root systems capable of holding the soil intact after removal from the container, but not enough to become root bound.

664.2.4 Substitutions
The Department will permit substitutions of equivalent varieties of plant Materials or other Materials only after the Contractor makes every reasonable effort to secure Materials of the species, varieties, and kinds listed on the Bid Forms or in the Contract. Submit requests for substitutions in writing to the Project Manager for approval by the Landscape Architect. Obtain written approval from the Project Manager before substituting the Materials.

664.2.5 Delivery of Shipment to Site
Protect plant Materials before shipment to prevent damage (overdrying or wind). Be careful when digging, wrapping, and binding plants to ensure safe loading, shipment, and handling of heavy balled plants.
Notify the Project Manager of the time and manner of delivery at least 7 Days in advance. Provide two copies of an itemized list of the quantities of plant Materials in each delivery with the notice.
The Project Manager will inspect the plants upon delivery. The Department will reject...
cracked or mushroomed balls and damaged plants that are unacceptable for planting.
Immediately remove rejected plants from the project.

664.2.6 Tagging and Labeling of Plant Materials
Securely tag plants with legible, durable labels using weather-resistant ink and identifying
the following for each plant:
1. Origin;
2. Species;
3. Variety;
4. Name; and
5. Size.
Keep tags on through final inspection.

664.2.7 Fertilizer
Provide fertilizer in accordance with the Contract.

664.2.8 Water
Use clean water that is free from pollutants harmful to plant growth or that could
contaminate the environment.

664.3 CONSTRUCTION REQUIREMENTS

664.3.1 Planting
Use the planting backfill mixture and provide watering basins in accordance with
Contract. Do not plant deeper than the original ground line.

664.3.2 Care and Replacement
Water and maintain the plants for at least one year from the date of final acceptance,
unless otherwise approved by the Landscape Architect. If the Contractor installs a drip
irrigation system, the Contractor shall hand water the plants until the drip irrigation system is in
place and operational.
At the direction of the Project Manager, replace dead or unhealthy plants for one year
after the date of final acceptance. Provide replacement plants that are in accordance with the
Contract.

664.3.3 Final Inspection and Acceptance
After the completion of the landscape planting work, the Project Manager and Landscape
Architect will make final inspection and acceptance.

664.4 METHOD OF MEASUREMENT
The Department will measure the actual number of trees, shrubs, or other plants
provided, planted, and accepted.

664.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees, Shrubs, and Ground Cover (_____)</td>
<td>Each</td>
</tr>
<tr>
<td>Sodding (_____)</td>
<td>Square Yard</td>
</tr>
</tbody>
</table>

664.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main
items and will not be measured or paid for separately:
A. Furnishing, transporting, and planting of plants;
B. Excavation, furnishing prepared backfill mixture, wrapping, staking, watering, care,
   and maintenance; of plants; and
C. One-year replacement of dead and unhealthy plants.
SECTION 667: REST AREA AND MISCELLANEOUS LANDSCAPING ITEMS

667.1 DESCRIPTION
This Work consists of providing and constructing rest area items and miscellaneous improvements.

667.2 MATERIALS
667.2.1 Portland Cement Concrete
Provide portland cement and aggregate for concrete in accordance with Section 509, “Portland Cement Concrete Mix Designs.”

667.2.2 Steel
Provide steel reinforcement in accordance with Section 540, “Steel Reinforcement.”
Provide anchor bolts for mailbox installations in accordance with ASTM A 307 Grade A steel.
Provide zinc coated anchor nuts and bolts.

667.3 CONSTRUCTION REQUIREMENTS
Construct Work in accordance with the applicable local and state codes, ordinances, and regulations governing the particular class of work involved.
If there is a conflict between the applicable codes and the requirements in the Contract, use the more stringent requirements.
After completing the Work, clean the areas of debris and leave them in their existing or an improved condition.

667.3.1 Mailbox Installations
Install mailboxes in accordance with AASHTO’s A Guide for Erecting Mail Boxes on Highways.
Contact and coordinate with the local post office and property owner before removing old mailboxes and installing new mailboxes. Provide and install temporary mailboxes, if necessary, as directed by the Project Manager.

667.4 METHOD OF MEASUREMENT
The Department will measure special landscaping items by units specified in the Contract.

667.4.1 Measurement Clarifications
A single mailbox installation consists of one mailbox and one mailbox support.
A double mailbox installation consists of two mailboxes and one mailbox support.
Multiple mailbox installations consist of from 3 to 16 mailboxes and one mailbox support.
A picnic table unit consists of one picnic table and two benches.

667.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber Parking Barriers</td>
<td>Each</td>
</tr>
<tr>
<td>Charcoal Grills</td>
<td>Each</td>
</tr>
<tr>
<td>Park Benches</td>
<td>Each</td>
</tr>
<tr>
<td>Picnic Shelters</td>
<td>Each</td>
</tr>
<tr>
<td>Picnic Table Pads</td>
<td>Each</td>
</tr>
<tr>
<td>Picnic Tables and Benches</td>
<td>Each</td>
</tr>
<tr>
<td>Litter Receptacles</td>
<td>Each</td>
</tr>
<tr>
<td>Historical Markers</td>
<td>Each</td>
</tr>
<tr>
<td>Skylights</td>
<td>Each</td>
</tr>
<tr>
<td>Mirrors</td>
<td>Each</td>
</tr>
<tr>
<td>Storage Buildings</td>
<td>Each</td>
</tr>
<tr>
<td>Air Systems</td>
<td>Each</td>
</tr>
<tr>
<td>Water Closets</td>
<td>Each</td>
</tr>
<tr>
<td>Lavatories</td>
<td>Each</td>
</tr>
<tr>
<td>Urinals</td>
<td>Each</td>
</tr>
<tr>
<td>Mailbox Installation (Single)</td>
<td>Each</td>
</tr>
<tr>
<td>Mailbox Installation (Double)</td>
<td>Each</td>
</tr>
</tbody>
</table>

Section 667: Rest Area and Miscellaneous Landscaping Items
If the Contract specifies a mailbox support foundation and anchoring only, the Department will pay for the concrete and steel in accordance with Section 511, "Concrete Structures," and Section 540, "Steel Reinforcement."

667.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:

A. Labor, tools, equipment, and appurtenances necessary to satisfactorily complete the work as approved by the Landscape Architect;
B. Removal and disposal of shrubs, brush, rocks, or other obstacles that interfere with proper installation of the improvements; and
C. Concrete slabs, steel anchor devices, reinforcement, and foundations for rest area items;
D. Coordination with the local post office and property owner;
E. Removal of existing mailboxes;
F. Removal and installation of temporary mailboxes.
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701.1 DESCRIPTION
This Work consists of providing and installing traffic signs and sign Structures in accordance with the MUTCD.

701.2 MATERIALS
701.2.1 General
Provide Materials manufactured in accordance with the requirements of ASTM D 4956, current version.

701.2.1.1 Sign Manufacturer's Quality Control
Manufacture permanent signs in accordance with a Quality Control (QC) program approved and certified by the Traffic Services Engineer before fabrication.

Ensure the QC program includes the following:
1. Basis of raw Material acceptance:
   1.1 Sign manufacturer Certificates of Compliance for sign Materials; or
   1.2 Random lot testing and certification of sign Materials by an independent testing laboratory (ITL); and
   1.3 Traffic Services Engineer’s approval of methods of manufacture.
2. Type, method, and frequency of control tests;
3. A record of QC program data for each sign component as follows:
   3.1 Maintain a logbook or other approved form of documentation that cross-references sign certifications. Include certifications for each sign component Material lot used to make each sign. Maintain these records for at least three years;
   3.2 File and cross-reference any special instructions on how to use sign Materials, such as substrate preparation before applying sign sheeting or use of special inks;
4. Final inspection:
   4.1 Provide a manufacturing checklist for signs. Identify all sign component Material lot numbers and cross-reference those with the manufacturer’s or ITL’s Certificates of Compliance;
   4.2 Provide a completed checklist to the Project Manager with each sign shipment;
5. Name and position of the quality control person.

701.2.1.2 De-certification of Quality Control Program
The Department may withdraw approval of a sign manufacturer’s QC program, if the manufacturer fails to follow the certified written QC program or fabricates signs that do not conform to Department specifications. The Traffic Services Engineer or designee will determine the de-certification period based on the severity and nature of infractions.

The Department may prohibit the use of sign manufacturers that do not have a certified QC program. However, the Traffic Services Engineer may allow the sign manufacturer to supply signs under the following conditions when the QC program certification has been withdrawn:
1. The sign manufacturer shall hire an ITL to inspect the manufacture of signs to be used on Department projects, as approved by the Department; and
2. The ITL shall have a certified quality control program. The ITL shall provide a checklist in accordance with the certified QC program to the Project Manager indicating the signs were inspected and in accordance with the specifications.

The Traffic Services Engineer or designee may recertify sign manufacturers, if they meet Department requirements.

701.2.1.3 Verification of Manufacturer's Certification
Submit the name of the proposed sign manufacturer and project number in writing. The Traffic Services Section will verify that the proposed sign manufacturer is eligible to supply signs to the project.

701.2.1.4 Sign Identification
Ensure that signs have identification labels as follows:
1. Display the following information on the manufacturer’s identification label:
1.1 The wording, “Manufactured By,” followed by the sign Fabricator’s initials;
1.2 Month and year fabricated;
1.3 Reflective sheeting type and manufacturer’s initials;
1.4 The statement, “Property of the State of New Mexico, Defacing or Theft is a Crime;” and
1.5 Whether sign is laminated with anti-graffiti sheeting.

2. Display the following information on the Contractor’s identification label:
   2.1 Contractor’s name; and
   2.2 Date installed (month and year).

The labels may be die stamped in 3/8 in letters and numerals, or 1/2 in letters and numerals made with high-tack adhesive reflective or non-reflective sign sheeting, prepared with screened ink. Place labels on the lower backside of the sign, where not hidden by any post or frame member. Provide labels with weather resistance characteristics having a service life at least equal to that of the sign. Do not damage signs during die stamping.

701.2.1.5 Special Coded Signs
Submit requests for significant deviations from Plan drawing sign sizes for special coded signs to the Project Manager for approval at the Preconstruction meeting. Provide drawings showing the complete legend, arrangement of letters and numerals, letter and numeral height, letter series, symbols, borders, and dimensions. Provide an I-beam post submittal and obtain approval, before installing posts and before submitting overhead sign Structure shop drawings for review.

701.2.2 Sign Components
701.2.2.1 Retroreflective Sheeting
Use retroreflective sheeting included in the Department's Approved Products List. Provide certification that sheeting is in accordance with ASTM D 4956, current version. Provide sheeting that has a smooth, flat exterior film with retroreflective elements homogeneous in appearance, weather resistant, and with a protected, pre-coated adhesive backing.

701.2.2.1.1 Colors
Provide the diffuse day color of the retroreflective sheeting in accordance with ASTM D 4956, current version, Table 13.

701.2.2.1.2 Coefficient of Retroreflection
Provide sign sheeting with a coefficient of retroreflection, expressed as Specific Intensity per unit area, or average candlepower per foot-candle per square foot. Ensure the intensity values meet at least the minimum values at 0.2° and 0.5° observation (divergence) angles, and, when specified in the Contract, at least the minimum values at 0.1° and/or 1.0° observation angles. Ensure intensity values are in accordance with Table 701.2.2.1.2:1, “Type III Sheeting—Encapsulated Lens, High Intensity,” Table 701.2.2.1.2:2, “Type IV Sheeting—Unmetallized Microprismatic Element,” Table 701.2.2.1.2:3, “Type V Sheeting—Metallized Microprismatic Element,” Table 701.2.2.1.2:4, “Type VII Sheeting—Microprismatic Lens,” Table 701.2.2.1.2:5, “Type VIII Sheeting—Microprismatic Lens,” Table 701.2.2.1.2:6, “Type VIII F Sheeting—Fluorescent Microprismatic Lens,” Table 701.2.2.1.2:7, “Type IX Sheeting—Microprismatic Lens,” and Table 701.2.2.1.2:8, “Type IX F Sheeting—Fluorescent Microprismatic Element.” Conduct testing methods in accordance with ASTM E 810.
### Table 701.2.2.1.2:1
**Type III Sheeting—Encapsulated Lens, High Intensity**

<table>
<thead>
<tr>
<th>OA</th>
<th>EA</th>
<th>White</th>
<th>Orange</th>
<th>Yellow</th>
<th>Red</th>
<th>Green</th>
<th>Blue</th>
<th>Brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>-4</td>
<td>250.0</td>
<td>100.0</td>
<td>170.0</td>
<td>45.0</td>
<td>45.0</td>
<td>20.0</td>
<td>12.0</td>
</tr>
<tr>
<td>0.2</td>
<td>+30</td>
<td>150.0</td>
<td>60.0</td>
<td>100.0</td>
<td>25.0</td>
<td>25.0</td>
<td>11.0</td>
<td>8.5</td>
</tr>
<tr>
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<td>30.0</td>
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<td>15.0</td>
<td>7.5</td>
<td>5.0</td>
</tr>
<tr>
<td>0.5</td>
<td>+30</td>
<td>65.0</td>
<td>25.0</td>
<td>45.0</td>
<td>10.0</td>
<td>10.0</td>
<td>5.0</td>
<td>3.5</td>
</tr>
</tbody>
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### Table 701.2.2.1.2:2
**Type IV Sheeting—Unmetallized Microprismatic Element**

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<th>White</th>
<th>Orange</th>
<th>Yellow</th>
<th>Red</th>
<th>Green</th>
<th>Fluorescent Yellow-Green</th>
<th>Fluorescent Yellow</th>
<th>Fluorescent Orange</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>-4</td>
<td>360</td>
<td>270</td>
<td>145</td>
<td>65</td>
<td>50</td>
<td>30</td>
<td>18</td>
<td>290</td>
</tr>
<tr>
<td>0.2</td>
<td>+30</td>
<td>170</td>
<td>135</td>
<td>68</td>
<td>30</td>
<td>25</td>
<td>14</td>
<td>8.5</td>
<td>135</td>
</tr>
<tr>
<td>0.5</td>
<td>-4</td>
<td>150</td>
<td>110</td>
<td>60</td>
<td>27</td>
<td>21</td>
<td>13</td>
<td>7.5</td>
<td>120</td>
</tr>
<tr>
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<td>+30</td>
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<td>54</td>
<td>28</td>
<td>13</td>
<td>10</td>
<td>6</td>
<td>3.5</td>
<td>55</td>
</tr>
</tbody>
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### Table 701.2.2.1.2:3
**Type V Sheeting—Metallized Microprismatic Element**

<table>
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<tr>
<th>OA</th>
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<th>White</th>
<th>Orange</th>
<th>Yellow</th>
<th>Red</th>
<th>Green</th>
<th>Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>-4</td>
<td>700.0</td>
<td>280.0</td>
<td>470.0</td>
<td>120.0</td>
<td>120.0</td>
<td>56.0</td>
</tr>
<tr>
<td>0.2</td>
<td>+30</td>
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<td>270.0</td>
<td>72.0</td>
<td>72.0</td>
<td>32.0</td>
</tr>
<tr>
<td>0.5</td>
<td>-4</td>
<td>160.0</td>
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<td>110.0</td>
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<td>28.0</td>
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### Table 701.2.2.1.2:4
**Type VII Sheeting—Microprismatic Lens**

<table>
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<th>Red</th>
<th>Green</th>
<th>Fluorescent Orange</th>
</tr>
</thead>
<tbody>
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<td>375</td>
<td>750</td>
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<td>100</td>
<td>45</td>
</tr>
<tr>
<td>0.1</td>
<td>+30</td>
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<td>430</td>
<td>115</td>
<td>57</td>
<td>26</td>
</tr>
<tr>
<td>0.2</td>
<td>-4</td>
<td>750</td>
<td>280</td>
<td>560</td>
<td>150</td>
<td>75</td>
<td>34</td>
</tr>
<tr>
<td>0.2</td>
<td>+30</td>
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<td>160</td>
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<td>43</td>
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<tr>
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<td>240</td>
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<td>180</td>
<td>48</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
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<td>+30</td>
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<td>27</td>
<td>14</td>
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### Table 701.2.2.1.2:5
Type VIII Sheeting—Microprismatic Lens

<table>
<thead>
<tr>
<th>OA</th>
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<th>White</th>
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<th>Yellow</th>
<th>Red</th>
<th>Green</th>
<th>Blue</th>
<th>Brow</th>
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</thead>
<tbody>
<tr>
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<td>750</td>
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<td>30</td>
</tr>
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<td>14</td>
</tr>
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<td>525</td>
<td>105</td>
<td>70</td>
<td>42</td>
<td>21</td>
</tr>
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<td>245</td>
<td>49</td>
<td>33</td>
<td>20</td>
<td>10</td>
</tr>
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<tr>
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<td>86</td>
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<td>12</td>
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### Table 701.2.2.1.2:6
Type VIII F Sheeting—Fluorescent Microprismatic Lens

<table>
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<th>OA</th>
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<th>Yellow</th>
<th>Yellow-Green</th>
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<td>0.1</td>
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<td>880</td>
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<td>120</td>
<td>280</td>
<td>360</td>
</tr>
<tr>
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<td>200</td>
<td>405</td>
<td>520</td>
</tr>
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</tr>
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<td>90</td>
<td>115</td>
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### Table 701.2.2.1.2:7
Type IX Sheeting—Microprismatic Lens

<table>
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<th>Red</th>
<th>Green</th>
<th>Blue</th>
</tr>
</thead>
<tbody>
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<td>130</td>
<td>66</td>
<td>30</td>
</tr>
<tr>
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<td>+30</td>
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<td>140</td>
<td>280</td>
<td>74</td>
<td>37</td>
<td>17</td>
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<td>—</td>
<td>90</td>
<td>24</td>
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</tr>
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<td>76</td>
<td>38</td>
<td>17</td>
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<td>22</td>
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<td>+45</td>
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<td>—</td>
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<td>26</td>
<td>9.8</td>
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<td>240</td>
<td>90</td>
<td>180</td>
<td>48</td>
<td>24</td>
<td>11</td>
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<td>50</td>
<td>100</td>
<td>27</td>
<td>14</td>
<td>6.0</td>
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<td>—</td>
<td>27</td>
<td>10</td>
<td>3.5</td>
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<td>17</td>
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<td>9.0</td>
<td>4.5</td>
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<tr>
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<td>+45</td>
<td>10</td>
<td>—</td>
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### Table 701.2.2.1.2:8
Type IX F Sheeting—Fluorescent Microprismatic Element

<table>
<thead>
<tr>
<th>OA</th>
<th>Rotation Angle (°)</th>
<th>EA</th>
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<th>Yellow/Green</th>
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</thead>
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<td>420</td>
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</tr>
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<td>300</td>
<td>465</td>
</tr>
<tr>
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<td>0</td>
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<td>30</td>
</tr>
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<td>0.1</td>
<td>90</td>
<td>-4</td>
<td>380</td>
<td>525</td>
</tr>
<tr>
<td>0.1</td>
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<td>+30</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>0.1</td>
<td>90</td>
<td>+45</td>
<td>115</td>
<td>160</td>
</tr>
<tr>
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<td>0</td>
<td>-4</td>
<td>280</td>
<td>375</td>
</tr>
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<td>0</td>
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<td>225</td>
</tr>
<tr>
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<td>+45</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
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<td>-4</td>
<td>200</td>
<td>275</td>
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<tr>
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<td>+30</td>
<td>130</td>
<td>180</td>
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Table 701.2.2.1.2:8

<table>
<thead>
<tr>
<th>OA</th>
<th>Rotation Angle (°)</th>
<th>EA</th>
<th>Minimum reflectivity (average candle power per foot candle per square foot)</th>
<th>Yellow</th>
<th>Yellow/Green</th>
</tr>
</thead>
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<tr>
<td>0.5</td>
<td>0</td>
<td>-4</td>
<td>160</td>
<td>225</td>
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</tr>
<tr>
<td>0.5</td>
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<td>+30</td>
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<td>0</td>
<td>+45</td>
<td>5</td>
<td>7</td>
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</tr>
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<td>-4</td>
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<td>250</td>
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<td>50</td>
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<td>25</td>
<td></td>
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<td>+45</td>
<td>9</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

701.2.2.1.3 Retroreflective Sheeting Backing

Provide backing for sheeting Types III through IX in accordance with ASTM D 4956, current version.

701.2.2.1.4 Retroreflective Sheeting Durability and Workmanship

Use retroreflective sheeting Material in accordance with ASTM D 4956, current version. Provide sheeting Material sufficiently strong and flexible enough for handling, processing, and application in accordance with the manufacturer’s recommendations without stretching.

When processed and applied in accordance with recommended procedures, sheeting Material must be weather resistant and, following cleaning, must show no discoloration, cracking, blistering, or dimensional change.

When exposed to normal traffic and weather, sheeting Material must not support fungus growth or accumulate dirt that reduce brightness before cleaning to less than 75% of the brightness after cleaning, measured at 0.2° divergence and -4° incidence.

Use a sheeting surface that can be refurbished by cleaning and clear overcoating in accordance with manufacturer’s recommendations.

Apply retroreflective sheeting to a treated substrate, as recommended by the manufacturer. Ensure that layers of paint and sealer are dry before applying succeeding coats and before packaging. Ensure finished signs have a smooth and uniform surface and that letters and numbers are clean-cut and sharp.

Ensure the sheeting surface is solvent resistant and can be cleaned with a soft, clean cloth dampened with VM & P naphtha or mineral spirits.

701.2.2.1.5 Retroreflective Sheeting Delivery and Handling

If the Contractor provides retroreflective sheeting in continuous rolls, the Contractor shall ensure splices are smooth with no discernible lines and that sheeting is suitable for continuous application.

Use sheeting within the manufacturer’s recommended time frame.

701.2.2.1.6 Multiple Pieces of Sign Sheeting

Ensure that sign faces from two or more pieces of retroreflective sheeting match in color and provide uniform appearance and brilliance by day and night.

Cover sign panels less than 48 in tall with one unspliced sheet of retroreflective sheeting. The Department will allow a horizontal splice, only if the substrate panel is 48 in or taller. Ensure sheet colors match, and lap the top sheet over the bottom sheet by at least 0.5 in. Do not splice sheets vertically.

701.2.2.1.7 Screening Inks and Process Paste

The Department will allow use of screening inks, process pastes, or film overlays recommended by the retroreflective sheeting manufacturer, instead of manufactured colors to produce the legend and background. Submit the manufacturer’s recommendations, in writing,
to the Department. File a copy of the recommendations in accordance with Section 701.2.1.1, “Sign Manufacturer’s Quality Control.” Use only green, blue, red, brown, and black.

Use ultraviolet (UV) resistant inks requiring no additional clear coating or UV protection. Use inks that are one part non-isocynate Material, easily removed from sign screens with citrus-based environmentally friendly screen cleaning solvents.

701.2.2.1.7.1 Outdoor Weatherability
Use screening inks, process pastes, or film overlays with weather-resistant properties equal to retroreflective sheeting.

701.2.2.1.7.2 Adherence
To test for screening ink, process paste, or film overlay adherence, apply cellophane tape to a cured color processed area, and remove the tape with one quick motion; no ink, paste, or film overlay should come off. Use 3/4 in wide 3M Company Scotch Brand Cellophane Tape No. 600, or approved equal for this test.

701.2.2.1.7.3 Solvent Resistance
After curing, ensure sign faces resist manufacturer recommended cleaning solvents.

701.2.2.1.7.4 Vandal Resistance
Ensure that sign faces resist manufacturer recommended aromatic solvents used to remove paint or other oil based matter sprayed or painted on signs.

701.2.2.1.7.5 Color
Use a sign face color in accordance with ASTM D 4956, current version.

701.2.2.1.7.6 Retroreflective Intensity (Transparent Colors)
Process and apply transparent colored inks or transparent colored film overlays in accordance with the sheeting manufacturer’s recommendations.

Ensure that the transparent color area processed on white sheeting provides a minimum retroreflective intensity value of at least 70% of the values specified in Table 701.2.2.1.2:1, “Type III Sheetling—Encapsulated Lens, High Intensity,” Table 701.2.2.1.2:2, “Type IV Sheetling—Unmetallized Microprismatic Element,” Table 701.2.2.1.2:3, “Type V Sheetling—Metallized Microprismatic Element,” Table 701.2.2.1.2:4, “Type VII Sheetling—Microprismatic Lens,” Table 701.2.2.1.2:5, “Type VIII Sheetling—Microprismatic Lens,” Table 701.2.2.1.2:6, “Type VIII F Sheetling—Fluorescent Microprismatic Lens,” Table 701.2.2.1.2:7, “Type IX Sheetling—Microprismatic Lens,” and Table 701.2.2.1.2:8, “Type IX F Sheetling—Fluorescent Microprismatic Element,” for each color at 0.2° OA and -4° EA (or 0.1° and/or 1.0° observation angles if, specified in the Contract).

701.2.2.1.7.7 Process Colors on Sheetling
Ensure the retroreflective intensity values are 70% of the retroreflective values specified in Table 701.2.2.1.7.8:1, “Retroreflective Intensity per Process Color.” Corresponding values at 0.2° OA and -4° EA are included in Table 701.2.2.1.7.8:1, “Retroreflective Intensity per Process Color.”

701.2.2.1.7.8 Process Inks
Ensure that process inks equal 70% of the coefficient of retroreflection of new sheeting and 70% at the end of the warranty period.
Table 701.2.2.1.7.8:1
Retroreflective Intensity per Process Color

<table>
<thead>
<tr>
<th>Type of sheeting</th>
<th>Intensity Value (average candelas per foot candle per square foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type III Encapsulated Lens Sheeting High Intensity</td>
<td>31.5 14.0 31.5</td>
</tr>
<tr>
<td>Type IV Unmetallized Microprismatic Element</td>
<td>24.5 14.0 24.5</td>
</tr>
<tr>
<td>Type V Metallized Microprismatic Element</td>
<td>84 39.2 84</td>
</tr>
<tr>
<td>Type VII Microprismatic Element</td>
<td>105 23.8 52.5</td>
</tr>
<tr>
<td>Type VIII Microprismatic Element</td>
<td>73.5 29.4 49</td>
</tr>
<tr>
<td>Type IX Microprismatic Element</td>
<td>53.2 11.9 26.6</td>
</tr>
</tbody>
</table>

701.2.2.2 Sign Legends and Sheeting

A sign legend shall contain such letters, numerals, symbols, arrows, borders, and other accessories that convey the sign's message.

Provide white Type III Sheeting-Encapsulated Lens (High Intensity) or better retroreflective sheeting for sign legends in accordance with Section 701.2.2.1, “Retroreflective Sheetings.”

The Department will only permit reverse screening on sign faces larger than 9 ft², if the Contractor uses Type III sheeting as the base Material. Apply the legends edge sealed, reverse screened, clear coated, and finished, as recommended by the reflective sheeting manufacturer.

Provide extruded panel signs with borders as follows:

1. 1 1/8 in wide with 6 in corner radii for signs under 6 ft tall;
2. 2 in wide with 9 in corner radii for signs from 6 ft to 7.5 ft tall; or
3. 3 in wide with 12 in corner radii for signs over 7.5 ft tall.

701.2.2.3 Sign Backgrounds

Provide a sign face with a plane surface free from defects. The Department may reject the entire sign face because of a defect or because of a dirty, marred, or defective background or legend. The Department will inspect in place signs at night for compliance.

Surface sign backgrounds with a minimum of Type III Sheeting-Encapsulated Lens (High Intensity).

701.2.2.4 Aluminum Panel Signs

Use 0.08 in minimum thickness 6061-T6 or 5052-H38 aluminum alloy for signs 24 in wide or less. Use 1/8 in minimum thickness 6061-T6 or 5052-H38 aluminum alloy for signs wider than 24 in.

Provide aluminum alloys in accordance with ASTM B 209. Supply as flat stock Material. Provide aluminum panel signs with smooth edges and corners.

701.2.2.4.1 Corners

Cut corner radii in accordance with the FHWA Standard Highway Signs manual.

701.2.2.4.2 Aluminum Sign Substrate

Prepare aluminum sign substrate for retroreflective sheeting as specified by the sheeting Material manufacturer. Apply sheeting, legend, and clear coat in accordance with the manufacturer’s recommendations. Keep a copy of the manufacturer’s recommendations on file as specified in Section 701.2.1.1, “Sign Manufacturer’s Quality Control.”

Punch or drill a hole in the aluminum sign panel to receive tamper proof hardware.
701.2.2.5 Extruded Panel Signs

Use extrusion-type signs, if mounted on steel I-Beam posts or on overhead sign Structures.

701.2.2.5.1 Aluminum Extrusions

Use 6063-T6 aluminum alloy in accordance with ASTM B 221, provided in 12 in or 6 in sections in accordance with the Contract.

701.2.2.5.2 Metal Panel Fabrication

Cover extrusion-type signs with a metal facing panel of the same metal as the extrusions.

The flatness tolerance for an installed panel is 1/32 in per foot of length and 0.004 in per inch of width.

For metal facing panels, use panel units 2 ft to 4 ft wide, installed vertically. Do not horizontally splice metal facing sign panels 8 ft tall or less.

For horizontal splices on signs taller than 8 ft, offset the metal facing splices from the corresponding extrusion joint by 1/2 in to 1 in.

For aluminum facing panels, use a sheet of aluminum 6061-T6 or 5052-H38 alloy in accordance with ASTM B 209, supplied as flat stock Material with a minimum thickness of 0.060 in.

701.2.2.5.3 Extrusion Hardware

Use 2024-T4 aluminum alloy extrusions for hardware with an alumilite or alodine finish, in accordance with ASTM B 221.

701.2.2.6 Inspection

The Department may inspect Material and finished signs before and after installation at the project site.

Ensure that the Department has free entry to plant areas involved in sign manufacture and production during work hours. Provide adequate facilities for the Department to inspect signs and verify the manufacturer’s QC program.

On request, provide 12 in × 12 in test panels representing each production stage to the Inspector. Produce the test panels during regular production in the presence of the Inspector. If the Inspector cannot validate that the test panel came from regular production, provide a complete sign, upon request.

701.2.2.7 Packaging and Shipping

Package and protect signs and hardware for shipment and storage.

701.2.3 Field Overlay Panels for Existing Extruded Signs

Provide retroreflective sheeting overlay panels that consist of a retroreflectorized face sheet fastened over an existing extruded sign.

For the face sheet use:

1. 6061-T6 or 5052-H38 aluminum sheet alloy, in accordance with ASTM B 209, a minimum of 0.060 in thick with Type III sheeting backgrounds applied; or
2. Type III sheeting with an integral, semi-rigid, aluminum alloy backing, a minimum of 0.005 in thick. Use Type III for legends.

Install retroreflective sheeting field overlays in accordance with Section 701.2.2.2, “Sign Legends and Sheeting.” Remove and repair the existing legend, as directed by the Project Manager.

701.2.4 Sign Structures and Hardware

Select aluminum panel sign and base posts from the Department’s Approved Products List. Install posts in accordance with NCHRP Report 350 criteria for single and multiple-post installations, and with the post manufacturer’s wind load chart. Supply Certificates of Compliance to the Project Manager.

Use one of the following finishes:

1. Hot dipped galvanizing in accordance with ASTM A 653 or ASTM A 123; or
2. Hot dip galvanized zinc coating, in accordance with AASHTO M 120, followed by a chromate conversion coating and a cross-linked polyurethane acrylic exterior coating; or
3. Color No. 17038 black paint or Color No. 14109 green paint for U-channel posts.
Provide paint in accordance with Federal Standard 595a, a minimum of 1 mil thick.

701.2.4.1 Post Assembly Hardware
Use post assembly hardware that is:
1. Hot dipped galvanized or cadmium plated in accordance with ASTM B766-86;
2. Stainless steel; or
3. Mechanically galvanized in accordance with ASTM B545 (Class Fe/Sn 20).

701.2.4.2 Fasteners
Use size M8 tamper-proof carriage bolts to attach signs that are:
1. Hot dipped galvanized, or cadmium plated in accordance with ASTM B766-86;
2. Stainless steel; or
3. Mechanically galvanized in accordance with ASTM B 545 (Class Fe/Sn 20).
The Contractor may use rivets to attach signs. Follow manufacturer’s recommendations for installation procedures.
Use size M8 tamper-proof nuts fabricated from C 1008 hot rolled steel, case hardened to R55-60, and plated with zinc yellow dichromate, from 0.002 in to 0.005 in thick.

701.2.4.3 I-Beam Posts
Fabricate I-beam posts for extruded panel signs from standard structural steel shapes in accordance with ASTM A 36. Use one of the following finishes:
1. Hot dipped galvanizing in accordance with the requirements of ASTM A 123;
2. Cold galvanizing in accordance with the fabrication method approved by the Traffic Services Engineer; or
3. Coating in accordance with Section 545, “Protective Coating of Miscellaneous Structural Steel.”
Use I-beam posts with fuse plate mechanisms.

701.2.4.4 Overhead Sign Structures
Fabricate overhead sign Structures as specified in the Contract.

701.2.4.5 Breakaway Base Systems
Use Type I Breakaway base systems that include slip-type connection, hardware, and stub post as specified in the Contract.

701.2.4.6 Fabrication
701.2.4.6.1 Shop Drawing Submittals & Review
Submit detailed overhead sign Structure shop drawings for approval before fabrication. The Department will review overhead sign Structure shop drawings. Do not erect the signs until obtaining approval.

701.2.4.6.2 General Fabrication Requirements
Ensure arrangement, letter spacing and height, letter series, symbols, and borders for each sign face are in accordance with the FHWA Standard Highway Signs manual.
Shear, blank, saw, or mill Material 1/2 in thick or less. Saw or mill Material over 1/2 in thick.
Ensure that cut edges are true, smooth, and free from excessive burrs or ragged breaks.
Fillet re-entrant cuts by drilling before cutting. Flame cutting is prohibited.
Drill bolt holes to finish sizes.
Shop assemble metal extrusions, facing panels, and legend items. Ensure that facing panels are tightly butted together.
Use additional fasteners, as needed, to achieve flatness, but do not exceed 8 fasteners per facing panel. Do not field assemble these items.
The Contractor may deliver assembled signs more than 8 ft high in two parts.

701.2.4.6.3 Fabrication Requirements for Contact Surfaces
Use galvanized or stainless steel for surfaces in contact with aluminum.
Coat aluminum surfaces in contact with concrete or earth with an alkali resistant asphalt paint in accordance with manufacturers recommendation.
701.3 CONSTRUCTION REQUIREMENTS

701.3.1 General
Deliver removed, existing traffic control signs to locations specified in the Contract, or as directed by the Project Manager. Document removals and deliveries in the Traffic Control Diary in accordance with Section 618, “Traffic Control Management.”

701.3.1.1 Installation of Breakaway Sign Posts
Ensure that slope and other Material does not interfere with the proper functioning of installed sign Breakaway systems.

701.3.1.2 Manufacturer Certification Verification
Supply signs with identification on the back as specified in Section 701.2.1.4, “Sign Identification,” that matches the approved sign manufacturer identified by the documentation letter.

Do not install permanent signs until the Project Manager has:
1. Verified that the sign shipment has a manufacturer's checklist; and
2. Given authorization to begin sign installations.

Use the manufacturer for which certification was requested.

701.3.2 Site Storage Requirements
Elevate stored Materials from the ground and surface runoff water. Store signs posts and hardware away from pavement or Shoulder.

701.3.3 Installation Requirements
Compact sign Structure footing foundations and backfill to 95% of maximum density as determined by AASHTO T 99.

Set posts plumb. Ensure that the mounting faces of multiple sign posts lie in the same plane.

701.3.4 Electrical Components
Provide and install electrical components such as light fixtures, lamps, ballasts, wires, conduit, junction boxes, and other items necessary to mount and operate the electrical system, in accordance with Section 716.2.4, “Sign Luminaire.”

701.3.5 Removing and Resetting Traffic Signs
Remove existing traffic signs, posts, and associated appurtenances from specified locations and reset on new posts with new hardware redesigned for existing conditions, in accordance with Section 618, “Traffic Control Management.”

Before removing existing signs, submit a sign removal and resetting schedule to the Project Manager for approval.

701.3.5.1 Removing and Resetting Extruded Panel Signs
Remove specified existing extruded panel signs, I-beam posts, and footing, and dispose of the materials in an environmentally acceptable manner. Stockpile removed I-beam posts at locations specified in the Contract. Reset removed extruded panel signs on new I-beam posts and Breakaway base systems using new hardware in accordance with Section 701.2.4.3, “I-Beam Posts,” and Section 701.2.4.5, “Breakaway Base Systems.” Design new I-beam posts, new Breakaway base systems, and new hardware for existing conditions in accordance with the manufacturer's recommendations and as specified in the Contract.

Backfill holes left by the removal of I-beam post footings and compact in accordance with Section 203, “Excavation, Borrow, and Embankment.”

701.3.6 Mileposts Installation
Notify the Project Manager two weeks before placing mileposts; the District Traffic Engineer will mark the milepost locations.

701.4 METHOD OF MEASUREMENT
The Department will not measure that portion of Steel I-Beam Posts extending below ground level.

The Department will not include stub post lengths in the measurement of Steel I-Beam Post lengths.
### 701.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extruded Panel Signs</td>
<td>Square Foot</td>
</tr>
<tr>
<td>Panel Signs</td>
<td>Square Foot</td>
</tr>
<tr>
<td>Overhead Sign Structure, _____ Type, _____ Size</td>
<td>Each</td>
</tr>
<tr>
<td>Steel I-Beam Posts</td>
<td>Foot</td>
</tr>
<tr>
<td>Breakaway Base System for Steel I Beam Post</td>
<td>Each</td>
</tr>
<tr>
<td>Steel Posts &amp; Base Posts for Aluminum Panel Signs</td>
<td>Foot</td>
</tr>
<tr>
<td>Retroreflective Sheeting Field Overlay Panels</td>
<td>Foot</td>
</tr>
<tr>
<td>Remove and Reset Traffic Sign</td>
<td>Each</td>
</tr>
<tr>
<td>Remove and Reset Panel Sign</td>
<td>Each</td>
</tr>
<tr>
<td>Remove and Reset Extruded Panel Sign</td>
<td>Each</td>
</tr>
</tbody>
</table>

#### 701.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:

- A. Hardware;
- B. Excavation, backfill, and compaction for sign installation and/or removal;
- C. Reinforcing steel;
- D. Concrete;
- E. Hauling of removals; and
- F. Protective coatings.
SECTION 702: CONSTRUCTION TRAFFIC CONTROL DEVICES

702.1 DESCRIPTION
This Work consists of providing and installing construction traffic control devices.

702.2 MATERIALS

702.2.1 Construction Signing
Provide sign substrate sufficiently durable to last the project duration and rigid enough to hold the sheeting flat.

Provide Materials in accordance with Section 701.2.2.1, “Retroreflective Sheeting,” Section 701.2.2.2, “Sign Legends and Sheeting,” and Section 701.2.2.3, “Sign Backgrounds.”

Provide Type III or greater intensity retroreflective sheeting for legends and sign backgrounds, unless otherwise specified in the Contract.

Use black letters on a reflective orange background for construction signing, unless otherwise specified in the Contract.

702.2.1.1 Steel Posts and Base Posts for Construction Signing
Provide steel post and base post Material in accordance with Section 701.2.4, “Sign Structures and Hardware.”

702.2.1.2 Portable Sign Supports
Provide portable sign supports in accordance with the MUTCD and the Department’s Approved Products List.

702.2.2 Barricades and Channelization Devices
Provide traffic control devices in accordance with the Department’s Approved Products List for barricades and channelization devices, available from the State Maintenance Bureau.

Suppliers proposing traffic control devices for inclusion on the Department's Approved Products List must submit product certifications for approval. The Department will review and approve or deny the proposed certifications within 30 Days.

Unless stated otherwise, submit, to the Project Manager, certification from the manufacturer stating that the traffic control devices proposed for use are in accordance with NCHRP Report 350. Submit certification showing that the proposed traffic control devices are listed on the Department's Approved Products List.

Use traffic control devices from the following categories:

1. Category I Traffic Control Devices. Low mass, single piece traffic cones; tubular markers; single-piece drums; delineators; or similar devices without lights or signs.
2. Category II Traffic Control Devices. Vertical panels; Type I, II, and III barricades; moveable skid mounted sign stands; or similar devices.

702.2.2.1 Barricades
Use reflectorized barricades with orange and white retroreflective sheeting or tape in accordance with the MUTCD and Table 701.2.2.1.2.1, “Type III Sheeting—Encapsulated Lens, High Intensity,” Table 701.2.2.1.2.2, “Type IV Sheeting—Unmetallized Microprismatic Element,” and Table 701.2.2.1.2.3, “Type V Sheeting—Metallized Microprismatic Element.”

702.2.2.2 Vertical Panels
Use reflectorized vertical panels with orange and white retroreflective sheeting or tape in accordance with the MUTCD and Table 701.2.2.1.2.1, “Type III Sheeting—Encapsulated Lens, High Intensity,” Table 701.2.2.1.2.2, “Type IV Sheeting—Unmetallized Microprismatic Element,” and Table 701.2.2.1.2.3, “Type V Sheeting—Metallized Microprismatic Element.”

702.2.2.3 Traffic Markers
Provide traffic marker Materials in accordance with Section 703, “Traffic Markers.”

702.2.2.4 Drums
Provide non-metal drums in accordance with the MUTCD and as approved by the Project Manager. Use only one size drum on the project.

Use reflectorized drums with orange and white high-performance retroreflective sheeting or tape. Use horizontal, circumferential, orange and white reflectorized stripes from 4 in to 6 in wide for drum marking. Ensure the number of alternating orange and white reflectorized
stripes and the amount of non-reflective drum surface space is in accordance with the MUTCD.

Provide drums that are a minimum 36 in high and 18 in diameter with a closed top, and either a sand-ballasted, preformed rubberized, or tire sidewall-collared base, in accordance with the manufacturer’s recommendations.

702.2.2.4.1 Warning Lights
Provide either Type “A” low intensity, Type “B” high intensity, or Type “C” steady-burn warning lights in accordance with the MUTCD.

702.2.2.4.2 Flexible High-Performance Reflective Sheeting
Provide retroreflective sheeting and adhesive Materials in accordance with Section 701, “Traffic Signs and Sign Structures,” except provide Type III or greater intensity retroreflective sheeting.

Provide sheeting with a pre-coated adhesive protected by a removable liner. Apply to channelization devices in accordance with manufacturer’s recommendations.

702.2.2.4.2.1 Sheeting Flexibility
Use sheeting that does not exhibit cracking when bent around a 1/8 in mandrel in one second, after conditioning for 24 h at 32 °F with the liner removed. Test by spreading talcum powder on adhesive and bending with the adhesive side contacting the mandrel.

702.2.2.4.2.2 Adhesive
Provide pressure sensitive adhesives for use on substrates, other than plasticized PVC, in accordance with Section 701.2.2.1, “Retroreflective Sheeting.”

702.2.2.4.2.3 Adhesive Backing Testing
Test pressure sensitive adhesive backing on flexible high performance sheeting in accordance with FHWA Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects (FP-96), Section 718. Backing adhesive must support a 1 3/4 lb weight for 5 min without peeling away more than 1 in if applied to a smooth aluminum surface.

702.2.2.4.2.4 Reflectivity
Provide flexible high-performance sheeting that meets or exceeds the minimum reflectivity requirements in Table 702.2.2.4.2.4:1, “Flexible High-Performance Sheeting, Type III.”

<table>
<thead>
<tr>
<th>OA</th>
<th>EA</th>
<th>Minimum reflective intensity (candlepower per foot-candle per square foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>White</td>
</tr>
<tr>
<td>0.2</td>
<td>-4</td>
<td>250</td>
</tr>
<tr>
<td>0.2</td>
<td>30</td>
<td>150</td>
</tr>
<tr>
<td>0.2</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>0.5</td>
<td>-4</td>
<td>95</td>
</tr>
<tr>
<td>0.5</td>
<td>30</td>
<td>65</td>
</tr>
<tr>
<td>0.5</td>
<td>50</td>
<td>35</td>
</tr>
</tbody>
</table>

702.2.2.5 Traffic Cones
Provide traffic cones in accordance with the MUTCD and having a flexible cone (above the base) with an outer section made of a highly pigmented fluorescent orange polyvinyl compound.

Provide cones at least 28 in tall weighing at least 10 lb with a base alone weighing 7 lb, with a distribution of cone weight effectively holding the traffic cones upright under traffic conditions.

702.2.3 Sequential Arrow Displays
Use a sequential arrow display consisting of a sign panel assembly and a power source. Mount the display on a two-wheeled trailer or on a vehicle for mobile operations. Provide a sequential arrow display in accordance with the MUTCD specifications for arrow displays.
Use Type B panels for mobile operations and Type C panels for stationary traffic control. Provide a trailer in accordance with Section 702.2.4.5, “Trailer.” Provide a display powered by diesel or solar power or one that connects to an external power supply. Ensure electrical connections meet or exceed the applicable electrical code requirements. Provide solar-powered systems with a battery-backup power supply capable of maintaining operation for a minimum of 12 consecutive 24-hour days.

702.2.3.1 Operating Modes
Ensure that displays are capable of the following operating modes (see the MUTCD specifications for advance warning arrow display):
1. Pass Left—Three chevrons of five lamps each sequencing right-to-left;
2. Pass Right—Three chevrons of five lamps each sequencing left-to-right;
3. Pass Either Side—Two outermost chevrons on each end of the panel pointing outward forming arrowheads with crossing lamp rows burning continuously. Do not burn the first lamp directly behind the point of each arrow, to define the arrow points;
4. Caution—Four lamps, one at each corner of the panel.

702.2.4 Portable Changeable Message Signs
Portable changeable message signs will consist of a sign panel assembly, controller, power supply, and structural support system mounted on a two-wheeled trailer. Supply new portable changeable message signs if the Contract specifies that the Department will retain the message signs upon final acceptance.

702.2.4.1 Sign Panel Assembly
Provide a sign panel consisting of a three-line panel assembly. Ensure that each line contains eight matrices capable of producing at least eight individually changeable characters. Ensure that each character module uses, as a minimum, a five-wide pixel by seven-high pixel matrix, with each matrix measuring at least 18 in high and 9 in wide.
Ensure a clearly displayed message on the sign panel from a distance of 800 ft during daytime and nighttime operation at angles that maintain legibility in accordance with the MUTCD specifications for portable changeable message signs.

702.2.4.2 Controller
Provide a compact controller located to allow easy access to sign and message functions from a control cabinet on the trailer.
Provide a solid-state unit controller capable of generating and storing sign messages. Provide a controller keyboard that allows the user to recall and use messages from permanent memory storage containing a library of standard messages. The controller will also have the capacity to store, recall, and use at least 50 additional messages generated by the operator.
Use a controller with a protective device that requires an entry code to access the memory and display messages to prevent unauthorized programming.

702.2.4.3 Power Supply
Provide a power unit capable of powering the message sign continuously for at least 21 consecutive 24-hour days, with a fail-safe backup power supply system, and capable of being powered directly by a 120 V AC external power supply.

702.2.4.4 Structural Support Systems
Provide a structural support system with a mechanism capable of raising and lowering the sign panel at sustained wind speeds of 55 mph, and capable of operation by one person without use of heavy equipment. Ensure a clearance of at least 7 ft between the sign panel bottom and the pavement surface, when fully raised.

702.2.4.5 Trailer
Use a two-wheel single-axle system trailer with a suspension rated at no less than 2,000 lb.
Provide a trailer equipped with the following:
1. Four non-removable leveling jacks, one at each corner of the trailer,
2. A tongue and either a towing eye, for use with the pintle hook, or a ball receptacle, for a ball-type trailer hitch. Fabricate a 2 1/2 in inside diameter towing eye from 1 in
round, solid steel. Size the ball receptacle to accept a standard 2 in ball;
3. Two safety chains with 1/4 in diameter links. Install one chain on each side of the draw bar and extend 24 in beyond the towing eye. Install a safety hook on the outer end of each chain;
4. Two combination tail, turn, and stop lights;
5. A license plate bracket and illumination lamp;
6. A standard SAE seven-way trailer light wire connector on a cable extending 24 in beyond the towing eye;
7. A means of securing a receptacle on the trailer tongue.

702.2.5 Temporary Signal Span
Provide poles and associated electrical items for temporary signal spans in accordance with Section 715, “Beacons and Temporary Signal Equipment.”

702.3 CONSTRUCTION REQUIREMENTS
702.3.1 General
Provide construction traffic control devices in accordance with MUTCD and NCHRP Report 350. Construction traffic control devices shall remain the property of the Contractor, unless otherwise specified in the Contract.
Install signs, steel posts, and base posts in accordance with the requirements of Section 701, “Traffic Signs and Sign Structures.” Provide drums equipped with Type “C” steady-burn warning lights on channelization tapers, if in night operation.
Install traffic markers in accordance with the requirements of Section 703, “Traffic Markers.”
Use Type A or Type B flashing warning lights and flags to call attention to advance warning construction signing.

702.3.1.1 Portable Sign Support System
Provide portable sign support systems from the Department's Approved Products List.

702.3.1.2 Temporary Signal Spans
Use temporary signal spans consisting of poles and associated electrical items in accordance with Section 715, “Beacons and Temporary Signal Equipment.”
Remove temporary signal spans after project detours are removed, or as directed by the Project Manager.

702.3.2 Maintenance
Maintain the traffic control plan and devices in accordance with Section 618, “Traffic Control Management.”
The Department will assess liquidated damages at a rate of $500 a day for each Day or portion of a Day a message board does not function.

702.3.3 Traffic Cones
Keep traffic cones clean so that the intended visibility is not diminished. Cone condition is subject to the Project Manager's approval.
Use cones only during daylight hours. Do not attach warning lights to traffic cones.
If approved by the Project Manager, use tubular traffic markers manufactured, installed, and maintained in accordance with Section 703, “Traffic Markers,” instead of traffic cones.

702.4 METHOD OF MEASUREMENT—Vacant

702.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Signing</td>
<td>Square Foot</td>
</tr>
<tr>
<td>Steel Posts and Base Posts for Construction Signing</td>
<td>Foot</td>
</tr>
<tr>
<td>Barricade, Type_____.</td>
<td>Each</td>
</tr>
<tr>
<td>Vertical Panel, Type_.</td>
<td>Each</td>
</tr>
<tr>
<td>Construction Traffic Marker</td>
<td>Each</td>
</tr>
<tr>
<td>Portable Sign Support</td>
<td>Each</td>
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<tr>
<td>Channelization Device, Type_____.</td>
<td>Each</td>
</tr>
<tr>
<td>Sequential Arrow Display</td>
<td>Each</td>
</tr>
</tbody>
</table>

Section 702: Construction Traffic Control Devices
702.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:

A. Supports required for vertical panels and poles, and all associated electrical and mechanical items for temporary signal span;
B. Moving of construction traffic control devices from one location to another, maintenance, and repair or replacement of damaged or destroyed traffic control devices;
C. Additional traffic control device quantities approved and implemented solely for the Contractor's convenience;
D. Type “A” low-intensity warning lights, Type “B” high-intensity warning lights, or Type “C” steady-burn warning lights and signing which are attached to barricades, drums and construction signs.
Section 703: Traffic Markers

703.1 DESCRIPTION
This Work consists of providing and installing traffic markers and appurtenances in accordance with the MUTCD and NCHRP Report 350, as specified in the Contract, or as directed by the Project Manager.

703.2 MATERIALS
703.2.1 Object Markers, Delineator Posts, Tenth-Mile Delineators
Provide posts of shape, dimensions, and tolerances in accordance with the Contract and the Department's Approved Products List.

Punch posts with 3/8 in diameter holes and, unless otherwise specified, ensure a total length of 7 ft ± 1/2 in.

703.2.1.1 Steel Posts
Provide steel posts that:
1. Are rolled from rail or billet steel in accordance with ASTM A 499;
2. Are galvanized in accordance with ASTM A 123, with the Pivoted Hammer Test waived, or painted with a black modified polyester paint meeting the requirements of Federal Standard 595a (Color No. 17038), applied by electro-deposition to a minimum 1-mil thickness;
3. Have a smooth, uniform finish free from defects effecting strength or appearance, whether galvanized or painted; and
4. Have a minimum weight of at least 1.07 lb per foot.

Obtain Project Manager approval of alternate paint colors or application before fabrication.

703.2.1.2 Hardware
Provide hardware that is galvanized or cadmium-plated in accordance with ASTM B 766-86, current version; or mechanically galvanized in accordance with AASHTO M 298, Class 25; or stainless steel.

703.2.2 Reflector Unit
For the reflector unit for object markers and road delineators, provide a methyl methacrylate (acrylic) prismatic reflector with a rustproof or plastic housing of a minimum 0.02 in thickness with a center mounting hole. Expand a metal or plastic grommet with a 3/16 in inside diameter within the reflector-mounting hole.

Provide reflector units in accordance with Table 703.2.2:1, “Specific Intensity Values — Round Reflectors,” or Table 703.2.2:2, “Specific Intensity Values — Rectangular Reflectors,” as applicable.

Provide round reflectors with at least a 3 in diameter and rectangular reflective panels at least 6 in × 12 in.

Table 703.2.2:1
Specific Intensity Values — Round Reflectors

<table>
<thead>
<tr>
<th>OA</th>
<th>EA</th>
<th>Crystal</th>
<th>Amber</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>0.0</td>
<td>119.0</td>
<td>71</td>
</tr>
<tr>
<td>0.1</td>
<td>20.0</td>
<td>47.0</td>
<td>28</td>
</tr>
<tr>
<td>0.33</td>
<td>0.0</td>
<td>26.0</td>
<td>16</td>
</tr>
<tr>
<td>0.33</td>
<td>20.0</td>
<td>13.0</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 703.2.2:2
Specific Intensity Values — Rectangular Reflectors

<table>
<thead>
<tr>
<th>OA</th>
<th>EA (°)</th>
<th>Crystal</th>
<th>Amber</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>20°</td>
<td>40.0</td>
<td>30.0</td>
<td>10.0</td>
</tr>
<tr>
<td>0.2</td>
<td>10°</td>
<td>105.0</td>
<td>75.0</td>
<td>27.0</td>
</tr>
</tbody>
</table>
Table 703.2.2:2
Specific Intensity Values — Rectangular Reflectors

<table>
<thead>
<tr>
<th>OA</th>
<th>EA</th>
<th>Crystal</th>
<th>Amber</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0</td>
<td>125.0</td>
<td>90.0</td>
<td>35.0</td>
</tr>
<tr>
<td>0.2</td>
<td>5°</td>
<td>125.0</td>
<td>90.0</td>
<td>30.0</td>
</tr>
<tr>
<td>0.2</td>
<td>10°</td>
<td>105.0</td>
<td>75.0</td>
<td>30.0</td>
</tr>
<tr>
<td>0.2</td>
<td>20°</td>
<td>85.0</td>
<td>60.0</td>
<td>25.0</td>
</tr>
<tr>
<td>0.2</td>
<td>30°</td>
<td>30.0</td>
<td>30.0</td>
<td>7.0</td>
</tr>
<tr>
<td>0.2</td>
<td>40°</td>
<td>15.0</td>
<td>15.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>

*Indicates off traffic side.
*bIndicates traffic side.

703.2.3 Flexible Traffic Markers

Provide flexible traffic markers that consist of a nonmetallic post with reflective sheeting and a drivable or non-drivable anchor system, as applicable.

Provide posts for flexible traffic markers fabricated from a flexible, nonmetallic Material, resistant to impact, ultraviolet light, ozone, and hydrocarbon damage, and stiffening with age. Provide well-manufactured posts free from burns, discoloration, contamination, and other objectionable marks or defects.

Use white, yellow, brown, or orange for flexible traffic markers, as specified in the Contract. Provide flexible traffic marker posts that are flexible throughout the temperature range of from -38 °F to 150 °F, and provide an installed height of from 18 in to 48 in.

Use self-restoring flexible traffic markers remaining serviceable after being subjected to a series of direct impacts by a standard vehicle. Ensure posts and delineators are capable of withstanding 5 impacts at any angle at a speed of 55 mph and 10 impacts at any angle at a speed of 35 mph.

Provide posts designed for a permanent installation to resist overturning, twisting, and displacement from wind and impact forces.

703.2.3.1 Tubular Flexible Traffic Markers

Provide tubular traffic marker posts and bases of a thermoplastic or pliable elastomer composition meeting the manufacturer’s requirements, with dimensions in accordance with Table 703.2.3.1.1: “Dimension Requirements for Tubular Traffic Markers.”

Provide tubular traffic marker bases painted black, or the same color as the post.

Provide assembly units necessary for the particular marker in accordance with the manufacturer’s recommendations.

<table>
<thead>
<tr>
<th>Description</th>
<th>Dimensions (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside diameter</td>
<td>2.23-4</td>
</tr>
<tr>
<td>Wall thickness, minimum</td>
<td>1/8</td>
</tr>
</tbody>
</table>

703.2.3.2 Flexible Traffic Marker Anchor Systems

Provide preformed steel anchors for drivable reusable anchor systems. If providing tubular anchors, ensure closed bottoms, to prevent soil entrance during driving.

Use non-driveable, pre-drilled systems for direct burial of the post into soil. The Contractor may retain posts with “O” clips (self-locking) for posts in holes 18 in deep. The Department may accept other direct burial methods after local demonstration of their stability.

Provide surface mounted bases with a height of from 1/2 in to 2 in and an outside diameter of from 7 in to 12 in.

Provide drive-down bases with the dimensions listed on the Department’s Approved Products List.

703.2.3.3 Adhesives for Flexible Traffic Markers

Provide epoxy type (permanent installation) or butyl type (temporary installation) adhesives in accordance with the manufacturer’s recommendations.

The Contractor may use other methods, as approved by the Project Manager before the
703.2.3.4 Flexible Traffic Marker Retroreflective Sheeting

Provide flexible traffic markers with two 3 in high pre-applied retroreflective sheeting bands. Begin the bands no more than 2 in from the top, with no more than 6 in between them in the front and back, or around the entire circumference.

Provide pre-applied retroreflective sheeting in accordance with Section 702.2.2, “Barricades and Channelization Devices,” and Table 702.2.2.4.2.4.1, “Flexible High-Performance Sheeting, Type III,” of a color in accordance with the Contract.

703.2.4 Reflective Barrier Delineator

Provide a reflective barrier delineator that consists of an acrylic-plastic shell assembled on a flat plastic base to form a hermetically sealed unit. Ensure that the sloped face contains one prismatic reflective surface to reflect incident light from a single direction.

Provide methyl methacrylate acrylic plastic shells and flat plastic bases in accordance with Federal Specification LP-390C, Type I, Class 3.

703.2.4.1 Reflective Barrier Delineator Adhesive

Provide adhesive capable of fixing delineators for the duration of their intended use. Use primer, as specified by the manufacturer, to prepare the pre-cleaned barrier surface.

703.2.4.2 Reflective Barrier Delineator Configuration

Provide the reflective barrier delineator in accordance with the Contract and Table 703.2.4.2:1, “Requirements for Reflective Barrier Delineator Configuration.”

<table>
<thead>
<tr>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope of reflecting face (degrees)</td>
<td>0–11</td>
</tr>
<tr>
<td>Area of reflecting face, minimum (square inches)</td>
<td>6 1/2</td>
</tr>
</tbody>
</table>

Ensure that the outer shell surface is smooth except for identification markings. Provide a nontransparent (white or light gray) base of the marker with an attached 0.12 in thick pad of pressure sensitive adhesive and a minimum overall height of 2.46 in including the adhesive pad.

703.2.4.3 Reflective Barrier Delineator Optical Requirements

When the reflective barrier delineator is mounted with its base flat against a vertical surface with the leading edge of the delineator perpendicular to the horizontal plane, ensure the Specific Intensity in accordance with Table 703.2.4.3:1, “Specific Intensity Values Reflective Barrier Delineator.” Ensure the Specific Intensity for yellow delineators of at least 60% of the value for crystal reflecting surface.

<table>
<thead>
<tr>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum reflective intensity (candlepower per foot-candle)</td>
<td></td>
</tr>
<tr>
<td>OA</td>
<td>0.1</td>
</tr>
<tr>
<td>EA</td>
<td>0</td>
</tr>
<tr>
<td>Crystal</td>
<td>55.0</td>
</tr>
</tbody>
</table>

703.3 CONSTRUCTION REQUIREMENTS

Set posts plumb and to the depth specified in the Contract. Posts may be driven. The Project Manager will direct placement of posts set in rock.

Provide object markers and road delineators in accordance with the MUTCD. Label object markers as A3, OM-1, OM-2H, or OM-3.

If removal of an installation (temporary or permanent) is necessary and the metal, concrete, or asphalt surface is damaged, repair and otherwise restore the damaged surface to its original condition, at no additional cost to the Department. Replace defective posts, bases, assembly units, adhesives, or reflective sheeting that interferes with the intended use of the traffic markers, at no additional cost to the Department.
703.3.1 Surface-Mounted Flexible Traffic Marker Installations

Thoroughly clean metal, concrete, or asphalt surfaces before mounting flexible traffic markers. Sandblast or wire-brush metal and concrete surfaces. Clean asphalt surfaces in accordance with the adhesive manufacturer’s recommendations. Remove loose sand, dust, and other deleterious material from cleaned mounting surfaces.

Apply adhesive and install surface mounted flexible traffic markers in accordance with the manufacturer’s recommendations.

703.3.2 Reflective Barrier Delineators Installation

Install reflective barrier delineators in accordance with the manufacturer’s recommendations, using a pressure-sensitive system on a clean, dry, vertical surface at intervals and the distance above the road surface, as specified in the Contract, or as directed by the Project Manager.

703.4 METHOD OF MEASUREMENT—Vacant

703.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Marker Type</td>
<td>Each</td>
</tr>
<tr>
<td>Road Delineator Type</td>
<td>Each</td>
</tr>
<tr>
<td>Flexible Traffic Marker</td>
<td>Each</td>
</tr>
<tr>
<td>Tubular Flexible Traffic Marker</td>
<td>Each</td>
</tr>
<tr>
<td>Reflective Barrier Delineator</td>
<td>Each</td>
</tr>
<tr>
<td>1/10-Mile Delineator</td>
<td>Each</td>
</tr>
</tbody>
</table>

703.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:

A. Adhesive;
B. Anchors;
C. Retroreflective sheeting;
D. Reflector units;
E. Hardware; and
F. Excavation, backfill, and compaction for marker installations.
SECTION 704: PAVEMENT MARKINGS

704.1 DESCRIPTION
This Work consists of providing and placing pavement markers, reflectorized-plastic pavement symbols, legends, and stripes.

704.2 MATERIALS

704.2.1 Traffic Paint
Provide traffic paint in accordance with the Department’s Specifications for White and Yellow Traffic Line Paints Used on Construction Projects (High Solids Waterbase Acrylic) Specification M-TPC-WBACR for standard acrylic paint or M-TPC-WBACRHB for Hi-Build acrylic paint, available from Traffic Services Engineer.

704.2.1.1 Acceptance of Traffic Paint
Provide Certificates of Compliance and documentation that the State Materials Bureau has tested the batch of paint. The Department may take random samples of the traffic paint. The Department will reduce payment for or reject traffic paint used before submitting the proper documentation, if the test results do not meet the specifications.

704.2.2 Reflectorized Glass Beads
Provide high performance beads for improved retro-reflectivity and durability for Highway markings in accordance with Table 704.2.2.1, “Bead Retained (Percentage).”

<table>
<thead>
<tr>
<th>U.S. Mesh</th>
<th>Microns</th>
<th>% Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>1000</td>
<td>5 - 15</td>
</tr>
<tr>
<td>30</td>
<td>600</td>
<td>20 - 35</td>
</tr>
<tr>
<td>50</td>
<td>300</td>
<td>55 - 75</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

Provide beads that are colorless/clear and free of carbon residue. Provide beads where all + 20 US Mesh beads are 85% minimum rounds and overall rounds are 75% minimum. Use ASTM D 1155 test method for all beads except the +20 US Mesh which are inspected visually.
Provide beads with an index of refraction minimum 1.51 by oil immersion method in accordance with ASTM D 1155.
Provide beads with a resistance to acid, specifically when tested as specified in Federal Specification TT-B 1325C, 4.3.6; the beads shall not develop any surface haze or dulling.
Provide beads with a resistance to calcium chloride, specifically when tested as specified in Federal Specification TT-B 1325C, 4.3.7, the beads shall not develop any surface haze or dulling.
Provide beads with a resistance to sodium sulfide, specifically when tested as specified in Federal Specification TT-B 1325C, 4.3.8, the sodium sulfide solution shall not darken the beads.
Provide beads with water resistance, specifically when tested as specified in Federal Specification TT-B 1325C, 4.3.9, the water shall not produce dulling or hazing of the beads, and not more than 4.5 ml of 0.1N hydrochloric acid shall be used for the titration.
Provide all post consumer and post industrial glass beads manufactured from North American glass waste streams. The bead manufacturer shall submit a notarized certification to the Department that North American glass waste streams were used in the manufacture of product meeting this specification.
Provide beads that are compatible with all binder systems, including alkyd and hydrocarbon thermoplastic, water and solvent based paint, epoxy, and methylmethacrylate.
Provide glass beads furnished in bags identifying contents, manufacturer and net weight.

704.2.2.1 Sampling, Testing, and Acceptance
Contractors or subcontractors supplying glass beads for use on Department projects shall notify the Department and make available to the State Materials Bureau a copy of the shipping invoice and a copy of the manufacturer’s test results of the lot numbers shipped to the Contractor.
Upon request, the Contractor will submit to the State Materials Bureau two unopened bags of glass beads per batch (or lot number) as well as a copy of the above information. The State Materials Bureau will obtain a representative sample and test it for specification acceptance by ASTM D 1214, ASTM D 1155, and such other tests as designated in these specifications.

Upon determination of acceptability or rejection of beads, a report covering the lot(s) tested will be issued by the State Materials Bureau to the Contractor. The Contractor shall furnish each project a certificate with reference to the State Materials Bureau test control number, indicating that beads provided to the project have been tested and accepted by the State Materials Bureau. Verifications of the certification will be made by project personnel checking the lot number on the bags furnished to the project.

No field sampling of beads will be required when the above procedures are followed.

704.2.3 Temporary Marking Tape

Provide temporary marking tape of traffic resistant yellow or white reflective marking Material on a conformable, nonmetallic backing coated with a pressure-sensitive adhesive and designed for marking asphalt or PCC surfaces that meets or exceeds the minimum retroreflectivity values in Table 704.2.3.1, “Temporary Marking Tape,” as measured in accordance with the testing procedure of Federal Test Method Standard 370, unless a higher value is specified.

Provide weather resistant Material that shows no measurable fading, lifting, or shrinkage, and is free of cracks, with true, straight, and unbroken edges.

The Department will designate temporary marking tape as removable or nonremovable in accordance with Section 704.2.3.1, “Removable Temporary Marking Tape,” and Section 704.2.3.2, “Non-Removable Temporary Marking Tape Dimensions.”

Match the visible or outer surface color to the paint color in Section 704.2.1, “Traffic Paint.”

<table>
<thead>
<tr>
<th>Table 704.2.3:1 Temporary Marking Tape</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum Retroreflectivity</strong> (millicandelas per foot-candle per square foot)</td>
</tr>
<tr>
<td><strong>OA</strong></td>
</tr>
<tr>
<td>0.2</td>
</tr>
<tr>
<td>0.5</td>
</tr>
</tbody>
</table>

Provide Material that is flexible; formable; shows no cracking, flaking, or loss of reflective elements; and remains consistent with the texture of the pavement surface after application.

704.2.3.1 Removable Temporary Marking Tape

704.2.3.1.1 Removable Temporary Marking Tape Dimensions

For normal use, provide removable temporary marking tape that is at least 35 mil thick and 4 in or 6 in wide.

704.2.3.1.2 Removable Temporary Marking Tape Removability

Provide removable marking tape that is readily removable from the pavement with the manufacturer’s recommendations without sandblasting, solvent, burning, or grinding methods, unless otherwise specified.

704.2.3.2 Non-Removable Temporary Marking Tape Dimensions

Provide non-removable temporary marking tape that is at least 10 mil thick and 4 in or 6 in wide.

704.2.4 Retroreflective Preformed Plastic Markings

Provide retroreflective preformed plastic marking Material made of white or yellow weather resistant retroreflective film.

Provide prefabricated legends and symbols in accordance with the applicable shapes and sizes in the MUTCD.
704.2.4.1 Composition
Provide retroreflective preformed plastic markings that consist of high quality plastic Materials, pigments, and glass beads uniformly distributed throughout their cross sectional area, with a retroreflective layer of beads embedded in the top surface.
Provide the adhesive system recommended by the manufacturer for installation.

704.2.4.2 Skid Resistance
Ensure that the surface of the retroreflective preformed plastic marking Material provides a minimum skid resistance value of 35 British Pendulum Number when tested in accordance with ASTM E 303.

704.2.4.3 Thickness
Provide retroreflective-preformed plastic marking Material, including symbols and legends without adhesive, which is 60 mil thick if inlaid into new asphalt surfaces or applied to existing surfaces.

704.2.4.4 Durability and Wear Resistance
Ensure that the retroreflective preformed plastic marking Materials provide a neat, durable marking when properly applied and that the preformed plastic marking Materials provide a cushioned resilient substrate that reduces bead crushing and loss.
Provide film that (through normal traffic wear) is weather resistant, shows no measurable fading, lifting, or shrinkage throughout the life of the marking, and shows no significant tearing, rollback, or other signs of poor adhesion.

704.2.4.5 Conformability and Resealing
Provide retroreflective preformed plastic marking Material capable of conforming to pavement contours, breaks, faults, etc., under traffic.

704.2.5 Raised Pavement Markers
The Department will specify raised pavement markers as follows:
1. Type A = Nonreflective Circular White Marker;
2. Type AY = Nonreflective Circular Yellow Marker;
3. Type B = Two-Way White Reflective Marker;
4. Type C = Red-White Reflective Marker;
5. Type D = Two-Way Amber Reflective Marker;
6. Type G = One-Way White Reflective Marker;
7. Type H = One-Way Amber Reflective Marker;
8. Type J = Red-Amber Reflective Marker;
9. Type TD = Temporary Two-Way Amber Reflective Marker;
10. Type TG = Temporary One-Way White Reflective Marker;
11. Type TH = Temporary One-Way Amber Reflective Marker;
12. Type TJ = Temporary Red-Amber Reflective Marker;
13. Type PD = Plowable Two-Way Amber Reflective Marker;
14. Type PG = Plowable One-Way White Reflective Marker;
15. Type PH = Plowable One-Way Amber Reflective Marker;
16. Type PJ = Plowable Red-Amber Reflective Marker.

704.2.6 Nonreflective Raised Pavement Markers
Types A and AY raised pavement markers consist of a heat-fired, vitreous, ceramic base and a heat-fired, opaque, glazed surface to produce the required properties. Provide markers produced from any suitable combination of uniformly mixed clays, shales, talcs, flints, feldspars, or other inorganic Materials that meet the required properties. Provide markers thoroughly and evenly cured and free from defects.

704.2.6.1 Nonreflective Raised Pavement Markers: Finish Requirements
Provide nonreflective raised pavement markers in accordance with Table 704.2.6.1.1, “Nonreflective Raised Pavement Marker Requirements.”
Table 704.2.6.1:1
Nonreflective Raised Pavement Marker Requirements

<table>
<thead>
<tr>
<th>Test Requirement</th>
<th>Specific Intensity (millicandelas per lux)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directional reflectance—Type A markers only</td>
<td></td>
</tr>
<tr>
<td>Glazed surface (minimum)</td>
<td>≥75</td>
</tr>
<tr>
<td>Body of marker (minimum)</td>
<td>≥65</td>
</tr>
<tr>
<td>Yellow index—Type AY markers only</td>
<td></td>
</tr>
<tr>
<td>Glazed surface (maximum)</td>
<td>≤0.07</td>
</tr>
<tr>
<td>Body of marker (maximum)</td>
<td>≤0.12</td>
</tr>
<tr>
<td>Color—Type AY markers only</td>
<td></td>
</tr>
<tr>
<td>Purity</td>
<td>76–96%</td>
</tr>
<tr>
<td>Dominant wave length</td>
<td>579–585 μm</td>
</tr>
<tr>
<td>Total luminous reflectance (Y value, minimum)</td>
<td>≥0.41</td>
</tr>
<tr>
<td>Autoclave resistance</td>
<td>peel</td>
</tr>
<tr>
<td>Strength (minimum)</td>
<td>≥1.5 kip</td>
</tr>
<tr>
<td>Water absorption (maximum)</td>
<td>≤2.0 %</td>
</tr>
</tbody>
</table>

704.2.7 Reflective Raised Pavement Markers

Provide the prismatic reflector type of reflective raised pavement markers consisting of a methyl methacrylate or suitably compounded acrylonitrile butadiene styrene shell that is filled with a mixture of an inert thermo-setting compound and filler material. Ensure a smooth exterior surface of the shell containing one or two methyl methacrylate prismatic reflector faces of the specified color.

704.2.7.1 Reflective Raised Pavement Markers Requirements

If illuminated by a motor vehicle headlight, ensure the reflectors appear an approved white, yellow, or red in accordance with Table 704.2.7.1:1, “Reflective Raised Pavement Marker Requirements.” The Department will reject markers with off-color reflection.

Table 704.2.7.1:1
Reflective Raised Pavement Marker Requirements

<table>
<thead>
<tr>
<th>Test reflectance</th>
<th>Requirement Specific Intensity (millicandelas per lux)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0° Incidence Angle, minimum</td>
<td>White 278 Yellow 139 Red 70</td>
</tr>
<tr>
<td>20° Incidence Angle, minimum</td>
<td>Strength 111</td>
</tr>
<tr>
<td>Strength 2.0 kip</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>28</td>
</tr>
</tbody>
</table>

704.2.8 Temporary Reflective Raised Pavement Markers

Provide the prismatic reflector type of temporary reflective raised pavement markers consisting of either a high-grade polystyrene or acrylic plastic in accordance with Federal Specification LP-390C(2), Type I, Class 3. Ensure a smooth exterior surface of the shell containing one or two prismatic reflector faces of the specified color.

Provide a reflector of either polycarbonate microprism sheeting or prismatic air cell reflective lens. Provide a sealed, metallic backed reflector to prevent water penetration with a reflector face area of 1/2 in².

704.2.8.1 Temporary Reflective Raised Pavement Markers Requirements

If illuminated by a motor vehicle headlight, ensure that the reflectors appear an approved white, yellow, or red in accordance with Table 704.2.8.1:1, “Temporary Reflective Raised Pavement Marker Requirements.” The Department will reject markers with off-color reflection.
Table 704.2.8.1:1
Temporary Reflective Raised Pavement Marker Requirements

<table>
<thead>
<tr>
<th>Test reflectance</th>
<th>Requirement Specific Intensity (millarcandela per lux)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White</td>
</tr>
<tr>
<td>0° Incidence angle, minimum</td>
<td>93</td>
</tr>
<tr>
<td>20° Incidence angle, minimum</td>
<td>37</td>
</tr>
</tbody>
</table>

704.2.9 Plowable Reflective Raised Pavement Markers

Provide a plowable reflective raised pavement marker with a replaceable prismatic retroreflector in accordance with Section 704.2.7.1, “Reflective Raised Pavement Marker Requirements.” Place the marker in a metallic or nonmetallic casting able to withstand bidirectional plowing without damage to either the casting or the retroreflector.

704.3 CONSTRUCTION REQUIREMENTS

704.3.1 General Standard Procedures

Sample and handle paint in accordance with the Contract requirements. Contact the State Materials Bureau for paint sealing, sampling, and testing requirements.

704.3.1.1 Re-dispersement of Settled Paint

If paint settles excessively, re-disperse the settled pigments at the bottom of the paint drums with a mixing device before pumping or loading paint into the striping unit so that excess pigments are not left in the drums.

704.3.2 Equipment

Place the traffic paint and beads on the pavement using a spray type, self-propelled pavement marking machine. The Department will allow placing temporary striping during construction with other Equipment designed for application of paint or beads. Use a machine capable of applying clearly defined 4 in lines.

Use a machine equipped with a mechanical device capable of placing a broken reflectorized centerline with a 10 ft painted segment and a 30 ft gap.

Use a machine with an air-operated glass bead drop-in dispenser controlled by the spray gun mechanism. Use a dispenser capable of placing the glass spheres into the paint line as the paint is applied to the pavement to provide marking and delineation as specified.

704.3.2.1 Measurement Devices

Provide measurement of the volume of paint and beads in the tanks by one of the following measurement methods:

1. Strap measurement;
2. External tank marks indicating a volume equivalent to the tolerances shown in Section 704.3.5, “Tolerance Requirements for Placing Paint and Beads,” or;
3. A calibrated rod marked with the equivalent volumes.

Provide certification for the volumes of the paint and bead tanks.

704.3.3 Volume Control Requirements

Measure the volumes of paint and glass beads placed with the quantity-per-mile method or using paint and bead gauges.

Strap the tanks before beginning striping operations and again after striping one mile. If approved by the Project Manager, and if the striping machine is equipped with air-atomized spray units and paint and bead gauges, the Contractor may determine the paint and bead volumes using these gauges. Also, measure the volumes at the start and end of each day’s operations.

704.3.3.1 Letter of Transfer for Paint

Ensure that the striping machine’s paint and bead tanks are empty before filling at the start of the striping operations for the project. The Department will allow transfer of paint or glass beads left in the tank from another Department project, if the Contractor provides the Project Manager a “Letter of Transfer for Paint.” Include the following in the letter:

1. The amount left in the tanks;
2. The previous project, including, the Termini, the project number, and control number;
3. The destination project;
4. The date;
5. The batch number for the paint;
6. The previous Project Manager's or designee's signature.

704.3.4 Placing Beads and Traffic Paint

704.3.4.1 Weather Limitations
Apply pavement markings during daylight hours or as directed by Project Manager, if the pavement surface is dry and the weather is not foggy, rainy, excessively windy, or otherwise detrimental to the application of markings. Pavement markings must be installed as per manufacturer's recommendation.

704.3.4.2 Surface Preparation
Ensure that the surface is free from excess asphalt or other deleterious substances before applying traffic paint or beads. Remove dirt, debris, grease, motor oils, rocks, or chips from the pavement surface before applying markings.

704.3.4.3 Striping Operations Traffic Control Requirements
Provide the necessary personnel and Equipment to divert traffic from the installation area while the work is in progress and during the drying time.
Submit a traffic control plan in accordance with the MUTCD to the Project Manager for approval before starting the work, unless the Contract already provides one.

704.3.4.4 Number of Striping Applications
Permanent reflectorized painted markings consist of three applications of markings, unless otherwise specified in the Contract. Place the second and third applications no sooner than 14 Days after placement of the first application of markings, or as directed by the Project Manager.

704.3.4.5 Repair and Replacement of Unacceptable or Damaged Striping
Remove and replace the striping if:
1. Paint does not adhere to the pavement;
2. Glass beads do not adhere to the paint;
3. The second application of pavement markings is not placed over the first application of markings in accordance with Section 704.3.5, “Tolerance Requirements for Placing Paint and Beads.”
Repair damage to pavement markings due to negligence or failure to maintain traffic control at no additional cost to the Department.

704.3.5 Tolerance Requirements for Placing Paint and Beads
Ensure smooth, aesthetically acceptable finished lines free from undue waviness.

704.3.5.1 Width Requirements
The allowable tolerance for 4 in, 6 in, 8 in, or 12 in wide painted lines is ± 1/8 in.

704.3.5.2 Paint Application Rate
Apply paint at a minimum rate of 19.75 gal per mile of paint for a solid 4 in line and 4.94 gal per mile for a broken 4 in line, based on a 10-foot stripe and a 30-foot gap (40-foot cycle). Apply other widths of striping at appropriate multiples of these minimum rates for solid and broken paint stripes.

704.3.5.3 Longitudinal Tolerance Requirement
Ensure that the length of painted segment and gap does not vary more than 6 in for a 40 ft cycle.

704.3.5.4 Transverse Gap Dimension
Provide the following transverse gap dimensions between centerline stripes for two and three stripe combinations using a three-paint gun set up on the striping machine:
1. Place the broken line on the centerline of the Roadway with the respective left and right no passing zone stripes placed with a 2 in gap between the broken and no
passing zone stripes;
2. Ensure an 8 in gap between the double yellow markings for no-passing zones.

704.3.5.5 Glass Reflectorizing Beads Application Rate
Apply glass reflectorizing beads on the wet paint at a minimum rate of 6 lb to each gallon of paint.

704.3.6 Placing Temporary Marking Tape
The Department will allow only removable marking tape for temporary marking of final pavement surfaces, unless otherwise specified in the Contract. Provide the necessary personnel and Equipment to warn and divert traffic during installation and removal of temporary marking tape from the area where the work is in progress.

Ensure that the pavement surface is dry and free of oils, grease, dust, dirt, and other deleterious substances and primed with a primer Material as recommended by the tape manufacturer. Roll or tamp the tape immediately after application until it adheres properly and conforms to the surface of the pavement. Where striping is continuous, do not place more than three splices per 120 ft of length.

704.3.7 Placement of Retroreflective Plastic Pavement Symbols, Legends, Stripes, and Markings
Apply retroreflective pliant polymer reflectorized plastic pavement symbols, legends, stripes, and markings to the pavement as specified, or as directed by the Project Manager. For placement of inlaid markings, apply retroreflective preformed plastic pavement markings to the pavement before final rolling is completed on new asphalt pavement or per manufacturer’s recommendations.

704.3.7.1 Surface Preparation
Ensure that the pavement surface is free of moisture, soil, or other deleterious substances by brooming clean or using compressed air.

704.3.8 Requirements for Adhesive for Raised Pavement Markers
Unless otherwise directed in writing by the Project Manager, cement the markers to the pavement with standard-set epoxy adhesive. The Contractor may substitute rapid-set epoxy adhesive for standard-set epoxy adhesive with approval from the Project Manager and at no additional cost to the Department.

Use butyl or standard-set epoxy adhesive for the installation of temporary reflective raised pavement markers.
Use rapid-set epoxy adhesive in heavy traffic areas, as specified in the Contract, or when the ambient temperature at the time of application is below 50 °F, except as limited in accordance with Section 704.3.8.2, “Temperature and Weather Limitations.”

704.3.8.1 Surface Preparation
For raised pavement markers, clean the specified pavement locations of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint, and material that would adversely affect the adhesive’s bond and prepare the pavement surface for preparation of placement of the adhesive and raised pavement marker.

Clean new and existing concrete surfaces by sandblasting and provide containment (blast-cleaning enclosure) for the airborne debris.
Ensure that sawcut slots for plowable raised pavement markers are dry and free of loose material before applying the epoxy adhesive.

704.3.8.2 Temperature and Weather Limitations
Do not use standard-set epoxy adhesive for placing plowable raised pavement markers, if either the pavement temperature or the air temperature is less than 50 °F.

704.3.8.3 Application
Set the raised pavement markers to the alignment established by the Project Manager. Place reflective markers so that the reflective face of the marker is perpendicular to a line parallel to the Roadway centerline. Do not place pavement markers over longitudinal or transverse joints in the pavement surface.
Place the adhesive and markers in accordance with manufacturer's recommendations. Immediately remove excessive adhesive around the edge of the marker, on the pavement, and on the exposed surfaces of the marker as per manufacturer's recommendation.

Ensure that temporary reflective raised pavement markers are easily removed without heating or grinding, and without damage to the pavement surface.

704.3.8.3.1 Plowable Raised Pavement Markers
Saw-cut slots in the pavement for the plowable raised pavement markers in accordance with the manufacturer's recommendations. Accurately lay out the locations of saw-cut slots on the pavement. Hand-place the plowable raised pavement marker casting into the manufacturer approved adhesive-filled saw-cut slot so that the snowplow deflecting surfaces are below the adjacent pavement surfaces.

704.3.9 Disposal of Hazardous Materials
Dispose of thinner, solvent, and other hazardous waste in accordance with appropriate Hazardous Materials regulations.

704.4 METHOD OF MEASUREMENT
The Department will measure Retroreflectorized Painted Markings for 4 in, 8 in, 12 in, and 24 in widths using multiples of the standard 4 in width to calculate a total length.

The Department will measure the volume of paint and glass beads in place by the quantity per mile method in accordance with Section 704.3.3, “Volume Control Requirements.”

704.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
<td>Retroreflectorized Painted Markings</td>
<td>Foot</td>
</tr>
<tr>
<td>Removable Marking Tape</td>
<td>Foot</td>
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<tr>
<td>Nonremovable Marking Tape</td>
<td>Foot</td>
</tr>
<tr>
<td>Retroreflectorized Plastic Pavement Stripe  ____ in</td>
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<tr>
<td>Retroreflectorized Plastic ____ (type) Arrow</td>
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<td>Retroreflectorized Word ____</td>
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</tr>
<tr>
<td>Retroreflectorized Plastic ____ (type) Symbol</td>
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<tr>
<td>Retroreflectorized Plastic Railroad Crossing</td>
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<tr>
<td>Retroreflectorized Painted Railroad Crossing</td>
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</tr>
<tr>
<td>Reflective Raised Pavement Marker, Type ____</td>
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<tr>
<td>Nonreflective Raised Pavement Marker, Type ____</td>
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<tr>
<td>Temporary Reflective Raised Pavement Marker, Type ____</td>
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</tr>
<tr>
<td>Plowable Reflective Raised Pavement Marker, Type ____</td>
<td>Each</td>
</tr>
</tbody>
</table>

704.5.1 Payments
The Department will not pay for striping until the Project Manager receives the required certification and documentation. If the Project Manager determines that the specified amounts of paint and glass beads were not installed, the Department will reduce payment in accordance with Table 704.5.1:1, “Retroreflectorized Painted Markings Payment Price Reduction Schedule Based on Actual Placement Quantities.”
Table 704.5.1:1
Reflectorized Painted Markings Payment Price Reduction Schedule Based on Actual Placement Quantities

<table>
<thead>
<tr>
<th>Paint (gallons per mile)</th>
<th>Percent reduction</th>
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<tr>
<td>&gt;19.75 to &gt;17.77</td>
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<tr>
<td>17.77 to &gt;14.81</td>
<td>10</td>
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<tr>
<td>14.81 to &gt;9.87</td>
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<tr>
<td>≤9.87*</td>
<td>50</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Glass Beads (pounds per gallon)</th>
<th>Percent reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;6 to &gt;5</td>
<td>0</td>
</tr>
<tr>
<td>5 to &gt;4</td>
<td>17</td>
</tr>
<tr>
<td>4 to &gt;3</td>
<td>33</td>
</tr>
<tr>
<td>≤3*</td>
<td>50</td>
</tr>
</tbody>
</table>

*Subject to complete rejection and replacement.

Price reductions for paint and glass beads are cumulative.

If the Contractor has not installed the specified amount of glass beads and paint, the Project Manager will observe the striping at night to determine whether re-striping is necessary, at no additional cost to the Department.

The Department will require the Contractor to re-stripe the Roadway for the following reasons:

1. If less than 50% of the specified quantity of paint or beads are placed on the Roadway, or
2. If the Project Manager determines that the striping is not adhering to the pavement or the glass beads are not adhering to the paint.

704.5.2 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:

A. Removal of temporary marking tape;
B. Repair or replacement of damaged striping due to Contractor’s negligence or operations;
C. Furnishing, mixing, and applying adhesive; and
D. Surface preparation.

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Section 704: Pavement Markings  Page 509
705.1 Description
This Work consists of providing and installing complete and functioning Traffic Signal and Highway lighting systems.

705.1.1 Definitions
Traffic-Actuated Controller. An electronic timing device that controls the timing and sequence of traffic phases in accordance with the varying demands of traffic registered by detectors.

705.2 MATERIALS
705.2.1 Signal and Lighting Materials
Provide new Materials, unless otherwise specified in the Contract. Provide electrical Materials in accordance with NEMA standards, the NEC®, and state and local ordinances or requirements. If revisions to NEMA or NEC® requirements create a conflict with material requirements, apply the more stringent. Provide signal and lighting systems complete with the necessary accessories for proper operation. The Contract will specify the extent and general arrangement of signal and lighting systems. Complete the systems as specified.

705.2.1.1 Material Approvals
Within 15 Days of Contract execution, submit a list of signal and lighting Materials proposed for use and their supply sources to the Project Manager for approval by the Lighting and Signal Engineer and Traffic Services Engineer. Include Materials, identified in the Contract by performance characteristics, on this list with the following information about each item:

1. Name of the manufacturer;
2. Size;
3. Catalog number of each item; and
4. Other performance data (if required).

Include complete shop drawings and Material certifications in submittals for Standards (poles), including lowering devices for high masts. Provide Material certifications after part manufacture, but before erection.

If requested by the Project Manager or specified in the Contract, submit samples of the proposed Material.

705.2.1.2 Prequalification
Use only Traffic-Actuated Controllers, controller cabinets, System Masters, signal monitors, vehicle detectors, load switches, signal Standards, and lighting Standards prequalified before Bid Opening. The list of pretested and acceptable signal items is on the Department’s Approved Products List and is available on the NMDOT website. The Department lists each acceptable item by manufacturer and model number or identification number. Sample items must be submitted (or resubmitted) by the manufacturer or its representative to the product evaluation committee. It will normally take the Department a minimum of 180 Days for evaluation and notification of results.

705.2.2 Backfill Materials
Provide backfill Materials for signal and lighting system excavations within the Roadway Prism or for foundations, suitable for compaction in accordance with Section 210.3.2, “Compaction.” Backfill excavations for conduit or drilling pits outside the Roadway Prism with the material removed from that excavation. Remove stones with diameters larger than 4 in, large pieces of concrete, vegetation, and other Deleterious Materials. Provide additional backfill Material, if necessary.

705.2.3 Pavement and Sidewalk Material
Provide pavement and Sidewalk replacements for signal and lighting system excavations.
in accordance with the Contract for the replacement of the material removed.

705.3 CONSTRUCTION REQUIREMENTS

705.3.1 General

Ensure that the electrical work is in accordance with the NEC® and applicable local ordinances. Obtain a permit from the State Electrical Board (or equivalent state or local agency) before constructing Traffic Signals, Highway lighting systems, or other electrical installations. Provide permit proof to the Project Manager before work begins.

All electrical work relating to the installation or preparation of installation of signals and lighting must be supervised by an on-site licensed journeyman electrician.

Obtain approval from the local power company for the exact location of the electric service before its installation.

Prior to final inspection of the project, submit a written certification to the Project Manager that all electrical work and installations have been done in accordance with project specifications and details. Unless waived by authorizing agency, submit evidence to the Project Manager that all electrical work and installations have been inspected and approved by an authorized representative of the State Electrical Board or the Traffic Services Signal Laboratory.

Know the NEC® and local requirements and notify the Project Manager promptly of any conflicts with the Contract documents.

705.3.2 Excavation and Backfill

Perform the excavation required for the installation of conduit, foundations, and other items, minimizing damage to Highways, Streets, or Roads. Do not excavate until immediately before the installation of conduit and foundations. Do not cut the existing pavement, until the Project Manager approves.

Perform compaction for Standard foundations in accordance with Section 210.3.2, "Compaction." The Contractor may use original Material, mechanically tamped, and neatly leveled to original grade, to backfill excavations in natural ground or out of defined Roadway Prism. In grassed or landscaped areas, carefully remove sod before excavation and replace it after backfilling.

To prevent damage to conduit during backfilling, place at least 2 in of fine-grained Material that passes a 3/8 in sieve on the sides and above the conduit for the width of the trench. If the bottom of the trench contains rocks or material the Project Manager determines to be unsuitable, place at least 2 in of this Material below the conduit to cushion it.

705.3.3 Existing and Temporary Traffic Signals and Lighting Systems

Provide, install, and maintain temporary Traffic Signals and lighting systems, if specified in the Contract. Provide the Project Manager with access to power disconnects and control Equipment during this period.

705.3.3.1 Temporary Traffic Signals

Timing plans for temporary Traffic Signals must be prepared by professional engineer registered and licensed by the State Board and must be submitted to the Traffic Services Section for approval. Remove and retain ownership of temporary Equipment, unless otherwise specified in the Contract. The Traffic Services Section, or their approved designee, will inspect the temporary Traffic Signals before their initial activation.

All access to any signal Equipment in the Construction Zone shall be controlled by the signal contractor. Notify in advance the Project Manager and Traffic Services Engineer of any modifications to a controller cabinet during construction. If circumstances prohibit advance notification, notify the Project Manager and Traffic Services Engineer as soon as possible afterwards. Keep and maintain a log of controller cabinet access. Weekly, send copies of the access log to Traffic Services for the entire length of the project. Payment for this activity will be incidental to the project.

705.3.3.2 Coordination of Work with Existing Facilities

Keep existing signal and lighting systems in operation until the new Material is installed and ready for operation, unless otherwise specified in the Contract. Do not start work that may cause the existing signals to become inoperative until Materials for the new installation are on hand and the specified regulatory signing or temporary signals are in place and approved by the Project Manager.

Schedule shutdowns in accordance with the construction traffic control plan. Notify the
Project Manager and the Maintaining Agency in writing at least 2 Working Days before a scheduled shutdown.

When the work requires additions or modifications to existing signal or lighting systems, give the Project Manager and the Maintaining Agency written notice at least 2 Working Days before any interruptions. Allow the Maintaining Agency to inspect the work before and after re-energizing.

705.3.3 Salvage of Existing Material

Salvage the existing signal material, including cabinets and cameras, and avoid damage in handling. Disassemble and deliver salvaged material to the Department’s Signal Laboratory or to the Contract specified location.

The local power company will remove salvaged lighting material. If specified in the Contract, remove and deliver the material to the required location.

705.3.4 Final Operations and Acceptance Requirements

After the signal is in operation and before final acceptance, ensure that the signal remains fully operational in accordance with Section 105.18, “Acceptance.”

If the signal malfunctions or is otherwise disabled, notify the Project Manager, the Traffic Services Signal Laboratory, the Lighting and Signal Engineer, and the Maintaining Agency immediately, and provide emergency repairs.

New signal and lighting systems or modifications to existing systems require a 30-Day installation test in accordance with Section 705.3.5, “Testing.”

705.3.4 Responsibility for Utility and Maintenance

Ensure that the Maintaining Agency is the customer of record for the electrical and communications utilities. The electrical energy and communications services cost, maintenance and operational responsibility for existing signal and lighting systems undergoing Contract modifications will remain with the Maintaining Agency, unless otherwise directed in the Contract.

Continue maintenance of new signals and lighting systems until partial or final acceptance of the Project. The electrical and communication costs of the signal and lighting systems shall be borne by the Contractor until acceptance of the system by the Department, after which the cost will become the responsibility of the Maintaining Agency. The Contractor will be reimbursed for actual energy and communication services costs and costs of permit transfer. Submit an appropriate billing verification to the Project Manager. A separate pay item will be established in the Contract documents for these activities.

After partial or final acceptance of the project, the Maintaining Agency is responsible for the signal and lighting systems' operations and maintenance.

705.3.5 Testing

705.3.5.1 Wiring Tests

Before the Department’s acceptance of the work, perform the following tests on the lighting and signal circuits:

1. Continuity of each circuit;
2. Grounds or shorts in each circuit;
3. Functional test to demonstrate that all parts of the system function as specified or intended; and
4. When requested, conduct a megger test of each circuit between the circuit and ground, including the insulation resistance for all vehicle loops, direct burial wire, or cable.

Ensure that the initially applied voltage for the tests is:

5. No greater than the rated voltage of the cables; and
6. Has a uniform rate of increase, of not more than 100% in 10 s or less than 100% in 60 s.

Replace or repair faults in Materials or in any part of the installation revealed by these tests, as approved by the Project Manager. Repeat the same test until no fault appears. Perform the tests in the presence of the Project Manager and/or Signal Laboratory personnel or both, as directed. Provide all electrical power, instruments, and personnel required for the test.
705.3.5.2 Operation Tests

The Department requires a 30-Day operational test period, which starts when the Traffic Signal is completely installed and fully operational, including detection and communications. Submit a request for approval to start the 30-Day operational test period, in writing, to the Project Manager and the Traffic Services Engineer.

The Department will grant partial acceptance of the system upon satisfactory completion of the 30-Day operational test period and will grant final acceptance in accordance with Section 105.18, “Acceptance.”

Shop-test the controllers in accordance with Section 714.3.2, “Testing.” This special testing is in addition to the 30-Day installation tests.

Ensure that timing for signal controllers during the installation test period is as specified in the Contract. Do not place a signal in operation until the Traffic Services Engineer verifies the time settings and the correctness of signal indication outputs. Provide access to the signal controller for the Inspector during the test period.

705.4 METHOD OF MEASUREMENT—Vacant

705.5 BASIS OF PAYMENT

Furnishing and installing of traffic signal and highway lighting systems will be measured and paid for, as provided in the applicable sections of these specifications, for the work specified in the contract.
706.1 DESCRIPTION
This Work consists of providing and installing service poles, service connections, and lighting control cabinets.

706.2 MATERIALS
706.2.1 Service Pole
Use timber poles treated in accordance with AASHTO M 133. Provide normal service requirements for Traffic Signals and rest areas that are 120/240 V, 60 cycle. Provide the lighting system service in accordance with the Plans or as required by the servicing utility.
Provide a circuit breaker type service switch or a type HD disconnect switch with fuses. Enclose the service switch in a NEMA rain-tight housing with a hinged cover. Ensure the cover stays in position when open and has a hasp for a padlock. Provide UL-approved switches and housings.

706.2.2 Service Riser
Provide Materials for service risers in accordance with Section 706.2.1, “Service Pole,” if installing electrical service on an existing pole.

706.2.3 Meter Pedestal
Provide Materials for meter pedestals in accordance with the NEC® and the following:
1. Provide meter pedestals made of 12-gauge steel with a corrosion-resistant finish;
2. Provide a meter socket with a minimum rating of 100 A and factory wired in separate a wireway from terminal block to meter socket;
3. Size services larger than 100 A in accordance with the NEC®;
4. Use insulated stud terminal blocks or bus pads to accommodate connectors;
5. Provide pedestal bonding lug-grounding conductors continuous to the breaker panel-grounding terminal; and
6. Use a termination section with a removable rain-tight cover that has provision for padlocking over a captive pentahead bolt. Ensure that other removable portions of the termination section are sealable.

706.2.4 Service Connection
Provide service connections to transformers and power sources in accordance with the Plans and the NEC®.

706.2.5 Lighting Control Cabinet
Provide Materials for lighting control cabinets in accordance with the Plans, the NEC®, and the following:
1. Cabinets of 14-gauge steel with a corrosion-resistant durable finish;
2. Ground-mounted, tamper-proof, lockable cabinets approved by the Rural Electrification Administration;
3. Stainless steel cabinet hardware, including the hinges;
4. Mounting brackets for attaching contactors, photoelectric cells, junction boxes, and other auxiliary equipment.

706.2.6 Photoelectric Controller
Provide a photoelectric unit that consists of a light sensitive element connected directly to an internal control relay without intermediate amplifications. Provide either the horizontal sensing or zenith sensing type of unit with turn-on at 1.5 fc ± 0.5 fc and a turn-off at a maximum of 5.6 fc. The minimum acceptable difference between turn-on and turn-off is 0.8 fc. The minimum acceptable load rating is 1,800 W (HID load).
Provide the unit base with a three-prong, NEMA standard, twist lock type plug mounting so that the unit mounts directly on Luminares, or with an adapter base, on pole tops or sides. Ensure that the controllers normally work in conjunction with external auxiliary load relays for handling the required lighting loads.
Ensure that the supply voltage rating is the same as the system voltage specified in the Contract. The minimum operating temperature range is from -40 °F to 140 °F. Ensure that the power consumption of the controller is less than 12 W.
Ensure that the lighting load turns on when the north sky illumination in the area falls to a preset value. Provide a potentiometer that is easily accessible for adjustment to vary the turn-on value within the operating range. Incorporate a time delay into the circuit to prevent streetlights from turning off at night when transient lights are focused on the controller. Ensure that the controlled lighting load remains on or becomes energized, if any functional failure occurs in the electronic circuit. Equip the controller with a lightning arrester capable of handling 500 V at 35,000 A.

706.2.7 Auxiliary Contactor

Ensure that the auxiliary contactor has the following properties:

1. Works in conjunction with a photoelectric controller and the specified lighting loads;
2. Is normally open and double pole;
3. Is the electrically held type, designed to withstand lamp load inrush current and to carry full rated current on a continuous basis.

Provide a three-position switch to permit manual operation of the lighting circuit with an indicating nameplate reading “PHOTO-OFF-MANUAL.” Use a toggle or rotary type switch with double-pole, triple-throw, and center-off position.

706.3 CONSTRUCTION REQUIREMENTS

706.3.1 General

The electrical service points shown in the Contract are approximate. Obtain the exact locations from the electric utility. Obtain approval of the final location from the Project Manager before beginning the service installation work. If a major change in location from that specified in the Contract is necessary, the Project Manager will determine the final location and adjust the service run.

Obtain the necessary permits and schedule electrical inspections required for service attachment. Obtain the approval of the Project Manager before hook-up.

Provide the electric utility with the name of the Maintaining Agency, as the customer of record, in accordance with Section 705.3.3, “Existing and Temporary Traffic Signals and Lighting Systems.”

706.3.2 Service Pole Installations

Attach the conduit to the pole, as specified in the Contract. Securely mount the conduit to the pole surface and bond it to the service pole ground system, as required by the NEC®. Provide and install conduits, covers, gaskets, switches, fittings, and necessary equipment. Refer to the Contract for layout, connections, and mounting details of the various switches and associated equipment.

Use rigid steel, galvanized conduit of the specified size for above ground service installations. Where rigid steel conduit is coupled to rigid PVC conduit used for the underground portion of the service run, join the conduits underground at a depth of from 2 in to 10 in below the surface.

Provide and install meter sockets required by the serving utility company as specified in the Contract. The serving utility company will supply and install the meters.

706.3.3 Service Riser

Install service risers on existing poles at the required locations, in accordance with Section 706.3.2, “Service Pole Installations.” Install service risers on the quadrant of the existing pole directed by the service utility company.

706.3.4 Meter Pedestal

Install meter pedestals at the locations specified and in accordance with the Contract. Install the pedestals at least 10 ft from the service pole.

706.3.5 Service Connection

Install the service connections at an existing service pole, service riser, meter pedestal, lighting control cabinet, or at a location specified in the Contract. Provide service connections at no additional cost to the Department.

706.3.6 Lighting Control Cabinets

Install the lighting control cabinets at the locations specified in the Contract or as directed by the Project Manager. Install the cabinets plumb on a concrete foundation with necessary
706.4 METHOD OF MEASUREMENT—Vacant

706.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tr>
<td>Service Pole (type)</td>
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</tr>
<tr>
<td>Service Riser (type)</td>
<td>Each</td>
</tr>
<tr>
<td>Meter Pedestal (type)</td>
<td>Each</td>
</tr>
<tr>
<td>Lighting Control Cabinet</td>
<td>Each</td>
</tr>
</tbody>
</table>

706.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately: All materials required for a complete installation including meter sockets and disconnect switches, if required. Concrete pads for lighting control cabinets. Service connections will be considered as included in the cost of the main items and will not be measured or paid for separately.
707.1 DESCRIPTION
This Work consists of providing and installing Traffic Signal and street lighting Standards. If the Contract specifies Standards provided and installed by others, this work only consists of the installation of anchor bolts.

707.2 MATERIALS
A Standard consists of the following:
1. Shaft with base;
2. Anchor bolts;
3. Mast arms, if required; and
4. Other hardware supporting the Traffic Signal and Highway lighting apparatus.

Provide Structures designed in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

707.2.1 Type I Standard
A Type I Standard is a pedestal-type support for traffic signals, controller cabinets, and splice cabinets. Provide a threaded pole pedestal-type support with a threaded (female) square cast aluminum base assembly with set screws. Provide an aluminum base approximately 15 in high with a covered hand hole at least 8 in × 18 in.

Fabricate the pole from either 4 in nominal diameter steel pipe, Schedule 40, or a tapered steel shaft of equal or greater wall thickness.

Provide a Type I Standard designed to support a post top-mounted Traffic Signal controller or splice cabinet weighing 150 lb. Design a Type I Standard 4 ft high or less for a projected area of 5 ft². Design a Type I Standard 10 ft high or more for a projected area of 15 ft².

707.2.2 Type II Standard
A Type II Standard is a mast arm traffic signal support. Provide Standards either with a monotube (single member) arm design fabricated from steel or a “trombone” truss arm design fabricated from either steel or aluminum. Provide Standards in accordance with the member attachment and size details specified in the Contract to ensure interchangeability and standardization between Fabricators.

707.2.2.1 Design Requirements
Provide a Standard installation designed to support Traffic Signal heads, back plates, dampers, and signing attached rigidly to the end of the arm. Use a design-projected area of 25 ft² and a design weight of 150 lb.

707.2.2.2 Shaft
Provide steel shafts fabricated from a weldable-grade hot rolled steel, having a yield point after fabrication of at least 55,000 psi and a No. 7 U.S. Std. Ga., 0.1793-inch, minimum wall thickness.

Provide a round or octagonal cross section shaft, tapered at a constant rate. After fabrication, hot-dip galvanize the steel shaft in accordance with ASTM A 123 and clean to provide a uniform and stain free surface.

Provide aluminum shafts fabricated from seamless round tapered tubing of alloy 6063-T6 or 6005-T5 in accordance with ASTM B 221, having a minimum thickness of 3/16 in. Provide a shaft with no welds, except at the joint between the shaft and the flange base. Provide a shaft finished by mechanical means, providing a uniform appearance and not requiring any surface preparation at the time of installation.

Provide a shaft with a removable pole top cap or mast arm hand hole with cover to allow access for pulling cable through the shaft.

707.2.2.3 Arm
Provide monotube (single member) arms fabricated from steel and “trombone” truss arms fabricated from either steel or aluminum. For the shaft, provide steel members with a minimum thickness of No. 11 U.S. Std. Ga., 0.1196 in and aluminum tubing with a minimum thickness of 0.156 in.
707.2.2.4 Transformer Base
Provide steel transformer bases fabricated from hot rolled mild steel with a yield point of at least 33,000 psi and a sidewall thickness of at least a No. 7 U.S. Std. Ga., 0.1793 in. Galvanize the steel transformer base after fabrication in accordance with ASTM A 123. Provide a one-piece casting of aluminum alloy 356-T6 for aluminum transformer bases in accordance with ASTM B 108. Provide bases with a height of at least 20 in and, in one side, a hand hole with cover at least 8 in × 12 in. Provide transformer bases designed to allow the shaft to rotate a full 360° and to align irrespective of anchor bolt placement.

707.2.2.5 Hardware
Provide either steel or stainless steel hardware. Provide steel hardware in accordance with ASTM A 307 or ASTM A 325, galvanized in accordance with ASTM A 153. Provide stainless steel hardware in accordance with AISI Series 300 stainless steel.

707.2.2.6 Anchor Bolts
Provide anchor bolts in accordance with Section 707.2.7, “Anchor Bolts.” Thread the top of each Type II Standard anchor bolt at least 8 in and hot-dip galvanize the full thread plus 6 in.

707.2.3 Type III Standard
Type III Standard is a combination mast and traffic signal and Roadway Luminaire support. Provide Type III Standards fabricated from steel in accordance with Section 707.2.2, “Type II Standard.” Provide Type III Standards that support a Luminaire with a shaft extension and arm. Provide arms designed to support a Luminaire of 75 lb and a projected area of 3.3 ft². Provide shaft extensions in accordance with Section 707.2.2.2, “Shaft,” except that steel shaft extensions may have a minimum thickness of No. 11 U.S. Std. Ga., 0.1196 in.

707.2.4 Type IV Standard
Type IV Standard is a post top Luminaire support. Provide Type IV Standards in accordance with Section 707.2.5, “Type V Standard,” except do not include mast arms on Type IV Standard poles. Include a tenon on the shaft for Luminaire mounting.

707.2.5 Type V Standard
A Type V Standard is a mast-arm Luminaire support. Provide Type V Standards of tapered shafts with davit-type mastarms. Provide Breakaway bases in accordance with Section 707.2.5.4, “Breakaway Bases.”

707.2.5.1 Design Requirements
Provide arms designed to support a Luminaire weighing 55 lb and a projected area of 2.7 ft². Ensure pole straightness is in accordance with Table 707.2.5.1:1, “Type V Standard Pole Straightness Tolerances.”

<table>
<thead>
<tr>
<th>Total mounting height (ft)</th>
<th>Straightness (in)</th>
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</thead>
<tbody>
<tr>
<td>20</td>
<td>3/4</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
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<td>1 1/4</td>
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<tr>
<td>40</td>
<td>1 1/2</td>
</tr>
<tr>
<td>50</td>
<td>1 3/4</td>
</tr>
</tbody>
</table>

Limit dead load deflection in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, subsection 1.9.1(B) 2a.

707.2.5.2 Fabrication Requirements
Fabricate Standards using spun aluminum or galvanized steel.
707.2.5.2.1 Spun Aluminum Standards

707.2.5.2.1.1 Shaft
Provide shafts of one-piece, seamless tapered tubes of alloy 6063 T6, in accordance with ASTM B 221 and having:
1. Wall thickness of at least 5/32 in for mounting heights of equal to or less than 33 ft;
2. Wall thickness of at least 3/16 in for mounting heights of from greater than 33 ft to 40 ft;
3. Wall thickness of at least 0.219 in for mounting heights greater than 40 ft.
4. No longitudinal welds and only two circumferential welds located at the joint between the shaft and the anchor base.
Secure a one-piece cast aluminum anchor base of alloy 356-T6, in accordance with ASTM B 108, to the base. Finish exposed edges of the plate that makes up the base assembly; smooth and furnish each base with four bolt covers.
Provide a rotary sand polished shaft, wrapped for protection during handling and shipping.

707.2.5.2.1.2 Mast Arm
Provide mast arms of seamless aluminum tubing, alloy 6063-T6. Assemble arms with a slip fitter onto the main shaft and hold with through bolts and set screws.

707.2.5.2.1.3 Hardware
Provide stainless steel hardware.

707.2.5.2.1.4 Welding
Perform welding in accordance with the Aluminum Design Manual, published by the Aluminum Association.

707.2.5.2.2 Galvanized Steel

707.2.5.2.2.1 Shaft
Provide steel shafts with a yield strength of at least 40,000 psi after fabrication and a minimum wall thickness of No. 10 U.S. Std. Ga., 0.1345 in. For shafts with an after-fabrication yield strength of 55,000 psi or greater, the Contractor may provide shafts with a minimum wall thickness of No. 11 U.S. Std. Ga., 0.1196 in. Provide a round cross section shaft, tapered at a constant rate. Ensure the shaft is a one-piece section, attached by two circumferential welds to a base plate.
Provide a base of either one-piece steel casting or fabricated from steel plate with a minimum yield strength of 36,000 psi.

707.2.5.2.2.2 Galvanizing and Finishing
Ensure exposed welds, except fillet welds, are ground flush with the base metal. Fully galvanize steel poles after fabrication in accordance with ASTM A 123. After galvanizing, clean poles to provide a uniform and stain-free surface.

707.2.5.2.2.3 Mast Arm
Provide arms fabricated from the same Material as the shaft and with a wall thickness of at least No. 11 U.S. Std. Ga., 0.1196 in. Assemble arms with a slip fitter onto an adapter casting fixed to the main shaft and held with through bolts and set screws.

707.2.5.3 Anchor Bolts
Thread the top of the anchor bolts for approximately 9 in and galvanize for a minimum of 12 in. Provide each anchor bolt for Type V Standards with nuts and washers, as required for a Breakaway base, or one nut, washer, and shims, if an anchor type base is required.

707.2.5.4 Breakaway Bases
Provide Type V Standards designed to meet the requirements for dynamic performance under vehicle impact and strength tests in accordance with AASHTO Standard Specifications for Highway Signs, Luminaires and Traffic Signals. Use Type V Standards located behind barriers, Bridge railing, or Sidewalks requiring anchor bases for direct, rigid mounting. The Contractor may use breakaway couplings or a steel slip-base system for Type V Standards. The Contractor may use either an integral aluminum base or breakaway couplings for
If the total weight of the Standard and the Luminaire assembly exceeds 600 lb or, if requested by the Project Manager, provide test data obtained in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

Provide breakaway couplings designed for placement between the anchor bolts and the pole base composed of a frangible Material that breaks away under impact (shear). Ensure that the tensile and compressive strengths of the coupling equal or exceed those required for the design wind loading of the furnished Type V Standard. Include a sheet metal "skirt" base cover for the coupling installation as specified.

707.2.6 Type VI Standard

A Type VI Standard is a high mast Luminaire support. Provide Structural Steel for Type VI Standards, anchor bolts, base plates, shafts, and suspension arms in accordance with the applicable AASHTO, ASTM, or Military specifications. Identify the AASHTO, ASTM, or Military specifications for each member on the shop drawings and in the design calculations.

Ensure that all Structural Steel used in base plates and shafts more than 1/2 in thick is in accordance with AASHTO specifications for the Charpy "V" notch toughness in Zone 2.

Fabricate, transport, and erect Type VI Standards in accordance with Section 541.3, “Construction Requirements.” Base the design on a wind velocity of 90 mph with a 1.3 gust factor.

707.2.6.1 Design

Design the installation to support Luminaires weighing 85 lb each, with a projected area of 3.4 ft². Base the design on the number of Luminaire positions specified in the Contract, assuming one Luminaire in each position. Submit eight copies of the design calculations and shop drawings to the Project Manager for review and approval by the State Bridge Engineer. Do not begin fabrication until the State Bridge Engineer approves the design calculations and shop drawings.

707.2.6.1.1 Slip-Fit Design

Provide shafts consisting of round or multi-sided telescoping, tapered sections, designed to create a minimum overlap of sections of two times the outside diameter of the female sections. Mate sections and match-mark before shipment to the job site. Do not allow the centerline alignment of an assembled shaft to vary from the theoretical centerline of the joining base and tip by more than 3 in.

707.2.6.1.2 Hand Hole

Provide a minimum 10 in × 30 in hand hole reinforced with a flange plate for each shaft, located near the base of the shaft. Design the reinforcing so that the original strength of the shaft is maintained. Provide the shaft with a weatherproof door and provisions for hand-locking. Provide stainless steel securing hardware.

707.2.6.1.3 Weld Joint Details

Use full penetration welds for circumferential seams and longitudinal seams in the female slip joint area. Ensure that longitudinal welds, other than in the slip joint area, have 75% minimum weld surface penetration. Use full penetration or socket-type welds for base plate and arm bracket joints.

Test and inspect all circumferential welds joining shaft sections, longitudinal welds in the female slip joint area, suspension arm to shaft connection welds, and pole to base plate connection welds using ultrasonic techniques. Use magnetic particle or visual inspection on all other welds.

707.2.6.1.4 Protective Coating

Provide galvanizing in accordance with the requirements of ASTM A 123. Ensure that galvanized coatings are uniform and bright. Fabricate Standards completely before galvanizing. Ensure that no embrittlement, warpage, and distortion occur, in accordance with ASTM A 143 and ASTM A 384.
707.2.6.1.5 Base Plate
   Integrially weld the base plate to the pole shaft with a backup bar using an AWS
   prequalified 100% penetration weld. Provide a hole with at least a 15 3/4-inch diameter in the
   base plate to allow insertion of a lowering device into the hole through the base plate.

707.2.6.1.6 Anchor Bolts
   Provide six, 2 1/4 in diameter anchor bolts for each Type VI Standard fabricated from
   ASTM A 615, Grade 75 steel. Provide one leveling nut, one hold-down nut, and washers for
   each anchor bolt. Galvanize the threaded ends of the bolts, nuts, and washers in accordance
   with ASTM A 153. Space the anchor bolts in accordance with the manufacturer's
   recommendations.

707.2.6.2 Luminaire Frame and Lowering Device
   The Luminaire frame and lowering device consist of a head frame, a Luminaire ring, a
   winch, a hoisting assembly, a circuit breaker, a portable power unit, and other necessary
   appurtenances (including wiring) to mount, operate, lower, raise, and test Luminaire fixtures.

707.2.6.2.1 Head Frame
   The head frame structure supports the hoist cable sheaves, symmetrically spaced, and
   the power cable sheave, placed midpoint between two hoisting cable sheaves. Cover the
   head frame with a firmly attached copper free aluminum cover. Fabricate the structure from
   1/4-inch ASTM A 36 steel plate that is hot-dip galvanized in accordance with ASTM A 123.
   Attach the head frame to the pole with a steel slip-fitter, and secure with stainless steel set
   screws.
   Provide press-fit oil-impregnated sintered bronze bushings at the hub for all sheaves.
   Provide keepers to prevent the lift and power cables from riding out of the sheaves or roller
   assemblies during erection and operation.

707.2.6.2.2 Luminaire Ring
   Construct the Luminaire ring of 6 in, 8.2-pound single-piece channel with the appropriate
   number of 2 in nominal steel pipe mounting arms, symmetrically mounted. Hot-dip galvanize
   after fabrication.
   Pre-wire the ring with a suitable number of conductors having a current-carrying capacity
   of the total load with a maximum voltage drop of 3% and with 105C type SEO distribution
   cable.
   Provide a protective roller system for the inner portion of the lowering ring to permit the
   ring to contact the pole shaft during raising and lowering operations, to prevent damaging
   either the ring or the pole. Use rollers consisting of water-resistant, non-marking Material with
   oil-impregnated bronze bushings on stainless steel shafts.
   Provide three high-visibility reflector indicator flags for the Luminaire rings, visible from
   the ground after mounting. Ensure that the Luminaire ring properly engages the head frame,
   so the flags trip to signal the operator.

707.2.6.2.3 Hoisting Cable
   Support the Luminaire ring with three (3/16-inch diameter) stainless steel 19 × 7 strand
   non-rotating aircraft cables (Military Spec.: MIL-W-83420) with a minimum breaking strength of
   3,700 lb. Anchor the ends of the cables in the Standard to the top of the suspension bracket.
   Pass the lift cable up through the pole shaft, over the head frame sheaves, to the
   Luminaire ring; lead through guides and a compression spring, and terminate with a collect-
   type device. Prevent twisting and eliminate torsion developed during the initial installation of
   the hoisting cable system.

707.2.6.2.4 Safety Mechanism (Latching Device)
   Provide a safety mechanism that allows disengagement of the winch assembly in the
   base of the pole, consisting of two multi-point safety chain and hook assemblies to maintain
   the tension on the transition assembly. Galvanize the chain and hooks. Secure each chain to
   a plate welded to the inside of the pole shaft. Ensure that the safety mechanism is self-
   contained within the pole and independent of the pole foundation.
   As an alternate to the above safety mechanism, the Contractor may provide a top latch
   returning system, as recommended by the manufacturer. Submit the shop drawings and
   design calculations for the lowering device to the Project Manager for preapproval of the
system by the Lighting and Signal Engineer. Do not begin fabrication until the Lighting and Signal Engineer reviews and approves the design and shop drawings.

Fabricate the safety mechanism, cams, and all hardware on the support ring of stainless steel.

707.2.6.2.5 Winch

Provide a worm-gear reducer type winch with a self-locking reduction ratio in both raising and lowering operations. Provide a winch drum prewound with stainless steel 19 × 7 strand, 1/4-inch diameter, aircraft cable (Military Spec.: MIL-W-83420). Ensure that the winch has an ultimate strength of five times the lifted load, if measured with the appropriate number of layers of cable on the drum. Provide a transition design to prevent twisting of support cables, to ensure smooth winding of the cable on the winch, and to prevent binding on the inside of the tower shaft. Provide a winch cable of sufficient length to maintain at least four complete wraps on the winch drum, once the system has been lowered to its lowest point.

707.2.6.2.6 Electrical

Use 3/c, #10 AWG (4/c if three-phase circuit is specified) Type SO portable power cable for the main power cable, unless otherwise specified in the Contract.

Securely connect power cables to a weather tight wiring box on the Luminaire ring and terminate on a 600-volt terminal block. Provide a twist lock power receptacle to allow testing of the Luminaires in the lowered position.

Provide a breaker complete with a NEMA 1 enclosure, accessible through the hand hole in each Standard. Size the breaker as follows:

1. Two-pole, 30 A for 240 V, single-phase.
2. Two-pole, 20 A for 480 V single-phase.
3. Three-pole, 15 A for 480 V, three-phase.

Provide the type of service specified in the Contract.

707.2.6.2.7 Hardware

Fabricate all miscellaneous fittings, fastenings, or hardware for the support head frame and Luminaire-mounting ring of AISI Series 300 stainless steel with approved means for locking nuts.

707.2.6.2.8 Portable Power Unit

Incorporate the drive motor, torque limiter, drive shaft, and electrical controls in the portable power unit. Provide a power unit that one person can install, operate, and remove. Provide a drill motor controlled by a reversing switch connected by a 20 ft remote cord. Use gasket-type cord grips to prevent damage to the flexible cords.

707.2.7 Anchor Bolts

Provide four anchor bolts with each Standard. For Type VI Standards, provide anchor bolts in accordance with Section 707.2.6, “Type VI Standards.” Fabricate anchor bolts of sufficient size and length to support the Structure with the design loads. Use high-strength steel bars, with a guaranteed minimum yield strength of 55,000 psi, or steel in accordance with AASHTO M 314.

Fabricate each anchor bolt with an “L” bend at the bottom. Provide one leveling nut and one hold-down nut with each bolt. Provide each anchor bolt with nuts and washers, as required.

707.2.8 State-Furnished Materials

If specified in the Contract, the Department will provide the Standards and mast arms at specified locations.

707.3 CONSTRUCTION REQUIREMENTS

707.3.1 General

Installation includes erection of completed Standards, leveling of Standards, required grouting between Standard bases and foundations, and the installation of anchor bolts in foundations.

Retap and seal threaded holes and hubs with heavy grease or another type of preservative to prevent rust. Drill the required field-made holes (such as for mounting
pedestrian push buttons) neatly. Do not use a cutting torch. If torque values are specified in the Contract for anchor bolt nuts, Breakaway couplings, or slip bolts, make all adjustments with an approved torque wrench. Do not use alternate torque values, unless approved by the Project Manager.

707.3.2 Galvanized Steel Standards
Repair scratches caused by erection and handling in the field with 95% zinc-rich paint.

707.3.3 Type II Standards Installation Requirements
Ensure that the length and position of arms are in accordance with the Contract. Attach the arms securely to the shafts.

707.3.4 Type V Standards Installation Requirements
Install davit arms in accordance with manufacturer’s recommendations, to prevent rotation under wind loads. Drill the through holes for bolts in the top pole tenon in the field. If the arms rotate after erection, lower the Type V Standard, reassemble the arm, and reinstall the Type V Standard with the arm in the proper position.

707.3.5 Type VI Standards Field Assembly
For a slip-fit design, submit the proposed method for field assembly of Standard sections to the Project Manager for approval. Perform field assembly of the Standard sections and the assembly of the lowering device under the supervision of a representative of the manufacturer, trained, experienced in field assembly, and knowledgeable of the operation and construction of the Material supplied.

707.3.6 System Training
Provide a field representative to train the Department’s personnel and local utility personnel, for one day, in the system’s operation (lowering the devices, changing luminaries, etc.). Submit the complete training program to the Project Manager and the Lighting and Signal Engineer for approval at least 15 Working Days before scheduling the system training. Include the following in the training:
1. Working outlines of presentations;
2. Specification manuals;
3. Videotape;
4. Handouts; and
5. Other materials to be distributed during the training.

707.3.7 New Foundations for Signal and Lighting Standards
Construct new foundations for signal and lighting Standards in accordance with Section 708, "Foundations for Signal and Lighting Installations."

707.3.8 Relocation of Existing Signal and Lighting Standards
Do not remove existing signal and lighting Standards until placement of new foundations, accepted by the Project Manager. Notify the Project Manager, Traffic Services Signal Laboratory, and the Maintaining Agency at least 5 Working Days before removing and resetting specified signal and lighting Standards. The Department will provide all shop drawings and other documents of record on the existing in-place signals and lighting Standards. Provide all work and Materials required for rewiring relocated signals and lighting Standards, as included in this work. Supply the new foundation for relocated existing signals and lighting Standards.

707.3.8.1 Removing and Resetting High-Mast Standard and Luminaire
When specified in the Contract, construct new foundations for the existing Type VI Standards. Remove the existing Type VI Standards and the Luminaires and relocate the Standards and Luminaires to the new foundations.

707.3.8.2 Removing and Resetting Roadway Standard and Luminaire
When specified in the Contract, construct new foundations for the existing Type V Standards. Remove the existing Standards and Luminaires and relocate the Standards and Luminaires to the new foundations.
707.3.8.3 Removing and Resetting Traffic Signal and Mast Arms
   When specified in the Contract, construct new foundations for the existing Type I, II, and
   III Standards. Remove the existing Type I, II, and III Standards, traffic signals, and mast arms.
   Relocate the Standards, traffic signals, and mast arms to the new foundations.

707.3.9 State-Furnished Standards, Mast Arms, and Roadway Luminaires
   If specified in the Contract, load, haul, and install State-furnished lighting Standards, mast
   arms, and Roadway Luminaires.

707.4 METHOD OF MEASUREMENT—Vacant

707.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
<td>Type____ Standard, ____ ft</td>
<td>Each</td>
</tr>
<tr>
<td>Type____ Standard, ____ ft, Arm</td>
<td>Each</td>
</tr>
<tr>
<td>Remove and Reset High Mast Standard and Luminaire</td>
<td>Each</td>
</tr>
<tr>
<td>Remove and Reset Lighting Standard and Luminaire</td>
<td>Each</td>
</tr>
<tr>
<td>Remove and Reset Traffic Signal and Mast Arm</td>
<td>Each</td>
</tr>
<tr>
<td>Install State-Furnished Standards, Mast Arms, and Roadway Luminaires</td>
<td>Each</td>
</tr>
<tr>
<td>High Mast Lowering Device</td>
<td>Each</td>
</tr>
</tbody>
</table>

   The Department will pay for foundations in accordance with Section 708, “Foundations for Signal and Lighting Installations.”

707.5.1 Work Included In Payment
   The following work and items will be considered as included in the payment for the main
   items and will not be measured or paid for separately:
   A. Anchor bolts;
   B. Hardware;
   C. Protective coatings; and
   D. Conductors for type IV, type V, and type VI standards; and training and technical
      services for type VI standards.
SECTION 708: FOUNDATIONS FOR SIGNAL AND LIGHTING INSTALLATIONS

708.1 DESCRIPTION
This Work consists of constructing reinforced concrete foundations for support of traffic signal Standards, Luminaire Standards, and control cabinets.

708.2 MATERIALS
708.2.1 Concrete
Use Class A concrete in accordance with Section 510, “Portland Cement Concrete.”

708.2.2 Steel Reinforcement
Provide steel reinforcement in accordance with Section 540, “Steel Reinforcement.”

708.3 CONSTRUCTION REQUIREMENTS
708.3.1 General
Place foundations on firm ground. If the excavation conflicts with existing underground or overhead utilities, the Project Manager will determine a new location or provide a new foundation design or utility relocation. Restore the ground surface to its original elevation, if relocation is necessary. Construct foundations with final elevations no more than 1 in above the final pavement elevations or nearest top of curb elevation.

In Sidewalks, provide flush top standard foundations level with the surface of the Sidewalk and place expansion Material between the foundation and the Sidewalk.

708.3.1.1 Cast-In-Place Requirements
Securely brace rigid cast-in-place forms true to line and grade. Thoroughly moisten the forms and ground before placing concrete. Place the concrete for each foundation in one operation.

After placement and before the concrete sets, raise and lower each anchor bolt to properly align, distribute concrete aggregate, and remove air voids. Give exposed surfaces of concrete foundations a smooth and straight finish, free of form marks.

708.3.2 Control Cabinet Foundations
Provide ground-mounted flush-top type control cabinet foundations, unless otherwise specified in the Contract.

Properly locate and place cabinet anchor bolts during concrete placement. Place a Class A concrete base pad in front of control cabinet foundations. Construct the concrete pad in accordance with the Contract.

708.4 METHOD OF MEASUREMENT—Vacant

708.5 BASIS OF PAYMENT
The Department will pay for PCC used in foundations for signal and lighting installations in accordance with Section 510, “Portland Cement Concrete.”

The Department will pay for steel reinforcement used in foundations for signal and lighting installations in accordance with Section 540, “Steel Reinforcement.”

708.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately: excavation, backfill, compaction, and additional excavation, backfill, and encasing of existing utilities due to utility line conflict and foundation relocation.
SECTION 709: RIGID ELECTRICAL CONDUIT

709.1 DESCRIPTION
This Work consists of providing and installing rigid electrical conduit.

709.2 MATERIALS
709.2.1 Nonmetallic Conduit
Nonmetallic conduit shall be high-impact PVC. Schedule 40 conduit and elbows are manufactured to NMEA TC-2 UL 651 Specifications. Conduit and fittings shall comply with requirements of UL standards (Publication UL 651) and carry respective UL listings and labels.

709.2.2 Metallic Conduit
Provide galvanized rigid conduit in accordance with UL 6, ANSI C80 and Federal Specification WW-C-581E, or intermediate metallic conduit (IMC) in accordance with UL 1242 and Federal Specification WW-C-581E.
Hot-dip galvanize IMC. Provide watertight fittings of the same material as the conduit. Provide approved watertight, expansion couplings for metallic conduit, as recommended by the manufacturer and designed to compensate for linear thermal expansion of a run of metallic conduit.

709.2.3 Liquid-Tight Flexible Conduit
Provide liquid-tight flexible conduit consisting of an extruded polyvinyl jacket over a flexible hot-dipped galvanized core (Type UAG), UL listed, and in accordance with the NEC®.

709.3 CONSTRUCTION REQUIREMENTS
709.3.1 General
Run electrical cable and wire in conduit, except inside poles, unless otherwise specified in the Contract.
Use nonmetallic conduit for underground installations. Use metallic conduit for Bridge decks and railings. The Contractor may encase conduit in concrete bases. Use metallic conduit for above ground installations. The Contractor may use larger size conduit than specified in the Contract, at no additional cost to the Department, provided the larger size is used for the entire run from outlet to outlet. The Department will not allow reducing couplings.
When using existing underground metallic conduit in a new system, clean with a mandrel and blow out with compressed air. Blow out existing nonmetallic conduit with compressed air. If the existing conduit contains excessive amounts of Deleterious Material, flush conduit with water and blow with compressed air, as directed by the Project Manager.
Provide pull boxes at the locations specified in the Contract.

709.3.1.1 Conduit Routings
The Project Manager may change conduit run routings specified in the Contract to avoid underground obstructions. Keep accurate records of any change from conduit locations specified in the Contract on as-built drawings, and submit the details to the Project Manager before the Department’s final acceptance of the project.

709.3.1.2 Excavation and Backfill
Plan the trenching and conduit placement operation to minimize overnight open trenches and exposed conduit.
Excavate (trench) and backfill conduit trench in accordance with Section 705.2.2, “Backfill Materials,” and Section 705.3.2, “Excavation and Backfill.”

709.3.1.3 Conduit Placement Depth
Lay conduit at least 30 in below the following:
1. Finished surface in street and driveway areas;
2. Top of curb in Sidewalk areas; and
3. Natural ground line in unpaved areas. If approved by the Project Manager, the Contractor may place the conduit from 18 in to 30 in deep in the following areas:
4. Unpaved median;
5. Open (natural ground) where the Department plans no future development; and
6. Where underground utility conflicts occur at the 30 in depth.

709.3.1.4 Conduit Terminations
Terminate, stub, and cap conduit, as required. Thread metallic conduit ends and cap with standard conduit caps until wire placement begins. Provide insulated metal ground bushings for threaded ends when caps are removed and electrically connect them in accordance with the NEC®. Cap nonmetallic conduit ends until wiring begins.

Extend conduit terminating in poles, cabinets, or pedestal bases from 2 in to 4 in vertically above the bases.

Terminate conduit that enters a pull box from 1 in to 3 in inside the box wall and from 2 in to 3 in above the top of gravel sump and slope it to facilitate convenient pulling of wires or cables.

To ensure pull boxes are uncluttered, run conduit into the pull box bottom at the nearest wall. Allow for expansion and contraction of the conduit.

Install conduit terminations with bushings to prevent wire insulation damage during installation.

709.3.1.5 Conduit Bends
Make conduit bends, except factory bends, with a radius of at least six times the inside diameter of the conduit. Ensure bending radii and the number of bends in accordance with the NEC® and local codes.

Use factory-made bends or bend conduit without crimping or flattening, using the longest radius practical.

Use metallic bends for difficult or long conduit runs.

709.3.2 Nonmetallic Conduit
Straight cut nonmetallic conduit; square and trim ends after cutting to remove rough edges. Use solvent weld connections in accordance with the conduit manufacturer's recommendations. If connecting nonmetallic conduit to metallic conduit, use threaded couplings.

Run a solid, bare No. 8 or larger, AWG copper conductor continuously in nonmetallic conduit, except in conduit containing only communication cables.

Install expansion couplings according to the manufacturer’s diagrams and instructions.

709.3.2.1 HDPE Conduit Extruded over Conductors
If allowed by local electrical codes for lighting and service run conduit, the Contractor may use HDPE conduit that is continually extruded over the wire or cable specified in the Contract. Prevent adhesion between the wire or cable and the conduit.

Obtain approval for this method from the electrical inspecting authority and provide proof to the Project Manager before installation.

709.3.2.2 Bending of Nonmetallic Conduit
Bend nonmetallic conduit using one of the following methods:
1. Apply an even heat, not to exceed 300 °F, to a portion of the conduit wrapped in aluminum foil, until attaining the desired flexibility. Minimize charring of the conduit.
2. Use of a thermobender, suitable for bending nonmetallic conduit.

709.3.3 Installation Under Existing Pavement
Install metallic conduit under existing pavement by approved jacking or boring methods. If using drilling mud, the Contractor may install nonmetallic conduit by machine pulling through a directionally bored hole. Do not machine pull nonmetallic conduit through dry holes (made by hole hog or other dry-expansion methods). Place jacking or boring pits at least 2 ft from the edge of any type of pavement, measured from the side of the pit nearest to the pavement. Only use metallic conduit, if jacking conduit.

The Department will not allow the excessive use of water in the installation of conduit under existing pavement.

Project Manager may approve relocation of conduit runs or pavement cutting where insufficient room exists for jacking or boring pits, or if underground obstacles are encountered.

Repair existing pavement, sidewalks, driveways and landscaped areas to original or better condition at no additional cost to the Department.
709.3.4 Conduit for Structures and Foundations
Cap conduit stubbed out for future use from Structures or foundations. Rust-protect metallic conduit to a minimum of 6 in inside concrete Structures or foundations. The Department will not require rust protection for nonmetallic conduit. Seal conduits running to soffits, walls, or light fixtures below the elevation of the pull box with an approved sealing compound. Also, seal light fixtures located below the elevation of the pull box.

709.3.4.1 Bridge Structures
Use metallic conduit embeded in concrete for abutments, piers, or bridge decks. Securely attach conduit to the reinforcing steel (by approved methods) at intervals not to exceed 4 ft. Use galvanized malleable iron clamps (or other approved methods) to secure conduit runs on Structure surfaces spaced no more than 5 ft apart.

709.3.4.1.1 Expansion Fittings
Install expansion fittings where conduit crosses a Structure joint, using tubing the same size as the conduit. Provide expansion fittings with a bonding jumper of No. 6 AWG flexible wire or approved equivalent. If use of expansion fittings or flexible tubing is not feasible, as determined by the Project Manager, install the conduit in a watertight metal sleeve. Ensure a clearance between the outside of the conduit and the inside of the metal sleeve of from 1/2 in to 1 in.

709.3.4.1.2 Flexible Conduit
The Contractor may use liquid-tight flexible conduit between Structure sections to accommodate movement, if specified in the Contract. The Contractor may use liquid-tight flexible conduit within a concrete pour, if approved by the Project Manager.

709.4 METHOD OF MEASUREMENT
The Department will measure Rigid Electrical Conduit parallel to the centerline of the installed conduit.

709.5 BASIS OF PAYMENT

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<th>Pay Item</th>
<th>Pay Unit</th>
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<tr>
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<td>Foot</td>
</tr>
</tbody>
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709.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately: hardware for conduit installation, excavation, backfill, boring, jacking and compaction, protective coatings; Bare No. 8 AWG copper conductor for nonmetallic conduit installation; and cutting of pavement and replacement of surfacing.
710.1 DESCRIPTION
This Work consists of providing and installing pull boxes and splice cabinets, and constructing Traffic Signal manholes.

710.2 MATERIALS
710.2.1 General
Provide electrical pull boxes:
1. Of reinforced fiberglass mortar or reinforced plastic mortar, unless otherwise specified in the Contract;
2. For use in Sidewalk, median and natural ground areas;
3. Open bottomed with provisions for drainage; and
4. Designed for light vehicular traffic, AASHTO H 10 loading (5,000 lb single axle over a 10 in × 10 in area).

Provide pull boxes in accordance with the structural requirements of Western Underground Committee Guide No. 3.6, Incidental Traffic Loading (parts 4.1.3, 4.2.1 and 4.2.3).

Provide enclosed, watertight metal pull boxes for installation in Bridge decks, railing, and other areas subject to vehicular traffic. Use only this type if specified in the Contract. Provide boxes that support, in place, an AASHTO H 20 loading (32,000 lb single axle over a 10 in × 20 in area).

710.2.2 Hybrid Fiberglass Polymer Pull Box
Provide hybrid pull boxes consisting of a compound prepared by blending an unsaturated polyester resin (esperox catalyst) with powdered mineral fillers (calcium carbonate and calcium stearate) and chopped fiberglass strands. Add UV inhibitors to the compound for UV stabilization. Color with pigment and other additives. Fabricate pull boxes in accordance with Western Underground Code 3.6.

Provide hybrid pull boxes that meet or exceed minimums for compressive strength of 20,000 psi, tensile strength of 5,000 psi, and flexural strength of 6,000 psi.

710.2.3 Reinforced Plastic Mortar Pull Box
Fabricate plastic mortar pull boxes using a “sandwich” method. Use an outer layer of fine sand and resin to provide a tough wear coating. Provide a sandwich of fiberglass reinforced plastic mortar consisting of coarse sand, graded sand, and ortho-type polyester resin for the interior material.

Ensure the Material meets or exceeds the following minimum strength requirements for compressive strength of 11,000 psi, tension strength of 1,700 psi, and flexural strength of 7,500 psi.

710.2.3.1 Testing and Acceptance of Plastic Mortar Pull Boxes
Provide Material in accordance with the following:
1. ASTM D 543, Section 7, Procedure 1;
2. ASTM D 756, Procedure E;
3. ASTM D 570, and
4. ASTM G 154.

For acceptance, test results shall meet or exceed the minimum acceptance criteria (retention of 75% of control values) with no visual cracking, checking, or surface pitting for Material tested at −40°F and at 194°F.

710.2.4 Metal Pull Boxes
Provide metal pull boxes in accordance with the following:
1. Of closed-bottom type (external recess flanged), designed for flush mounting in concrete;
2. Designed for vehicular traffic (AASHTO H 20 loading), except if installed in Sidewalk areas where the Contract specifies a minimum of AASHTO H 10 loading design; and
3. Fabricated from cast iron with a hot-dipped galvanized finish.
710.2.4.1 General Pull Box Cover Requirements

Provide each cover with flush lifting eyes and two openings for bolting the cover down.
Provide covers designed to support an AASHTO H 10 load. If specified in the Contract, provide covers designed to support an AASHTO H 20 load.
Fabricate cast iron covers with No. 4 bare copper ground clamps to attach grounds.
Provide cast iron covers for concrete pull boxes.
Provide steel or cast iron covers for reinforced plastic mortar pull boxes with the following characteristics:
1. Galvanized crossribbed cast iron or ductile iron,
2. Designed for the required loading,
3. Fastened to the boxes with stainless steel or brass screws,
4. Sealed with a neoprene gasket providing a water tight NEMA 4 enclosure,
5. Checkered (non-slip) surface with pry bar slots.

710.2.5 Pull Box Cover Inscriptions

Inscribe or emboss pull box covers with the words “TRAFFIC SIGNAL” or “LIGHTING,” as specified in the Contract. On metal pull boxes use a bead weld or other type of permanent lettering approved by the Project Manager to identify the specific circuit, as follows:
1. “LIGHTING” = Lighting and Rest Area Electrical;
2. “TS” = Traffic Signal; and
3. “SC” = Sprinkler Control.
If using a bead weld on a galvanized box, coat the affected area with zinc-rich paint.

710.2.6 Splice Cabinet

Provide a NEMA 12 enclosure UL listed “Industrial Control Panel” in accordance with UL 506.

710.2.7 Concrete and Reinforcing Steel

Provide Class A concrete, cement, air entrain ment, admixtures, water, and aggregate in accordance with Section 510, “Portland Cement Concrete.”
Provide steel reinforcement in accordance with Section 540, “Steel Reinforcement.”

710.2.8 Drainage Geotextiles

Provide Class B drainage geotextiles in accordance with Section 604, “Soil and Drainage Geotextiles.”

710.2.9 Traffic Signal Manhole

710.2.9.1 Concrete Collar

Provide Class A concrete in accordance with Section 510, “Portland Cement Concrete.”

710.2.9.2 Steel Culvert Pipe

Provide corrugated metal pipe Culvert in accordance with Section 570, “Pipe Culverts.”
Dip steel Culvert pipe in coal tar enamel or coat with polymeric coating approved by the Project Manager. Provide a 3 mil thick coating in accordance with AASHTO M 246.

710.2.9.3 Manhole Covers

Provide Traffic Signal manhole covers in accordance with Section 662, “Manholes.”

710.3 CONSTRUCTION REQUIREMENTS

710.3.1 General

Install each pull box flush with the curb or Sidewalk grade with no part of the box or attaching screws protruding above the surface. If no grade is specified, place pull boxes slightly higher than the surrounding ground to provide drainage away from the pull box.
Install metal pull boxes in Bridge decks and pavement flush with the pavement surface.
Install electrical pull box extensions to provide additional volume, as necessary or as specified in the Contract.
If necessary to facilitate the work (for the Contractor convenience), install more pull boxes than shown in the Contract at no additional cost to the Department.
Provide each pull box with a Class A concrete collar placed around the pull box, separated by a 1/2 inch felt expansion joint. If placing concrete collar in an area to receive colored concrete, match the pull box concrete color with the colored concrete.
710.3.2 Metal Pull boxes
Make conduit entrances in metal pull boxes with a hole saw, or as approved by the Project Manager.

710.3.3 Pull Box Sumps
Provide sumps in pull boxes consisting of 2 in maximum size rock fill, surrounded by drainage geotextile.
With the exception of metal pull boxes installed in concrete, provide an 18 in deep sump below pull boxes. If using pull box extensions with pull boxes to provide extra depth, make sumps 30 in deep.
Excavate holes to allow a minimum 6 in clearance on the sides of the boxes and extensions. Provide rock fill around outside walls. Place Class B drainage geotextile between the backfill and rock fill.

710.3.4 Traffic Signal Manhole
Install each Traffic Signal manhole so that the cover is flush with the curb or Sidewalk grade and no part of the manhole protrudes above finish grade. If the Contract does not specify a grade, place covers slightly higher than the surrounding ground to provide drainage away from the manhole.

710.4 METHOD OF MEASUREMENT—Vacant

710.5 BASIS OF PAYMENT

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<td>Electrical Pull Box (Large)</td>
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<td>Electrical Pull Box Extension</td>
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<tr>
<td>Metal Pull Box</td>
<td>Each</td>
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<tr>
<td>Splice Cabinet</td>
<td>Each</td>
</tr>
<tr>
<td>Traffic Signal Manholes</td>
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</tbody>
</table>

710.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:
A. Hardware;
B. Excavation, backfill, and compaction;
C. Reinforcing steel;
D. Concrete; and
E. Materials for pull box and traffic signal manhole sumps.
SECTION 711: WIRING

711.1 DESCRIPTION
This Work consists of providing and installing wiring for Traffic Signal and Highway lighting systems.

711.2 MATERIALS

711.2.1 General
Provide wire and cable in accordance with the appropriate sections of the International Municipal Signal Association’s (IMSA) Wire and Cable Specifications and the New Mexico Electrical Code (14.10.4 NMAC) and that carries the UL label. Use only copper conductors of the specified trade size.

711.2.2 Multi-Conductor
Provide polyethylene insulated, PVC or polyethylene jacketed, solid wire signal cable multi-conductors in accordance with IMSA Specification 19-1 or 20-1. Provide special multi-conductor cable for direct burial or self-supporting applications, as specified in the Contract.

Provide color code conductors in accordance with IMSA Specification 19-1 or 20-1, Section 5.1 Table II for unpaired conductor cables. Provide No. 14 AWG size copper conductors, or conductors as specified in the Contract.

Provide molten dyed polyethylene tracer color co-extruded with the base color.

711.2.3 Single Conductor
Provide moisture- and heat-resistant thermoplastic insulated electrical cable for single conductors rated at 600 V for installation in conduit and pipe.

Provide No. 12 AWG size or smaller solid copper conductors in accordance with ASTM B 3. Use uncoated wire unless otherwise specified. Provide No. 10 AWG size or larger stranded conductors in accordance with ASTM B 8, Class B. Provide solid No. 8 AWG minimum for ground wires.

711.2.3.1 Insulation
711.2.3.1.1 Compound
Provide thermoplastic high heat resistant nylon coated (THHN) or thermoplastic heat and water resistant nylon coated conductors in accordance with UL 83.

711.2.3.1.2 Thickness
Ensure that insulation thickness is in accordance with ASTM D 2220 and NEC®, Table 310-13.

711.2.3.1.3 Testing
Provide conductors factory tested to ensure compliance with UL 83.

711.2.3.1.4 Identification
Provide conductors with distinctive, permanent markings on the outer surface for the entire length showing manufacturer, type of insulation, size of conductor, and voltage rating. Provide solid color or basic colored insulation with a permanent colored stripe the entire length of the conductor.

711.2.4 Communication Cable
Provide a paired polyethylene-insulated, polyethylene-jacket communication cable with electrical shielding, rated 300 V, in accordance with IMSA specification No. 40-2-1990 (or Rural Electrification Administration specification PE-22 or PE-39), suitable for use in underground conduit. Provide a conductor of No. 19 AWG copper, unless otherwise specified.

711.2.5 Ground Rods
Provide ground rods from hard-drawn, high-conductivity electrolytic copper fluted rods, or bare, round, hard-drawn copper-covered steel rods.

711.3 CONSTRUCTION REQUIREMENTS

711.3.1 General
Install wire in accordance with the NEC®, state, and local requirements. Neatly arrange
and lace wiring within cabinets, pull boxes, and pole bases.
Install bushings on metallic conduit ends before pulling wire.
For each conductor or cable, leave a minimum of 4 ft of slack at each signal or lighting Standard and a minimum of 2 ft of slack at each pull box.
Tape or otherwise insulate ends of spare conductors.

711.3.2 Identification
Identify the phase or function of signal cable conductors with the insulation colors specified in the Contract and the following:
1. Black insulation for lighting circuit and signal service conductors;
2. Black or red insulation for two ungrounded multiple lighting circuits; and
3. White insulation for neutral and common wiring.
Install identification tags at cabinet, pull box, and pole locations where two or more conductors or cables for different functions have the same insulation colors. Use permanent fiber or PVC tags for tagging wires.
Place the low-voltage circuits for pedestrian push buttons in a separate multi-conductor cable from 115-V function conductors, and identify all conductors at each splice point.

711.3.3 Terminals
Secure cable wires to screw-type terminals in traffic signal heads, pedestrian push buttons, and traffic controllers, or as specified in the Contract. Spade tongue-type connectors shall be affixed to conductors using a pigtail connector or a tool specifically designed for connecting connectors to conductors.

711.3.4 Splices
The Contractor may use conductor splices for Traffic Signals only inside cabinets and transformer bases with wiring access. Do not use splices in pull boxes, except in those for signals in medians. The Contractor may use conductor splices for lighting installations inside cabinets, transformer bases, or pull boxes.
Make wiring connections at the appropriate terminals. Loop detector wire or video camera power and data cables as specified by the manufacturer. Do not splice suspended cable used on span wire installations.
Do not use soldered connections for splicing, except for connection of loop lead in cable to loop detector wire. Weatherproof the entire splice. Wrap splices with all-weather plastic electrical tape. Tape cable ends to exclude moisture while pulling cables into conduit. Keep ends taped until completing splices or attaching terminal appliances.
Use communication cables for signal interconnect systems, with splicing at terminals or as specified in the Contract. The Department will not allow other splicing. For signal installations, use only spring-type connectors for splicing 600 V conductors. For lighting installations, make underground splices waterproof, using an NEC® approved method.

711.3.4.1 Spring-Type Connector
Join the wire ends with an insulated spring-type connector without soldering. Provide a two-component, self-curing epoxy resin in a double-compartment plastic envelope. To make the splice insulation, thoroughly mix the components in the envelope and, after cutting open one end of the envelope, insert the wire connection into the epoxy resin and tape the envelope shut. Provide sufficient epoxy resin to completely cover the connector and exposed bare wires at the connector.

711.3.4.2 Fused Splice Connector
Install a fused disconnect splice connector of the “breakaway” type at each ungrounded conductor in Type IV and V Standard bases between the line and load sides on multiple lighting circuits. Provide an integral un-fused connection in the connector, providing similar and simultaneous disconnect between the load and line sides on the neutral, if a neutral is used. The Contractor may use fused splice connectors with either single or dual housings. Make connectors readily accessible from the Standard base hand hole.
Provide a fully self-insulated and waterproof splice connector. Provide line and load side housings of an elastomeric material capable of meeting the Impact and Dielectric Voltage Withstand Test, in accordance with UL 486D, for an assembled connector. Integrally mold line and load side housings with cable sealing boots providing a defined series of cylindrical bores.
to receive and provide a waterproof seal on appropriately sized insulated conductors. Do not use tapes or other sealing compounds.

Design fused-splice connectors to disconnect at a maximum tension of 35 lb, for each conductor attached to the load side. Ensure that the fuse(s) or neutral pin contact is securely retained on the load side when disconnected. Provide line-side housings with a thickness of at least 1 1/4 in.

Use in-line type Buchanan 65/D65 fused splice connectors, or an approved equal, with fuse housings for all phase/phase type connections requiring one or two fuses. Use polarized dual connectors (D65 or equivalent) that provide simultaneous disconnect of both phases, assuring no exposure to energized electrical contacts.

Use 20/D65 PN connectors, or an approved equal, for circuit designs of the phase/neutral type connection. Provide polarized dual connectors (D65PN or equal) with two compartments. Fit one compartment with fuse contacts and the opposite compartment with a solid neutral pin contact. Fit the neutral side with a white marker to indicate the neutral side.

Rigidly crimp splice connector terminals onto line and load connectors using a tool recommended by the connector manufacturer. Insulate and waterproof terminals in accordance with the connector manufacturer's recommendations.

Use standard midget ferrule type fuses. Use 10 A fuses for 240 W or 400 W lamps.

711.3.4.3 Tap Splices

Make tap splices in pole bases are to be as specified by the service utility provider.

Splice each circuit conductor in the pole base, inserting the feeder conductor and the continuing run conductor into the double end boot of the connector and securing each into the respective set screw terminal. Use No. 10 AWG Copper, Type thermoplastic heat and water resistant insulated wire, rubberized heat and water resistant insulated wire, or approved equal insulation, for the tap conductor feeding the fused splice connector. Do not use THHN-type insulation.

Feed the tap conductor through the tap boot (as specified in the manufacturer's instructions) and attach under the center set screw.

Mark neutral conductors with white marking tape.

711.3.5 Bonding and Grounding

Mechanically and electrically secure metallic cable sheaths, metal conduit service equipment, and metal poles and pedestals to form a continuous system. Effectively ground the system. Bond with copper wire or copper strip of at least the same cross sectional area as No. 8 AWG. Use solid No. 8 AWG at minimum for grounding jumpers.

Use a bonding strip attached to the lower portion of the shaft or base to bond Standards and pedestals.

For nonmetallic conduit systems, run a bare copper wire of No. 8 AWG or larger through conduit runs, pull boxes, and to poles. Splice these wires at termination points and tie into neutral bars at service facilities or control cabinets.

Install a ground rod (electrode) at each multiple service point, each Traffic Signal Standard, each cabinet foundation, and each Luminaire foundation. Provide 3/4 in nominal diameter ground rods. Install so that at least 7.5 ft of the ground rod length is in contact with the soil and in accordance with NEC® specifications. Bond service equipment to the ground rod by a No. 6 AWG copper wire.

Where encasing portions of ground rods in concrete, wrap with three layers of pipe insulation tape, 0.01 in minimum thickness, or place through a 1-inch diameter PVC conduit.

Where a metallic conduit system parallels or crosses a permanent water system in accessible areas, install grounding jumpers at intervals not exceeding 500 ft. The Department will not allow grounding to a metallic water system at or near a service point, in lieu of driven ground rods. Use insulated grounding bushings and bonding jumpers to bond metallic conduit in nonmetallic pull boxes. Use lock nuts to bond metallic conduit in metal pull boxes. Use one lock nut inside and one lock nut outside of each box when the box is not threaded.

711.4 METHOD OF MEASUREMENT—Vacant

711.5 BASIS OF PAYMENT

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<td>Single Conductor  (AWG number)</td>
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Section 711: Wiring  Page 534
711.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:
   A. Splice connectors;
   B. Ground rods and grounding conductors;
   C. Hardware;
   D. Weatherproofing; and
   E. Tape.
SECTION 712: SIGNAL ASSEMBLIES

712.1 DESCRIPTION
This Work consists of providing and installing traffic and pedestrian signal assemblies on signal poles and attaching base plates and directional louvers to traffic signals.

712.2 MATERIALS
712.2.1 Traffic Signal Assembly
Provide standard 12 in lens size signal faces. A list of approved signal assembly equipment is available on the Department’s Approved Products List.

Ensure that signal assemblies meet the requirements of the latest edition of ITE Publication, *Adjustable Face Vehicular Traffic Control Signal Heads*. Provide adjustable, colored light, vertical or horizontal type signal assemblies with the number and type of lights (faces) specified in the Contract. Ensure that the signal assemblies adjust 360° about a vertical axis.

Fabricate signal assemblies, housings, and doors of either aluminum or polycarbonate resin material. If using polycarbonate resin material, ensure its capability to withstand an impact of 70 lb per foot without fracture or permanent deformation.

Design signal assemblies to accept mounted back plates.

712.2.1.1 Optical Units
Ensure that an optical unit consists of a lens, a reflector, and a lamp holder with lamp in accordance with ITE standards and ANSI D 10.1.

Provide circular lenses with visible diameters of 12 in that produce an outward and downward light distribution, with a minimum of light distributed above the horizontal. Provide true color lenses (as specified in the Contract), of best quality glass or polycarbonate resin material, free from imperfections, and of high-illumination transmission.

Provide one-piece alzak aluminum reflectors. Provide an opening in the back of each reflector for the lamp holder, designed to eliminate dark spots cast on the lens. Ensure that reflectors, lenses, and hoods reduce sun phantom to a minimum.

Provide heat-resistant molded phenolic housings for lamp holders designed for a 150-W standard A-21 Traffic Signal lamp. Ensure that the holder allows lamp positioning at the exact focal point of the reflector and proper lamp filament orientation without affecting lamp focus.

712.2.1.2 Housing
Signal housing consists of an assembly of separate sections without tie rods, substantially secured in a watertight manner to form the number of units required. Each section houses an individual optical unit.

Provide a one-piece housing for each section made of a polycarbonate resin material with sides, top, and bottom integrally molded. Ensure ribbed polycarbonate housings have at least a minimum thickness of 0.09 in. Ensure that the housing passes the ITE wind-load testing.

Include a one-piece hinged door in each section with mounting for the lens and other parts of the optical system, watertight gaskets, and a simple corrosion-resistance door-locking device. Provide interchangeable sections constructed for easy removal or addition. Provide a round opening in the top and bottom of each head for a 1 1/2 in supporting pipe frame.

Hinge each door and secure to the body of the housing with two stainless steel hinge pins, eyebolt, washer, and wing nut. Use corrosion-resistance screws and fasteners, where exposed to the elements. Make interior screws and fasteners from zinc-plated brass.

Integrally cast or mold a locking boss with 72 teeth into the signal housing at both openings. Make the angle of the teeth 90° and the depth of the teeth 0.0468 in. Ensure that the locking boss provides positive positioning of the entire signal head to eliminate rotation or misalignment.

Hold the reflector and lamp holder in place by an aluminum reflector ring, pivoting independently of the door, allowing lamp replacement without the use of tools. Seal the inside of the lens and reflector from dust and moisture with weather-resistant neoprene gaskets.

Mount a terminal block in the back of the middle section of the Signal Assembly. At a minimum, provide a four-position, eight-terminal, barrier-type strip terminal block for signal assemblies. Attach the signal section leads to the left of each terminal block and leave the opposite terminals for the field wires.
Provide two coded leads with NEMA quick-disconnect tabs for wiring from each lamp holder. Connect a white wire to the shell of the lamp holder and a black or colored wire to the bottom or end terminal of the lamp holder. For identification, color-code leads with the appropriate red, yellow, or green, (yellow or green tracer for arrow indications). If using black wires, permanently mark the terminals to identify the leads where they attach. Provide No. 18 AWG size, Type TFF leads.

712.2.1.3 Visors
Provide each signal section with a 12 in nominal length tunnel visor of 3003-H16 corrosion-resistant aluminum alloy sheet a minimum of 0.04 in thick in accordance with ASTM B 209. Encircle the lens with tunnel visors for 300° with a 4 in open slot on the bottom. Provide the visor with four twist-on attaching ears for installation to the signal door by four corrosion-resistant screws. Provide the vertical outer face of the door with four threaded holes equally spaced around the circumference of the lens opening and 45° from the horizontal or vertical axis, to allow vertical or horizontal installation of the Signal Assembly.

712.2.1.4 Framework and Mounting Brackets
Provide mounting brackets consisting of assemblies of 1 1/2 in nominal size standard steel pipe and malleable iron, ductile iron, or brass pipe fittings. Securely assemble members to provide plumb or level support.

Conceal conductors within framework, poles, and signal assemblies. Provide cable guides that support and protect conductors that enter assemblies from poles. Coat threads with grease during field assembly.

712.2.1.5 Finish
When making the Signal Assembly of aluminum, completely impregnate the inside and outside surfaces of the signal housing and door with the resin material. Do not allow scratches that expose uncolored material.

When making the Signal Assembly of polycarbonate resin material, completely impregnate the required color into the resin material. Do not allow scratches that expose uncolored material.

Finish the visor and the outside surfaces of framework and mounting brackets with two coats of best-quality infrared oven-baked paint as follows:
1. Signal housing and door inside and out:
   1.1. Signal housing—federal yellow
   1.2. Signal door—flat black
2. Visor inside and out:
   2.1. First coat—baked epon primer, zinc chromate, or equal
   2.2. Second coat—flat black urea baked enamel having zero glass reflectance. Minimum dry film thickness of 0.001 in.
3. Use special finishes for special applications and as specified in the Contract.

712.2.1.6 Geometrically Programmed Louver
712.2.1.6.1 General
Provide a louver with the following features:
1. Fit all manufacturers’ 12 in signal visors;
2. Retrofit into existing 12 in signal visors;
3. Provide a full round ball display, with minimum slat effect, throughout the selected view range;
4. Provide an absolute exact visual cut-off;
5. Allow the view angle within each signal section to be adjusted to a designated area;
6. Have a minimum glow outside the view range;
7. Allow for controlling either the horizontal or vertical view range within the signal visor;
8. Lightweight (Not to exceed 5 lbs.);
9. Maintenance free

712.2.1.6.2 Housing
The housing design shall allow the baffle positions to be changed in order to adjust the view angle.

Section 712: Signal Assemblies Page 537
712.2.1.6.3 Baffles
1. Provide baffles identical in design and interchangeable within the housing.
2. The plane of each baffle shall be 90° to the centerline axis in the housing.

712.2.1.6.4 Attaching Hardware
Provide 6 black, self-threading screws with each louver assembly for attaching the louver to the signal section.

712.2.1.6.5 Installation Kit
Provide an installation kit suitable to be utilized as an aid in installing the louver assembly.

712.2.1.7 Traffic Signal Assembly (LED)
712.2.1.8 Optical Units
Design light emitting diode signal modules that do not require special tools for installation as retrofit replacements for optical units of standard traffic signal sections. Light emitting diode signal modules must fit into the existing traffic signal section housings, built in accordance with the requirements in the ITE publication ST-008B, Vehicle Traffic Control Signal Heads (VTCSH) without modification.

Removal of Material in the traffic signal section, excluding the optical unit components (lens, gaskets, lamp, lamp socket, and reflector) are not required during the installation of light emitting diode signal modules. Install light emitting diode signal modules to fit securely in the doorframe and be weather tight.

Use terminal block connections in the signal face or utilize an adapter that screws into the medium base lamp socket. Splices will not be allowed.

Integrate the lens of the light emitting diode signal module with the unit. Fabricate the convex lens, with a smooth outer surface, from ultraviolet stabilized plastic or glass. The lens is required a minimum exposure of 48 months to direct sunlight (ultraviolet) without deterioration.

If a polymeric lens is used, use a surface coating or chemical surface treatment to provide front surface abrasion resistance.

The operating temperatures range for light emitting diode signal modules are from −104 °F to 165 °F.

Protect light emitting diode signal modules against dust and moisture intrusion in accordance with the requirements in NEMA Standard 250-1991 for Type 4 enclosures.

Use a single, self-contained light emitting diode signal module not requiring onsite assembly for installation into existing traffic signal housing. Integrate the power supply for the light emitting diode signal module into the unit.

Manufacture the light emitting diode signal module assembly to withstand mechanical shock and vibration.

Conform the minimum initial luminous intensity values for light emitting diode signal modules to the requirements in Section 11.04 of the VTCSH at 77 °F.

Provide light emitting diode signal modules that after 48 months of continuous use over the temperature ranging from −104 °F to 165 °F, are at least 85 percent of the standard light output values specified in the VTCSH.

Ensure that the measured chromaticity coordinates of light emitting diode signal modules are in accordance with Section 8.04 and Figure 1 of the VTCSH over the temperature ranging from −104 °F to 165 °F.

Take luminous intensity measurements over the temperature ranging from −104 °F to 165 °F.

Measure color requirements while operating throughout the temperature ranging from −104 °F to 165 °F.

Operate light emitting diode signal modules over a voltage range from 120 V AC: 80 V to 135 V, 240 V AC: 184 V to 276 V, 12 V DC: 8 V to 24 V at a frequency of 60 Hz ± 3 Hz. Prevent perceptible flicker over the specified voltage range using the light emitting diode circuitry. Voltage fluctuations shall have no visible effect on the luminous intensity of the indications.

Use wiring and terminal blocks conforming to the requirements in Section 13.02 of the VTCSH. Provide two secured, color coded jacketed wires (600 V, 20 AWG minimum), in accordance with the NEC®, rated for service at least 221 °F for electrical connection for each light emitting diode signal module.
Include voltage surge protection to withstand high-repetition noise transients in accordance with Section 2.1.6 of NEMA Standard TS2-1992 for the light emitting diode signal module on-board circuitry.

Ensure that light emitting diode signal modules are operationally compatible with currently used controller assemblies (solid state load switches, flashers, and conflict monitors).

Provide and install light emitting diode signal modules and associated onboard circuitry in accordance with Federal Communications Commission (FCC) regulations concerning the emission of electronic noise (47 C.F.R. § 15.101 et seq.).

Provide a power factor of at least 0.90 while operating light emitting diode signal modules throughout the temperature ranging from –104 °F to 165 °F.

Ensure that light emitting diode signal modules are compatible with the controller unit, conflict monitor, and load switch.

712.2.2 Pedestrian Signal

Provide one-way pedestrian signals in weather-proof, vandal-resistant, dust-tight housings, designed to display the alternating symbol messages “HAND” in portland orange or “WALKING PERSON” in lunar white. Provide incandescent assemblies, as specified in the Contract.

712.2.2.1 Screens (Visors)

Provide each signal with one of the following types of screens (visors):

1. Z-crate-type screen, consisting of a minimum of 20 straight horizontal louvers and 21 horizontal louvers formed in a zigzag pattern. Reverse every other formed louver to form cells. 1 in² rotated 45° from the horizontal (diamond-shaped cells). Bisect each diamond by insertion of a straight louver interspersed between each pair of formed zigzag louvers. Where each apex of each formed louver contacts a straight louver, chemically weld the entire length of the joint;

Provide 0.03 in (nominal) thick, black polycarbonate plastic with a flat finish on both sides. Enclose the screen in a 0.04 in minimum thickness polycarbonate plastic frame, 1 1/2 in deep containing mounting holes for insertion in the doorframe;

2. Eggcrate-type screen, 0.02 in minimum thickness aluminum made of 0.036 in nominal thickness polycarbonate, and 1 1/2 in deep. Mount the assembly on a polycarbonate frame of 0.04 in minimum thickness;

Provide spacing between horizontal members of 1/2 in, beginning near the top of the symbol, supported by a minimum of 15 vertical members;

712.2.2.2 Finish

Finish the inside and outside surfaces of the housing and doors and the outside surfaces of the mounting brackets in accordance with Section 712.2.1.5, “Finish,” or as specified in the Contract. Use screws with a flat black finish.

712.2.2.3 Fasteners

Use AISI Type 304 stainless steel screws and fasteners, where exposed to the elements. Use interior screws of corrosion-resistance material or Material protected by cadmium plating.

712.2.3 Pedestrian Signal Incandescent

Provide an incandescent signal having the same appearance as an LED pedestrian signal.

Provide an optical system consisting of a two-section message lens, double parabolic reflector, lamps and lamp sockets, and a sunscreen. Locate the lens at least 1 3/4 in from the closest extremity of the lamp. Provide ANSI A 21 Traffic Signal lamps, 67 W.

Provide 1/4 in minimum thickness polycarbonate plastic lens material with pattern texture on the outside, or 1/8 in minimum thickness. Paint the symbol areas of the inside faces of each message section with an appropriate transparent color to produce a portland orange “HAND” symbol and a lunar white “WALKING PERSON” symbol when illuminated. Paint other areas black.

Use a neoprene gasket to seal the perimeter when the reflector, lens, door frame, and case are properly mated.

Center and pre-focus each molded, heat-resistant lamp socket in its respective section of the reflector. Pre-wire the sockets to a three-terminal pair screw-type terminal block provided in the housing.
Form a single-piece double parabolic reflector from 1/4 in minimum thickness polycarbonate plastic sheet. Vacuum deposit an aluminum coating on the lamp side for texture and reflectability, and protect with a hard wear-resistant coating. Divide the two sections with a full-depth aluminum divider that properly mates with the message lens. Vent both sections with proper vent holes.

712.2.4 Pedestrian Signal (LED)

Design light emitting diode pedestrian signal modules that do not require special tools for installation as retrofit replacements for optical units of standard pedestrian signal sections. Light emitting diode signal modules must fit into the existing pedestrian signal section housings built in accordance with the requirements in the VTCSH without modification.

The LED signal module consists of a double side-by-side message combining the symbols of a hand and walking person. Arrange the LEDs in a manner to form an outline of the symbols. The shape of the outline must conform to the standard symbols for pedestrian signals.

Ensure that the measured chromaticity coordinates for the "lunar white" walking person and the "portland orange" hand are in accordance with Section 8.04 and Figure 1 of the VTCSH. Ensure that the chromaticity measurements remain unchanged over the input line voltage range from 120 V AC: 80 V to 135 V, 240 V AC: 184 V to 276 V, 12 V DC: 8 V to 24 V.

Distribute the LEDs evenly along the message outline. Do not vary the distance between each LED more than 10%. Ensure that the hand or walking man symbols are at least (H×W) 10 in × 6.5 in. Interconnect the individual LED light sources to minimize the loss of no more than 3 LEDs or 5 percent of the signal light output when a catastrophic failure of single LED occurs. The display face consists solely of LEDs mounted on a black printed circuit board mat.

Provide an LED signal module that is rated for use in operating temperature ranging from −104 °F to 165 °F. Completely seal the LED module against dust and moisture intrusion in accordance with NEMA Standard 250-1991 Section 4.7.2.1 and Section 4.7.3.2 for Type 4 enclosures.

Use a single, self-contained LED signal module device not requiring onsite assembly for installation into existing traffic signal housing. Manufacture the LED signal module assembly to withstand mechanical shock and vibration from high winds and other sources.

Do not exceed the maximum rating for DC current recommended by the LED manufacturer used by the driver board to drive the LEDs. Use the driver board to regulate the LED drive current on both the hand and walking man messages to compensate for line voltage fluctuations over the range of 120 V AC: 80 V to 135 V, 240 V AC: 184 V to 276 V. Ensure that the luminous output does not vary more than 10% over the voltage range and that it is not perceptible to the human eye. Use drive circuitry that includes voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients in accordance with Section 2.1.6, NEMA Standards TS-2, 1992. Provide onboard circuitry in accordance with FCC regulations concerning the emission of electronic noise (47 C.F.R. § 15.101 et seq.). Ensure compatibility in the circuitry, proper triggering and operation of the load switches, and conflict monitors in signal controllers currently in use by the procuring traffic authority.

Design the LED signal modules to reduce the intensity of light output in response to diminished ambient light levels. Ensure that the dimming circuit has a 30 s delay to prevent interference. Provide a switch or jumper connector to allow the user to disable the dimming feature.

712.2.5 Back Plates

Provide back plates as follows:
1. For signal faces with vehicular signal indications, if specified in the Contract;
2. Of one-piece polycarbonate;
3. Of a size that provides a 5 in border around the perimeter of the signal; and
4. Louvered.

712.2.6 Directional Louvers

Submit actual louver angles to the Traffic Services Engineer for approval before ordering.

712.2.7 Traffic Signal Lamps

Provide clear, ANSI A 21, horizontal with medium base, 16,000 h minimum rated life
traffic incandescent signal lamps for signal assemblies. Use 150 W, 1,770 average minimum initial lumens lamps for 12 in signal assemblies. Provide incandescent pedestrian signals with 67 W, 660 average minimum initial lumens lamps.

Design each lamp socket and lamp to position the lamp filament accurately within the reflector. (Light center length: 67 W - 2 7/16 in; 150 W – 3 in).

712.2.8 Pedestrian Sound Unit
Install a sound unit for blind persons on “WALK” and “DONT WALK” pedestrian signal assemblies, if specified in the Contract.

712.2.8.1 Material
Provide a pedestrian sound unit consisting of a weatherproof audio signal device operating continuously during the protected walk interval of the corresponding visual pedestrian signal. Obtain the operating voltage (115 V AC) for the pedestrian sound unit directly from the walk terminal in the visual pedestrian signal.

Ensure that the output volume of the pedestrian sound unit automatically adjusts to the ambient noise level in the intersection. Provide a programmable unit set to produce a “Peep-Peep” electronic bird chirping for east-west crosswalks and a “Cuckoo” electronic bird chirping for north-south crosswalks. Face the pedestrian sound unit toward the crosswalk and attach to the visual pedestrian signal in accordance with the manufacturer’s recommendations.

Provide pedestrian sound units in accordance with the Americans with Disabilities Act of 1990 (ADA) (42 U.S.C.S. § 12101 et seq.).

712.3 CONSTRUCTION REQUIREMENTS
Cover vehicular Signal Assembly faces after installation until the controller and intersection signals are put into operation. Ensure that the covering does not permit any misunderstanding by the general public that the signal is in operation.

Make signal faces plumb and adjust them to proper direction. Make faces and frameworks plumb and level, symmetrically arranged, and secure after alignment.

Mount overhead mast arm–mounted traffic signal assemblies horizontally, unless the Contract specifies mounting an overhead Signal Assembly vertically to a mast arm or span wire.

Install back plates and directional louvers on signal assemblies in accordance with the recommendation of the manufacturer.

712.3.1.1 Installations and Training
Install LED signal assemblies per the manufacturer’s recommendations. Ensure all Materials are new.

712.3.1.2 Warranties and Maintenance
1. Obtain and assign to the Department all manufacturer’s and producer’s guarantees or warranties for items and Materials incorporated into the Work. If the manufacturer’s or producer’s guarantee is absent, a guarantee from the Contractor is necessary for six months after acceptance by the Department. Include the following in this guarantee:
   1.1 Mechanical and electrical equipment and Material incorporated into the Work are free from any defects or imperfections;
   1.2 Repair of any malfunction or defect in any such equipment or Material, which develops is at no additional cost to the Department;
2. Supply installation guides and user manuals to the Department for the equipment incorporated in the project;
3. Provide the Department with a Certificate of Compliance from the manufacturer in accordance with the requirements in these specifications. Include a copy of applicable test reports on the light emitting diode signal and pedestrian modules in the certificate.

712.4 METHOD OF MEASUREMENT
The Department will measure signal assemblies, signal assemblies (LED), pedestrian signals (LED), pedestrian countdown signals (LED), back plates, directional louvers, and pedestrian sound units by the number of sections required and by type specified (if applicable).
712.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>___(number) Section Traffic Signal Assembly</td>
<td>Each</td>
</tr>
<tr>
<td>___(number) Section Optically Programmed</td>
<td>Each</td>
</tr>
<tr>
<td>Signal Assembly</td>
<td>Each</td>
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<tr>
<td>Pedestrian Signal: Neon</td>
<td>Each</td>
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<tr>
<td>Pedestrian Signal: Incandescent</td>
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<tr>
<td>___(number) Section Back plate</td>
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<tr>
<td>Directional Louver</td>
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<tr>
<td>Pedestrian Sound Unit</td>
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</tr>
<tr>
<td>___(number) Section Traffic Signal Assembly (LED)</td>
<td>Each</td>
</tr>
<tr>
<td>Pedestrian Signal (LED)</td>
<td>Each</td>
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</tbody>
</table>

**712.5.1 Work Included in Payment**

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately: all materials required for a complete installation, including hardware and lamps.
SECTION 713: DETECTORS

713.1 Description

713.1.1 Vehicle Detection System
This work shall consist of furnishing and installing Video Vehicle Detection System that tracks vehicles on a roadway via processing of video images and provides detector outputs to a traffic controller.

713.1.2 Emergency Vehicle Optical Detector System
This work consists of providing and installing an emergency vehicle optical detector (EVOD) system at signalized intersections, using optical communication to identify the presence of priority vehicles and instruct the traffic signal controller to find and hold a desired traffic signal display.

713.1.3 Vehicle and Pedestrian Detectors
This work consists of providing and installing vehicle detectors in roadways and pedestrian push buttons on signal standards.

Contact the State Traffic Services Engineer for a list of approved equipment and manufacturers.

713.2 MATERIALS

713.2.1 Video Vehicle Detection System
Provide a system with the following performance requirements:
1. Complete intersection detection;
2. Automatic incident detection;
3. Freeway detection/management;
4. Freeway ramp control;
5. Vehicle counting/classification;
6. Collection of traffic statistics;
7. Turning movement analysis;
8. Wrong-way detection;
9. Enforcement;
10. Queue length analysis; and
11. Critical incidents in real time for traffic management.

Provide a system with the following equipment, installation, and support requirements:
1. A Video Processor (VP) including the following:
   1.1. All necessary cables;
   1.2. Harnesses;
   1.3. Materials;
   1.4. Fittings;
   1.5. Field programming unit (FPU);
   1.6. All field assistance during installation (if specified in the contract);
   1.7. Software;
   1.8. Training during installation;
   1.9. Follow-up training;
   1.10. Technical support after installation; and
   1.11. Any miscellaneous components detailed in the contract necessary to provide a complete and operating video detection system at signalized intersections.
2. Zoom lens closed circuit television (CCTV) cameras at each intersection, as specified in the contract, with focal length and zoom determined by the manufacturer, to optimize performance;
3. Zoom lens camera (PTZ) for motorized pan and tilt operation with mounting assembly at each intersection with PTZ control receiver and driver when called for in the contract;
4. Video hardware system consisting of components necessary to maintain the quality of video signal for extended distances;
5. Video power cable compatible with the system;
6. Video coax cable compatible with the system.

713.2.1.1 Video Processor
Provide a VP system that detects vehicles in multiple traffic lanes using a minimum of
100 user-definable detection zones. Provide a system with interactive graphics that allows a user to define or redefine detection zones. Ensure the VP calculates traffic parameters in real-time and provides local non-volatile data storage for later downloading and analysis.

Provide a VP system that is capable of simultaneously processing information from a minimum of four synchronous video sources, including CCTV video cameras and videotape players. The video sources may be synchronized or line locked. Ensure the system digitizes and analyzes the video at a rate of 30 times per second. Provide a fifth camera input as a surveillance video input switchable as one of the five video sources.

Provide a VP system that detects the presence of vehicles in a minimum of 100 detection zones within the combined field of view of the cameras.

Provide a system that allows selection of different detector types and detector logical functions using software. Detector types include the following:

1. Counting;
2. Presence;
3. Directional presence;
4. Speed (capable of reporting vehicle classification based on length with software that allows a user to define three length categories);
5. Station; and
6. Input.

Provide a VP system that a user can disconnect after set up using the FPU. Ensure the VP is capable of the following:

1. Detecting vehicles as a stand-alone unit;
2. Calculating traffic parameters in real-time; and
3. Storing traffic parameters in its non-volatile memory.

Provide a system with user-selectable time intervals (or time slices) of 10 s, 20 s, 30 s, 1 min, 5 min, 10 min, 15 min, 30 min, or 60 min. Provide a non-volatile electrically erasable programmable read-only memory (EEPROM) flash memory within the VP to retain time interval data for later uploading to the FPU for analysis.

Provide a system that allows retrieval of data stored in the non-volatile memory of the VP via a serial communications port. Make provision for downloading data via a modem and dial-up telephone lines, private cable or fiber optic network, and direct cable connection to another computer.

Include the capability to capture a video image (snapshot) from a selected image sensor input and transmit the image to the FPU for display in the VP. Ensure the system can compress the captured video image to minimize the time needed to transmit the image. Provide an option to allow continuing or suspending detection while the video image is being compressed and transmitted.

713.2.1.2 Detection Zone Placement

Provide a video detection system that allows flexible detection zone placement anywhere and at any orientation within the combined field of view of the cameras. Lines placed across lanes of traffic or lines placed in-line with lanes of traffic are preferred presence detector configurations. Provide a system where a single detector line can replace multiple conventional detector loops connected in series. Ensure that the system allows overlapping of detection zones capable of implementing logical functions, including "AND", "OR", "NAND", "N", or "M" and delay/extend timing.

713.2.1.3 Detection Zone Programming

Locate and place the detection zone with a FPU capable of showing images of the detection zones superimposed on the video image of traffic.

Provide a system that changes the color or intensity of the detection zone on the monitor when a vehicle is detected, verifying proper operation of the detection system. The system may use color changes to indicate detection delay and extension timing.

713.2.1.4 Optimal Detection

The video detection system shall reliably detect vehicle presence when the camera is mounted 25 feet or higher above the roadway, the camera is adjacent to the desired coverage area, and the length of the detection area or field of view is not greater than 10 times the mounting height of the camera.

The Department will not require the camera to be mounted directly over the roadway. Provide a system that allows a single camera, placed at the proper mounting location with the
proper lens, to monitor from six to eight traffic lanes simultaneously.

Provide a video detection system with an overall performance comparable to inductive loops. Ensure that the system detects vehicle presence with 98% accuracy under normal conditions (day and night) and 96% accuracy under adverse conditions (fog, rain, snow, etc.), using standard camera optics, and in the absence of occlusion.

713.2.1.5 VP Mounting

The VP shall be shelf- or rack-mountable and be able to fit in a conventional traffic signal controller cabinet.

713.2.1.6 VP Environment

The VP shall:

1. Operate reliably in the adverse environment found in the typical roadside traffic signal controller cabinet;
2. Meet the environmental requirements of NEMA TS1 and NEMA TS2, as well as the environmental requirements for Type 170 and Type 179 controllers; and
3. Withstand operating temperature of from -31 °F to +165 °F at 0% to 95% relative humidity, non-condensing.

713.2.1.7 VP Electrical

Provide a VP, modular in design, with a processing capability equivalent to the INTEL 486SX microprocessor. Use gold-plated DIN connectors for the bus connections used to interconnect the modules of the VP.

Provide a power supply for the VP that provides and automatically adapts to one of the following input power levels:

1. From 89 V to 135 V AC, 60 Hz single phase; or
2. From 190 V to 270 V AC, 50 Hz, single phase.

Allow for surge ratings in accordance with NEMA TS1 and NEMA TS2.

Provide controller state information for detection and extend/delay timing functions with NEMA red/green inputs for up to 16 phases. Provide an approved connector on the front of the VP for the inputs.

Equip the VP with four RS-170 (B&W)/National Transmission Standards Committee (NTSC) (color) composite video inputs, so signals from four cameras or other synchronous, or non-synchronous, video sources process in real-time. Provide a fifth video input to allow connection of a local surveillance camera (pan and tilt) or other non-detection video source. Do not process the video from this auxiliary video input for detection. Use an approved connector on the front of the VP for all video inputs.

713.2.1.8 Field Programming Unit System

When called for in the contract, provide a Field Programming Unit having communication capabilities as specified in the plans as needed for set-up and viewing of vehicle detections. The equipment manufacturers shall contact the Department's Traffic signal design Engineer for approval prior to bidding. This unit shall be considered incidental to Video Vehicle Detection System.

The field programming unit shall be capable of driving an external current industry standard monitor, shall be capable of both battery and AC operation, and shall include required batteries, chargers, protective carrying case, and system software.

713.2.1.9 Closed Circuit Television (CCTV) Cameras

Provide a video detection system that uses medium-resolution, closed circuit detection (CCD) cameras as the video source for real-time vehicle detection, as required by manufacturer's recommendations. Ensure that each camera meets the following minimum requirements:

1. Uses medium resolution, from ¼ in to ½ in, monochrome CCD or color cameras with a minimum of 383 lines of resolution and an "auto-iris" motorized zoom lens selected uniquely for each site to optimize performance;
2. Uses RS-170, NTSC, CCIR, PAL, or SECAM video signals;
3. Each camera shall be housed, as a minimum, in NEMA 4 water-resistant, dustproof and/or gas filled enclosure;
4. Uses a single Military Specification-connector for interconnection to video and power cables. Provide optional video and power cable configurations if requested;
5. Securely mounted (to minimize sway and motion) in the field using a bracket or pedestal mount and/or pan and tilt unit and with a field-adjustable zoom to provide optimal field of view;

6. Equipped with a video surge protection device, a ground wire, and an in-line junction of the coaxial cable. Fasten this device securely and wrap in watertight material;

7. Field video cables terminate in the traffic signal controller cabinet on each VP camera interface panel. Ensure that the panel provides lighting protection (Innovative Technology, Inc., or “approved equal”) and terminating junctions between the field and each VP. Provide terminal strips, lighting protection, and a ground buss for power cables from the cabinet to the cameras;

8. Equipped with a weatherproof lockable steel junction box for installation on the structure used for camera mounting. Ensure the junction box contains a terminal block for terminating power to the camera, connection points for coaxial cables from the camera and from each VP, and a ground fault interrupt outlet;

9. When the connection between the camera and each VP is coaxial cable, the coaxial cable used shall be a low loss 75 ohm precision video cable suited for outdoor installation, such as Belden 8281 or West Penn P806 as specified.

713.2.1.10 Video Hardware System (Auxiliary Equipment)

Provide an analog, 30-frames-per-second, full-motion video driver/equalizer video hardware system that allows sending and receiving of standard baseband video signals of from 50 Hz to 10 MHz over twisted pair copper wire or coaxial cables. Provide a broadcast-quality color television picture in accordance with NTSC standards, or a monochrome high-resolution picture up to 1,023 scanning lines at 60 Hz.

Provide a video hardware system consisting of video drivers, video equalizer amplifiers, video equalizer amplifier/drivers, and multiplexers, to maintain the quality of the video signal for extended distances. The type and size of wire used determines if the system requires one or more video equalizer amplifier/drivers. Install power service, as specified in the contract.

Provide watertight enclosures for outdoor use.

Ensure that a manufacturer’s representative for the video hardware system is on-site to assist in the installation, and to meet with Department staff for a one-day training session to explain the installation, operation, and maintenance of the video hardware system.

713.2.2 EVOD System

Provide a system that uses optical communication to identify the presence of designated priority vehicles and causes the traffic signal controller to advance or hold a desired traffic signal display selected from normally available phases.

Provide an EVOD system with a matched set of components that identify the presence of (signal from) priority emergency vehicles and instruct the traffic signal controller to find and hold a desired traffic signal display.

Ensure that this communication is effective to the optical detectors at or near the intersection over a line-of-sight path of at least 2,300 ft.

Provide an EVOD system that operates on a first-come, first-served basis or on a selected priority basis and is designed to yield to other priority demands such as railroad crossings.

Interface the EVOD system with existing traffic signal controllers without compromising normal operation or existing safety provisions. Provide an EVOD system that consists of an optical emitter, optical detectors, optical detector cable, and phase selectors.

Ensure desired performance of the EVOD system by providing matched system components, proven through integrated testing and extensive functional experience. Provide matched system components that offer compatibility with all types of traffic signal controllers, for example electromechanical, or solid-state, and provide future system compatibility of priority control elements.

713.2.2.1 EVOD Optical Emitter Assembly

EVOD optical emitters shall be a light-weight, weather resistant, user addressable, light-emitting device with internal regulated power supply. Ensure that the optical emitter assembly produces precisely timed, crystal-controlled optical energy pulses of high-intensity light from a single source, at a rate of from 14.635 Hz or 9.639 Hz, depending on the emitter control switch used.
713.2.2.2 EVOD Optical Detector

Provide lightweight, weatherproof, adjustable, single- or dual-directional EVOD optical detector assemblies. Provide internal circuitry that transforms optical energy from the optical emitter assembly into electrical signals for delivery to the phase selection equipment, through optical detector cable (up to 1,000 ft). It shall be programmable to detect addressable emitter.

Provide a high-impact polycarbonate unit constructed with non-corrosive hardware, designed for simple mounting at, or near, an intersection on mast arm, pedestal, pipe, or span wire, and operating over an air temperature range of from -22 °F to 140 °F.

Ensure the unit is responsive to the optical emitter at a distance of at least 1,800 ft and is capable of providing the necessary electrical signal to the phase selector through up to 1,000 ft of optical detector cable.

713.2.2.3 EVOD Optical Detector Cable

Provide durable EVOD optical detector cable with the necessary electrical characteristics to carry power to the optical detector from the phase selector and to carry the optical detector signal to the phase selector.

Provide three conductors, AWG 20 (7 x 28) stranded and an individually tinned drain wire cable to provide signal integrity and transient protection. Use copper cable conductors shielded with aluminized polyester. Overlap the shield wrapping 20% to ensure shield integrity following conduit and mast arm pulls. Ensure the cable delivers the necessary quality signal from the optical detector to the phase selector over a non-spliced distance of 1,000 ft and sufficient power to the optical detector over a non-spliced distance of 1,000 ft.

Provide cable with an insulation rating of at least 600 V and a temperature rating of at least 176 °F.

Provide color-coded cables as follows:

1. Orange for delivery of optical detector power (+);
2. Blue for optical detector power return (-) or optical detector signal;
3. Yellow for optical detector signal;
4. Bare for optical detector power return (-).

713.2.2.4 EVOD Phase Selector Assembly

Interface the EVOD phase selection assembly between the optical detectors and the controller unit. Do not compromise the existing controller unit’s fail-safe provision, and provide sufficient power for up to three optical detectors per channel.

Ensure the assembly provides suitable sensitivity to the optical detector signal via adjustable range potentiometers.

Provide a plug-in, two- or four-channel, dual-priority assembly device intended for installation directly into the input file of control cabinets equipped with priority-phase selection software.

Power the assembly from AC mains and ensure the assembly contains an internal, regulated power supply to power optical detectors.

Ensure the assembly is capable of recognizing the following pulse rates as delivered by the optical detectors:

1. 9.639 Hz ± 0.119 Hz as Frequency I.
2. 14.035 Hz ± 0.255 Hz as Frequency II.

Provide an assembly that delivers signals to the controller to cause selection of the desired phase green display for the approaching vehicle.

Provide a test switch for each channel to deliver Frequency I or Frequency II signal pulse rates to verify proper function at both optical emitter flash rates, first-come, first-served operation, and Frequency II override capability.

Provide a selectable call dropout time of 5 s or 10 s, ±2.5%.

Provide a modular, microprocessor controlled, two-channel, four-phase, high-priority phase selector expandable to a four-channel, eight-phase dual-ring controller. Ensure the phase selector continuously monitors all “GREEN”, “WALK”, and pedestrian clearance displays for a smooth transition from controller to phase selector interval timing.

713.2.2.5 EVOD Reliability

Ensure that equipment supplied as part of the optical priority remote traffic control system intended for use in the controller cabinet meets the electrical and environmental specifications of the NEMA standards.

Ensure that all equipment supplied as part of the priority control system intended for use
in or on emergency vehicles operates properly in air temperatures of from -20 °F to 140 °F), in
air with relative humidity of from 5 to 95%, and a vehicle battery voltage of from 10 V to 15 V.

713.2.3 Loop Vehicle Detector

Provide a self-contained, electronic sensing loop vehicle detector that registers the
presence of a vehicle by recognizing inductance change in a loop of wire embedded in a
roadway.

Rack-mount the detector in a traffic signal controller cabinet, connected to the cabinet
wiring through 44 terminal cinch jones connector (50-44-30m) and wire harnesses. Provide
two-channel type detectors with independent channel controls. If specified in the contract,
include a delay/extension time function and/or count function for each channel.

Provide all loop vehicle detectors in accordance with NEMA TS1, Part 15, Inductive Loop
Detectors.

713.2.3.1 Loop Detector Wire

Use No. 14 AWG stranded copper wire cross-linked polyethylene (XHHW) insulation
conforming to requirements of IMSA Specification No. 51-3 for loop detector wire installations
in pavement saw cuts.

713.2.3.2 Loop Lead-in Cable

Connect the loop installed in the pavement to the loop detector unit installed in controller
cabinet with No. 16 AWG copper, polyethylene insulated twisted pairs, shielded and enclosed
within a polyethylene-jacket lead-in cable. Provide loop lead-in cable in accordance with IMSA
Specification No. 50-2.

713.2.3.3 Loop Detector Sealant

Use loop sealant as filler for loop saw cuts, and to secure and protect the loop wire.
Provide sealant of sufficient strength and hardness to withstand stress and abrasion from
vehicular traffic while remaining flexible enough to provide stress relief under thermal
movement:

The following are additional sealant properties:

1. Ability to bond to concrete and asphalt;
2. Rapid cure rate allowing pavement opening to traffic ½ h after installation;
3. Initial fluidity permitting installation in a narrow saw cut down to at least 40 °F;
4. Moisture insensitivity allowing application to damp pavement effectively; and
5. Resistance to vehicular fluids and road salt.

Provide only one-part sealant material for this application, unless listed on the
Department's Qualified/Approved Products List.

713.2.3.4 Ducted Loop Wire

Use ducted loop wire loosely encased in ¼ in outside diameter polyvinyl chloride (PVC)
or polyethylene tube for insulation in pavement saw cuts or by directly overlaying with paving
material. Provide ducted loop wire in accordance with IMSA Specification No. 51-5, or use
insulated PVC with a nylon jacket (THHN) or polyethylene (XHHW) for the interior No. 14
AWG stranded conductor.

713.2.3.5 Hot-Type Applied Loop Detector Sealant

Use a hot-melt, rubberized asphalt compound sealant provided in “bricks” formulated
specifically to be stiff, non-tracking, flexible at low pavement temperatures, and suited for use
as a sealant for traffic loop cuts.

Provide thin, free-flowing fluid sealant that pours easily, penetrates fine cuts, self-levels,
and allows easy application at application temperatures. Melt sealant and apply to pavements
in accordance with the manufacturer’s recommendations, using either pressure-feed melter
applicator units or pour pots. Ensure that hot-applied sealants meet or exceed the property
requirements in Table 713.2.3.5.1, “Hot-Applied Loop Sealant Property Requirements,” after
curing.
Table 713.2.3.5:1
Hot-Applied Loop Sealant Property Requirements

<table>
<thead>
<tr>
<th>Test</th>
<th>Procedure</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration @ 77 °F, 3.53 oz, 5 s</td>
<td>ASTM D 5329</td>
<td>35, maximum</td>
</tr>
<tr>
<td>Softening Point</td>
<td>ASTM D 36</td>
<td>180 °F, minimum</td>
</tr>
<tr>
<td>Ductility, 77 °F</td>
<td>ASTM D 113</td>
<td>6 in, minimum</td>
</tr>
<tr>
<td>Mandrel Bend 180 °F, 5s, 1.07 in diameter</td>
<td>—</td>
<td>Pass</td>
</tr>
<tr>
<td>Pour temperature</td>
<td>—</td>
<td>380 °F, Minimum</td>
</tr>
<tr>
<td>Safe heating temperature</td>
<td>—</td>
<td>380 °F–420 °F</td>
</tr>
</tbody>
</table>

713.2.3.6 Cold-Applied Loop Detector Sealant

Apply sealant by conventional cartridge gun or bulk handling pump equipment. Ensure that the uncured (wet) material has a viscosity of approximately 20,000 cP at 77 °F using a Brookfield Viscometer, #6 spindle at 20 RPM, and nonvolatile content (solids) of from 75% to 85% by weight.

Provide material that cures at a rate such that it is dry to the touch within 24 h, while being driven on almost immediately after installation. Provide non-shrink sealant that remains flexible at temperatures greater than or equal to -40 °F. Ensure that cold applied sealants meet or exceed the property requirements list in Table 713.2.3.6:1, “Cold Applied Loop Sealant Property Requirements,” after curing.

Table 713.2.3.6:1
Cold-Applied Loop Sealant Property Requirements

<table>
<thead>
<tr>
<th>Test</th>
<th>Procedure</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>ASTM D 2240</td>
<td>65–85</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>ASTM D 412</td>
<td>500 psi, minimum</td>
</tr>
<tr>
<td>Elongation</td>
<td>ASTM D 412</td>
<td>400%, minimum</td>
</tr>
<tr>
<td>Adhesion (peel strength) (Canvas to conc.)</td>
<td>ASTM D 903</td>
<td>15 lb, minimum</td>
</tr>
<tr>
<td>Arc resistance</td>
<td>ASTM D 49</td>
<td>71 s, minimum</td>
</tr>
<tr>
<td>Dielectric strength @ 50 Hz</td>
<td>ASTM D 150</td>
<td>6.35, minimum</td>
</tr>
</tbody>
</table>

713.2.3.7 Design

Provide loop detectors that use digital design throughout, for threshold, time, and cycle calculations. The Contractor may use the following techniques to determine a change in inductance:

1. Period measurement;
2. Time elapsed per cycle;
3. Frequency measurement; or
4. Cycles counted in a set time interval.

Ensure isolation of the channels with two-channel construction to eliminate “cross talk” between adjacent loops. Provide period measurement detectors using alternate scanning to accomplish this isolation.

Provide a detector with a fail-safe to call feature on each channel to provide a detect output, if open circuit loops occur. Provide for a minimum composite loop inductive operating range of from 50 μH to 1,000 μH and allow up to 1,000 ft of loop lead-in. Provide self-tuning detectors with automatic tracking or detectors that require initial tuning with a minimum automatic drift compensation tolerance of ± 5%, after initial adjustment. Optically couple detector outputs. Provide a fail-safe (closed) output in case of power loss.

713.2.3.8 Testing

Before Project Manager acceptance, send the loop vehicle detectors to the Traffic Services Signal Laboratory in Santa Fe for testing and approval. The Department will test the detectors concurrently with the controller testing in accordance with Section 714.3.2, “Testing.”
The Department will inspect and test loop vehicle detectors as follows:

1. Visual inspection for compliance with the contract.
2. Sample tests in accordance with NEMA standards for the following:
   2.1. Sensitivity;
   2.2. Hold time;
   2.3. Long detection and recovery;
   2.4. Adjacent lane rejection; and
   2.5. Pulse mode re-phase.

The Department will base acceptance on the satisfactory performance of the loop detectors for the test period in accordance with Section 714.3.2, “Testing.”

713.2.4 Operation

Provide digital switches on the front panel for making operational selections or adjustments. Provide a minimum selection of three frequency ranges and three sensitivity (change in inductance) ranges along with a presence or pulse output mode and a reset selector. Separate and repeat controls for each channel.

Provide an LED output indicator on the front of each channel.

713.2.5 Two-Channel Detectors

Provide active power inputs on both channels of two-channel detectors, to allow independent operation of either channel without the remaining channel being connected. Ensure that connector terminal assignments are in accordance with NEMA Standards, Part 15. Rack mount detectors.

713.2.6 Lightning and Transient Protection

Provide detectors that meet NEMA requirements for transient testing. Accomplish this using metal oxide varistors for protection from voltage induced in loop lead-in cables installed in the cabinet, and flash-over protection from internal circuit to ground.

713.2.7 Pedestrian Detectors

713.2.7.1 Push-Button Station

Provide cast aluminum push-button station housing of tamperproof construction. Ensure the assembly is weatherproof and constructed so there is no possibility of electrical shock under any weather conditions. Ensure that stations are in accordance with Americans with Disabilities Act of 1990 (ADA) (42 U.S.C.S. § 12101 et seq.).

Shape the housing to provide a rigid installation that fits the curvature of the pole it attaches to. Provide a direct push-type actuator button, micro-switch type or approved equal in the housing body. Fit the housing cover snugly on the housing that contains the push-button sign.

Provide porcelain enameled sheet steel or sheet aluminum pedestrian push-button signs of 0.36 in minimum thickness. Make the signs 9 in × 12 in.

If using porcelain enameled steel signs, provide each hole with a brass grommet. Round sign corners.

Use black enamel on white enamel background to show instructions and arrows on the signs. Show the instructions in accordance with the contract. Finish push-button housings with two coats of best quality infrared oven baked paint as follows:

1. First Coat: Baked epon primer, zinc chromate, or equal.

713.3 CONSTRUCTION REQUIREMENTS

713.3.1 Video Detection System

Install the Video Detection system per the manufacturer’s recommendations and provide assistance from the supplier as described below:

1. Have the supplier of the Video Detection system supervise the installation and testing of the video and computer equipment. Have a factory representative from the supplier set up, test, program, and adjust the system in the field at each temporary signal location and the final signal location. Have factory representatives conduct a one-day training and programming session in conjunction with the setup and test for each signal location, if specified in the contract;
2. During the warranty period, ensure that the supplier provides technical support by toll-free telephone 24 h per day, 365 days per year. Ensure factory-certified personnel answer Department requests for support within 1 h;
3. During the warranty period, ensure that certified personnel from the supplier are on site within 48 h, if the Department requires;
4. Ongoing software support by the supplier includes updates of each Central Video Processor (CVP) and the computer software. Provide these updates for a one-year period after acceptance of the work;
5. Have the supplier maintain a program for technical support and software updates following expiration of the warranty period.

713.3.2 EVOD Optical Detector System

Install EVOD optical detector systems in accordance with the manufacturer’s recommendations. Do not allow the equipment manufacturer to modify the existing traffic controller unit beyond adding the necessary hardware to the traffic controller cabinet.

713.3.2.1 System Training

Provide appropriate training and assistance to the Department’s personnel and emergency vehicle operators in troubleshooting, maintenance, and system operation for the duration specified in the contract. Submit the complete training program to the Department for approval, 15 working days before scheduling the training. Include in the training program submission, working outlines of presentations and manuals, handouts, and other materials to be distributed during the training.

713.3.3 Loop Detectors

Install loop detector consisting of two distinct elements. First, install the loop (inductive coil) in the pavement, at the location, and geometry specified in the contract, including a low-inductance lead-in cable back to the control cabinet. Second, install the loop vehicle detector-sensing unit in the control cabinet, including wiring to output the presence of a vehicle. The Department will not accept loop detector (total system) installations until the installation accurately detects the presence of vehicles in accordance with the contract.

713.3.3.1 Loop Detectors Installation Requirements and Procedures

713.3.3.1.1 Saw Cuts

Make saw cuts using an abrasive cutting wheel concrete saw. Make saw cuts from 2¼ in to 2½ in deep and approximately 0.275 in wide. Use a ⅜ in wide slot to install ducted loop wire.

If the contract requires new pavement or additional paving material overlay, make the saw cut and wire installation at least below the last paving layer of ⅝ in or greater thickness. The Department will not allow saw cuts in the final layer of surfacing. In the case of pavement overlay, make a saw cut a minimum of 2 in below the final surfacing elevation. Install piezoelectric detectors in accordance with the manufacturer’s recommendations, which may require saw cutting of the open-graded friction course.

If the contract specifies heater-scarification pavement treatment, make the saw cuts after completing this operation. Provide 2 in diameter holes, drilled at angle points to the same depth as the saw cuts. The Department will allow 45° angle cuts made at corners instead of drilled holes. The Department will not allow sharp corners greater than 45° between overlapping saw cuts. Also, drill cuts across concrete pavement expansion joints to allow wire slack. Overlap saw cuts by a sufficient length to provide a smooth bottom, even-depth wire channel. If there is more than one loop terminating at a pull box, provide each loop with a separate saw cut back to the box. Make these saw cuts no closer than 6 in. Before placement of the sealant and wire, clean the saw cut of debris and standing water by blowing out with compressed air. The Department will allow the pavement surface to be damp to the touch. Ensure the inside of the saw cut is free of sharp protrusions from loose aggregate or uneven saw cuts.

713.3.3.1.2 Rigid Electrical Conduit Entrance

Provide a separate 1 in rigid electrical conduit entrance at the pull box for each loop. Begin the rigid conduit at the end of the pavement saw cut and run under any curb and gutter, and sidewalk. Leave slack in wire through the conduit entrances, and seal the end of the
conduit with a soft-setting butyl rubber or asphalt joint sealer. Fill the remainder of the hole with the appropriate material and approved saw cut sealant.

### 713.3.3.1.3 Loop Wire Placement
Place a continuous run of loop wire in the saw cut and wind around the coil section the number of turns specified in the contract, or directed by the Project Manager. Install no more than four wires or turns in a single saw cut. Leave wire run through drilled corners and joint crossings slack. Encapsulate the slack portion of wire with a soft-setting butyl rubber or asphalt joint sealer. Installation of ducted loop wire during a paving operation by securely attaching the loop in the proper shape to the pavement surface and overlaying with the next paving layer(s) of 2 in or greater total thickness is allowable. Secure the loop before overlaying by placing the ducted wire in a slot cut in the pavement, or by securing the corners using a method approved by the Project Manager, then covering the wire by hand with a small amount of asphalt paving material. Do not bend the ducted loop wire to less than a 1 in radius.

### 713.3.3.1.4 Sealant Application
Do not place sealant, if the air temperature is below 40 °F or if precipitation is occurring or impending. Place sealant in accordance with the manufacturer’s recommendations.

Place sealant in saw cut using a special nozzle. Fill the saw cut to within approximately \( \frac{1}{8} \) in of the top. Do not allow spillover onto the pavement surface; immediately strike off excess material.

### 713.3.3.1.5 Multiple-Loop Systems
If using a multiple-loop system (same channel), wind adjacent loops with opposite rotations. Accomplish rotation reversal by reversing leads at the pull box. Mark the beginning of the loop wire and the pull box before beginning the winding process to identify the direction of rotation. Connect multiple loops in series to the lead-in cable at the pull box or splice point.

### 713.3.4 Loop Lead-in Cable Installation
Run loop lead-in cable continuously from the loop wire splice to the terminal in the control cabinet. The Department will not allow splices in the lead-in cable.

Connect the drain (ground) wire in the lead-in cable to earth ground at the cabinet end only. Neatly clip off the ground wire at the curbside pull box adjacent to the end of the outer jacket.

Solder connections between the loop wire and the lead-in cable. Do not use open flame torches for soldering. Make splices waterproof by stripping from \( \frac{1}{4} \) in to \( \frac{1}{2} \) in of the insulation, and inserting into a self-sealing epoxy-filled twist-on connector in accordance with Section 711.3.4.1, “Spring-Type Connector.” Use of a two-part sealant, DBY-3M #3570 connector sealant, or approved equal is allowable.

Wrap #3570 connector splices with a high-quality all-weather electrical tape, or approved self-bonding tape, by overlapping the wire insulation approximately 1 in and in layers equal to or greater than \( \frac{1}{2} \) times the thickness of the original wire insulation. Seal the outer jacket of the cable in a similar manner, except overlap the tape on the outer jacket 4 in.

If using ducted loop wire, apply sealant at the end of the tube portion and then wrap with tape to prevent water entry. Suspend the “V” splices formed high in the pull box to prevent immersion in water.

### 713.3.5 Integrity Test Check
After completing loop installation in the roadway, check each loop with a megger to ensure the integrity of the installation. Ensure that the resistance of each loop is greater than 100 MΩ. If directed by the Project Manager, check the completed loop detector system in accordance with Section 713.2.3.8, “Testing.”

### 713.3.6 Push-Button Stations
Mount push-button stations on the side of traffic signal poles with the arrow sign indicating the direction of pedestrian movement.

### 713.4 METHOD OF MEASUREMENT—Vacant

### 713.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVP</td>
<td>Each</td>
</tr>
</tbody>
</table>

Section 713: Detectors
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video Coaxial Cable</td>
<td>Foot</td>
</tr>
<tr>
<td>Video Power Cable</td>
<td>Foot</td>
</tr>
<tr>
<td>Video Camera</td>
<td>Each</td>
</tr>
<tr>
<td>Video Hardware System</td>
<td>Each</td>
</tr>
<tr>
<td>Optical Detector Cable</td>
<td>Foot</td>
</tr>
<tr>
<td>Optical Emitter</td>
<td>Each</td>
</tr>
<tr>
<td>Loop Detector Wire</td>
<td>Foot</td>
</tr>
<tr>
<td>Ducted Loop Detector Wire</td>
<td>Foot</td>
</tr>
<tr>
<td>Loop Lead-in Cable</td>
<td>Foot</td>
</tr>
<tr>
<td>Detector Saw Cut</td>
<td>Foot</td>
</tr>
<tr>
<td>Phase Selector Rack, ____ Channel</td>
<td>Each</td>
</tr>
<tr>
<td>Phase Selector Module</td>
<td>Each</td>
</tr>
</tbody>
</table>

The Department will pay for conduit for detector installations in accordance with Section 709, “Rigid Electrical Conduit.”
714.1 DESCRIPTION
This work consists of providing and installing traffic-actuated controllers, special auxiliary control equipment, and cabinets.

714.2 MATERIALS
714.2.1 Traffic-Actuated Controller

These Standard Specifications and the National Electrical Manufacturers Association (NEMA) standards describe required features, functions, and test procedures for traffic-actuated controllers. Provide TS2-Type I controllers for state-maintained signalized intersections. Provide “Plug-and-Play” controller equipment. Do not modify controllers, cabinets, wiring harness, and other equipment tested and approved by the State Signal Maintenance Lab. Obtain State Traffic Services Engineer and State Signal Maintenance Lab Supervisor approval of equipment in writing.

Ensure controllers meet all requirements for a solid-state, NEMA, traffic-actuated controller. Provide controllers that use the current designs employing microprocessor and CMOS logic circuitry.

Unless otherwise specified in the contract, provide microprocessor controllers of a modular design. Provide controllers that consist of a main processor unit (MPU), input/output interface, and a power regulator. Power transformer and capacitors may be rigidly fixed to the frame. Ensure modules are easy to remove.

Provide multi-terminal, Military Specification (Mil-Spec)-type plugs for standard and special function input/output electrical connections on the front of the controller in accordance with NEMA interface standards, or Department-approved controllers with RS-232-C standard input/output ports. Provide RS-232-C ports for communications and special functions. Equip controllers with a K-1 backup relay in the back panel.

Provide battery backup in the same module for power-down clock operation and battery-backed random-access memory (RAM) for non-programmed data such as message logs.

Provide controller ports with the following capabilities:
1. Printing out program data to a stand-alone printer;
2. Direct interface with a personal computer for uploading and downloading program data; and
3. Direct interface with a dial-up modem for remote communications with a personal computer over telephone lines.

Provide port connections that prevent interruption to signal operation. The traffic-actuated controller shall have the capability to report alarms to central computer remotely, without assistance from a system master unit.

Provide controllers with a keyboard and liquid crystal display (LCD) on the front. Ensure the display has an adjustable contrast and backlighting. Ensure the controller design allows time based coordination and preemption programming through the controller keyboard. Provide controllers that can display alphanumeric timing, status, and programming information. Ensure each ring has a separate display for simultaneous, dual-ring display.

Ensure the display has two modes of operation: the run mode current phase that displays interval and remaining interval time; and the programming mode that displays the phase, interval or programmable function, and the time or value.

714.2.1.1 Programming Requirements

Provide controllers with a keyboard for entering operator timing and functional data into nonvolatile memory and with a menu-driven interface and to enter, revise, and display operator data using a minimal number of keystrokes. Ensure key functions are clearly displayed on the front of the controller. Ensure the controller is capable of storing operator data for at least 30 days after disconnecting the primary power.

Provide controllers capable of being programmed in different patterns of phase sequences: quad-left, sequential, or a combination of concurrent and sequential. Ensure the following:
1. The controllers allow programming of inactive phases;
2. The manufacturer preprograms the signal plan, including sequence, inactive phases, any overlaps, and/or preempt sequences; and
3. The programmed data is retained in nonvolatile electrically erasable programmable read-only memory (EEPROM). Provide a controller that displays operator-entered times or values, before entering into memory. Ensure the controller does the following:
   1. Allows automatic sequencing through the programming;
   2. Prevents unauthorized changes in the programming mode with a four-digit numeric security code;
   3. Allows access to view stored information.

714.2.1.2 Internal Preemption
Provide controllers with internal preemption, capable of railroad or emergency-vehicle preemption sequences. Ensure that the internal preemption feature allows for at least six independent preemption programs. Make it possible to prioritize preemption, delay before preemption, cycle during preemption by hold phase assignments, and provide for pedestrian clearance through initial clearance yellow. Ensure preemption intervals can be timed, and operator data programmed through the controller keyboard. Ensure operator-entered preemption data is printable. Provide railroad preemption in accordance with the Manual on Uniform Traffic Control Devices requirements and include a track clearance phase. Ensure return-to-normal controller operation is in accordance with the plan-phasing diagram, and place a detector call on phases as specified in the contract.

714.2.1.3 Internal Coordination
Provide controllers with internal time based coordination. Provide synchronization and control functions for coordinating actuated signalized intersections, without the use of interconnecting cables. Ensure coordination can be made on a time of day, day of week, and week of year basis. Provide a coordinator that functions as a standard signal system coordinator, using Force Offs, Holds and Phase/Ped Omits outputs, and Phase Green inputs, capable of supervising the controller. Ensure that the coordinator maintains the accuracy of the AC line frequency, and without line voltage to an accuracy of at least ± 0.005%.

Provide battery backup capable of maintaining real time and memory for at least 720 h. Provide a time clock that keeps track of time of day in seconds, day of week, and week of year and programmable automatic daylight savings time changes. If a power disruption occurs, ensure that the coordinator will automatically upload itself once line voltage returns. Provide a coordinator capable of 160 program changes, selectable on the minimum basis of 10 daily program groups, 2 weekly programs, and 10 exception days (holidays). Ensure that the program change selectable to at least a minute, on or off of any single function.

Provide coordinators with minimum selectable system options of four cycles, four splits per cycle, three offsets per cycle, three permissive periods per split, one pedestrian permissive period per split, and three force-offs per split. Ensure that the coordinator has selectable cycle settings from 0 s to 255 s in one-second increments, or as a percentage of the cycle length. Offsets, permissive periods, and force-off points may be programmable from 0 s to 255 s in one-second increments, or as a percentage of the cycle length. Provide selectable offset seeking for dwell or shortway offset transitions. Ensure manual selection of any program. Provide for selectable coordinated phase(s) programmed as required in the contract. Ensure that displays show the current time of day, week of year, cycle countdown, current plan in effect, hold, force-off, sync outputs, and all programmed data as they occur.

714.2.1.4 General Design Requirements
714.2.1.4.1 Components
Provide timing circuits consisting entirely of solid-state electronic circuitry that use state-of-the-art large-scale integration (LSI) circuit techniques. Provide cross reference and data sheets showing the parameters of all solid-state devices used. Ensure that all switching functions operate using solid-state electronic circuitry. Do not use electromechanical devices such as time/break relays or rotary, stepping, or line-switches for switching functions.

Provide printed circuit board assemblies consisting of glass epoxy, 60 guage copper circuit traces that meet NEMA requirements for traffic signal controllers. Cover current-carrying traces with a solder mask material. Coat boards containing several CMOS components with a humidity sealant. In addition, clearly mark circuit reference designations immediately adjacent to each component.
De-rate all components with regard to heat-dissipating capacity and rated voltage so that in operation, under maximum air temperature and maximum applied voltage, there is no life shortening of the material or shift in values. Ensure the design life of components operating 24 h a day is at least five years.

714.2.1.4.2 Constancy of Intervals

Provide a controller designed so that the length of any interval, portion, period, or unit extension may be set to two significant digits and will remain within that accuracy level through an air temperature range of from 30 °F to 165 °F, with a line frequency of 60 Hz ± 0.3 Hz. This performance includes cold and hot starts, obtained without the use of a power-consuming heating or cooling apparatus.

714.2.1.4.3 Power

Provide controllers and associated equipment that use 115 V, 60-cycle, single-phase AC power.

714.2.1.4.4 Mechanical Construction

Provide controllers housed in either aluminum or steel sheeting or in a Department-approved housing with a durable finish.

Plug printed circuit boards into receptacles within the controller and provide with fastening devices to prevent loss or loosening during transportation or handling.

Provide controller assemblies interchangeable with those of the same manufacturer and series.

714.2.1.4.5 Environmental, Interface, and Functional Requirements

Provide controllers in accordance with 1989 NEMA Standards TSI-1, or the latest NEMA standards.

714.2.1.5 Controller Requirements

Provide internal programmed NEMA overlaps within the controller. Provide keyboard operator programming.

714.2.1.5.1 Phase Timing

Provide timing intervals for each traffic phase. Ensure the interval and minimum range of adjustment of the timing intervals is in accordance with Table 714.2.1.5.1:1, “Timing Intervals and Minimum Range of Adjustment.”

<table>
<thead>
<tr>
<th>Interval</th>
<th>Timing range (s)</th>
<th>Maximum resolution (second increments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial or minimum</td>
<td>0–99</td>
<td>1</td>
</tr>
<tr>
<td>Extension (gap)</td>
<td>0–9.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Yellow change</td>
<td>0–9.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Red clearance</td>
<td>0–9.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Maximum (Max 1)</td>
<td>0–99</td>
<td>1</td>
</tr>
<tr>
<td>Maximum (Max 2)</td>
<td>0–99</td>
<td>1</td>
</tr>
<tr>
<td>Walk</td>
<td>0–99</td>
<td>1</td>
</tr>
<tr>
<td>Pedestrian clearance</td>
<td>0–99</td>
<td>1</td>
</tr>
<tr>
<td>Red revert</td>
<td>2–7</td>
<td>1</td>
</tr>
</tbody>
</table>

714.2.1.5.2 Phase Control Functions

Ensure each phase is capable of the following functions:

1. Max Recall (Non Act). Automatically returns the phase and extends green timing to that of maximum green. In absence of an opposing phase demand, the controller rest in green;
2. Ped Recall (Non Act). Automatically returns phase to walk-ped clearance and vehicle right-of-way without vehicle and pedestrian demand;
3. Veh. Recall (Ext.). Automatically places a recurring demand for vehicle service without actual vehicle demand when not in its green interval;
4. **Non-Locking (Memory Off).** Phase operates in fully actuated mode. Memory of vehicle demand is retained only when a vehicle is in the detection zone (detector outputting).

5. **Locking (Memory On).** Phase operates in fully actuated mode. Memory of vehicle demand (detector output) is retained in the phase until that phase is served.

### 714.2.1.6 Operational Requirements

#### 714.2.1.6.1 Timing Requirements

Provide an initial interval control for each phase that determines the guaranteed minimum green period for that phase. The minimum green period consists of the sum of the walk interval and the greater of the pedestrian clearance interval or minimum green interval with pedestrian or pedestrian and vehicle actuation.

Ensure that each phase provides vehicles additional green time beyond the minimum green time by vehicle actuations by means of an extension interval control. Ensure that successive actuations cancel the remainder of the previous extension interval and initiate a new extension interval for the vehicle that provided the actuation. Should transfer of right-of-way occur while an extension interval is un-expired, ensure that the right-of-way returns at the next opportunity in the cycle.

Equip each phase with at least two maximum green timing interval controls that set a limit on the time that continuous traffic during the right-of-way phase can be extended, after an actuation is registered for any conflicting phase. Maximum interval (MAX 1) is for normal operation. Maximum interval (MAX 2) is for external and internal input.

Provide each phase with a clearance period consisting of a yellow change interval and a red clearance interval, both of preset duration.

Ensure that the presence of a pedestrian is registered upon actuation of a pedestrian push button during a pedestrian clearance interval, or whenever the “Don’t Walk” signal is displayed, so that the walk signal occurs at the next assignment of right-of-way to the phase. Ensure that the phase is capable of recycling and providing pedestrian and pedestrian clearance intervals when a pedestrian actuation is registered on a phase with no demand for pedestrian or vehicular right-of-way on a conflicting phase. The pedestrian clearance interval is the minimum and guaranteed pedestrian protection. Ensure that the “Don’t Walk” display is steady during the remaining right-of-way and clearance intervals.

#### 714.2.1.6.2 Phasing Requirements

The Department does not want the equipment to give the right-of-way to any street without an actuation (call). In the absence of traffic or recall option, the Department wants the right-of-way to remain on the street where it was last assigned, unless the “RED REST” option is implemented. If the “RED REST” option is used, ensure that the controller cycles to all red and remains until a phase call.

Provide controllers that operate in a concurrent phase timing, dual-ring or sequential, single-ring configuration. Number and operate all phases in accordance with a NEMA dual-ring (quad-left) configuration or sequential configuration. Provide controllers capable of operating at least eight field phases.

Provide controllers capable of assigning the right-of-way to a single phase or any combination of non-conflicting phases. Specify phases skipped on each ring for no demand, and recall functions for each phase for sequential controllers. Provide controllers capable of providing four overlap phases in any phase combination, and programmable on both a standard NEMA plug-in overlap program board and operator keyboard entry.

#### 714.2.1.6.3 Input/Output Features

Provide all controllers with all input/output features per phase, ring, and unit in accordance with NEMA Functional Standards. Wire any unused inputs or outputs to the controller and identify on the controller back panel (NEMA Table 13-3).

#### 714.2.1.6.4 Initialization Requirements

Provide controllers with an initialization control to start at the beginning of:

1. The programmed green, yellow, or red interval of the selected phase(s);
2. The application of power;
3. The external start input; and
4. As specified in the contract.

Place vehicle and pedestrian calls on phases.
714.2.2 Traffic Control Systems
Ensure all systems meet the design, operational, and communication requirements specified in the contract.

714.2.2.1 System Master
Provide a traffic-adjusted, arterial or multi-system, microprocessor design system master. Provide units that shelf-mount in the controller cabinet with Mil-Spec or RS-232-C type connectors, and house in a metal cabinet in accordance with Section 714.2.1.5, “Controller Requirements.”

714.2.2.2 Closed Loop System
Provide a closed loop computer system that controls, operates, and supervises a traffic signal control system consisting of:
1. A computer facility for uploading and downloading traffic data;
2. A communications network;
3. Field equipment; and
4. System training.
Equip the system with software and peripheral equipment that is compatible with the existing controllers.
Obtain pre-approval from the Lighting and Signal Design Engineer for the proposed system components. The Department will reject the proposed equipment, if shop drawings are submitted before obtaining pre-approval of the Lighting and Signal Design Engineer.
Implement timing plans, if required. Peripheral equipment, communication equipment, and field programming unit are a part of timing plans, if specified in the contract.
Have a traffic engineering consultant collect the data for turning movements for each intersection and develop three signal-timing plans for the system at peak morning hours, peak mid-day hours, and peak evening hours. Ensure that these plans outline the objective, minimize intersection and overall system delays, and indicate the trade-offs between mainline optimization and side street operations.

714.2.2.2.1 System Training
Hire a traffic engineering consultant to train Department personnel for two days and assist in the following tasks:
1. Operation of program Arterial Master Controller;
2. Uploading and downloading traffic data;
3. Intersection timing;
4. Volume, occupancy, and standard and custom reports;
5. Counting traffic through system detectors;
6. Troubleshooting;
7. Maintenance; and
8. Initial system operation for progressive traffic movement.
Submit the complete training program to the Lighting and Signal Engineer for approval, 15 working days before training is scheduled. Include working outlines of presentations, videotapes, and all manuals, handouts, and other materials to be distributed during the training in the training program.

714.2.2.3 Controller Interconnect Systems
Provide controller interconnect systems in accordance with the contract.

714.2.2.4 Equipment Approval
The Department’s Traffic Services Engineer will approve all equipment.

714.2.2.5 Delay/Extend Operation
If specified in the Contract, include a digital timer for delaying or extending detection outputs for each channel. Include switches to select delay, extend or delay time, extension or timer off operation for loop vehicle detectors. Ensure the minimum range and steps are 0 s to 30 s in one-second increments for delay time, and 0 s to 7.5 s in 0.5-second increments, for extend time.
Provide output indicators that display a difference in normal detection and delay/extend interval by flashing during this period, or by two indicators per channel that separate “call” and “detect.”

Provide an external input for each channel for the “green” indication of the associated phase. Ensure that delay timing disables when this “green” input is true and extension timing disables when false.

When detector logic inhibits times only on the application of external, 115 V AC signal, connect the external input to same phase red if the Contract requires the extend operation.

714.2.3 Cabinets, Support Equipment, and Wiring

Provide the components of the controller in a sturdy, weatherproof metallic controller cabinet.

714.2.3.1 General

Unless otherwise specified in the Contract, wire all cabinets for the full application of all phases, pedestrian signals on all through movements, and all normal overlaps for either four-phase single-ring operation, or eight-phase dual-ring operation. Provide wiring for all vehicle detection. Furnish the cabinet so that it is only necessary to add load switches, vehicle detectors, disconnect any jumpers, and rearrange field conductors in order to implement any initially unused phases or functions. Unless specified in the plans, all controllers and cabinets shall be assembled and tested at the controller’s point of origin.

Fabricate all ground-mounted cabinets of #14 gauge sheet steel or 5052-H32 aluminum that is at least ⅛ in thick. Fabricate pedestal cabinets of aluminum at least ⅛ in thick. Provide barrier type terminal blocks.

Design and manufacture all cabinets for rigid mounting with no flexing. Provide lifting tabs for all cabinets. Ensure that the types, internal components, and wiring arrangements of controller cabinets for an installation provide a complete operating traffic control system.

714.2.3.1.1 Cabinet Design

Design the cabinet with one door in the front and one door in the back and include a Corbin-tumbler lock Number 1548-1 for each door. Provide an auxiliary door equipped with a treasury-type lock Corbin Number R3575G5 for a police key on the front cabinet door.

Provide door handles that accommodate a padlock in the closed position. Provide a rain channel over the door openings to prevent liquids from entering the enclosure. The cabinet door opening must cover at least 80% of the cabinet’s front surface. Weld a stiffener plate across the inside of the doors to prevent flexing. Slope the top of the cabinet toward the rear to prevent accumulation of water.

Seal all seams with RTV sealant or equivalent material on the interior of the cabinet. Provide an in-door weatherproof and dust-proof, closed cell, neoprene gasket seal for the main door and police door to close against.

Provide louvered air entrances in the lower section of the cabinet door that satisfy the NEMA rod entry test for 3R ventilated enclosures. Provide an air inlet at least 16 in × 20 in. Secure a non-corrosive, vermin- and insect-proof, removable air filter to the air entrance. Fit the filter fit snugly against the cabinet door wall. Provide a one-piece, continuous piano hinge for each door with a stainless steel pin that runs the entire door length, mounted on the right side when facing the cabinet. Attach hinges without rivets or bolts.

714.2.3.1.2 Cabinet Shelving

Support the controller and auxiliary equipment with metallic shelves or brackets. Provide at least two shelves, unless approved otherwise by the Department. Support both ends of the shelves with angle-type braces. Provide shelves strong enough to support the equipment weight without sagging.

714.2.3.1.3 Control Cabinet Equipment Accommodation

Provide control cabinets large enough to:

1. Stand the controller assembly and associated equipment upright on the shelving;
2. Remove the controller assembly straight out without turning it sideways; and
3. Close the door without interfering with the wire harness running to the door.

Do not place equipment on the floor of ground-mounted cabinets. Ensure that it is possible to remove all equipment and wall-mounted devices without relocating or unpacking devices. Do not allow cabinet wiring to obscure the front panels of control equipment.
### 714.2.3.1.4 Control Cabinet Dimensions

Size cabinets as shown in Table 714.2.3.1.4:1, “Control Cabinet Dimensions Requirements,” or as specified in the contract. Meet the space requirements of Section 714.2.3.1.3, “Control Cabinet Equipment Accommodation.”

<table>
<thead>
<tr>
<th>Type of cabinet</th>
<th>Outside dimensions (in)</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>33 x 20 x 14</td>
<td>If specified on plans</td>
</tr>
<tr>
<td>M</td>
<td>48 x 30 x 16</td>
<td>If specified on plans</td>
</tr>
<tr>
<td>MS</td>
<td>54 x 38 x 24</td>
<td>4-phase single-ring operation</td>
</tr>
<tr>
<td>P</td>
<td>54 x 38 x 24</td>
<td>8-phase dual-ring operation</td>
</tr>
<tr>
<td>R</td>
<td>72 x 38 x 24</td>
<td>If specified on plans</td>
</tr>
</tbody>
</table>

### 714.2.3.1.5 Cabinet Mounting Hardware

Provide ground mount type cabinets with internal bolts for controllers, unless otherwise required in the Contract. Have anchor bolts and templates for cabinet installation on site before installing the concrete base for the controller.

### 714.2.3.1.6 Cabinet Finish

Two-coat finish all cabinets with the following:

1. A four-stage iron phosphate coating;
2. A triglycidyl isocyanurate polyester powder coat paint matching Federal Standard 595A Color Chip 27886, with a minimum thickness of 2 mm.

### 714.2.3.2 Cabinet Wiring, Terminals and Facilities

Provide wiring, terminals, and facilities within the cabinet in accordance with NEMA TS 1, or the latest NEMA standards.

Provide field terminal blocks wired with four positions per vehicle or overlap phase (green, yellow, red, and flash). Ensure that all harness and cabinet wiring is neat, firm, and bound together with Ty wrap or equivalent. Meet the gauge and color requirements in Table 714.2.3.2:1, “Back Panel Wiring Requirements.”

<table>
<thead>
<tr>
<th>Description</th>
<th>Wire color</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green/Walk load switch output</td>
<td>Brown</td>
<td>14</td>
</tr>
<tr>
<td>Yellow load switch output</td>
<td>Yellow</td>
<td>14</td>
</tr>
<tr>
<td>Red/Don’t Walk load switch output</td>
<td>Red</td>
<td>14</td>
</tr>
<tr>
<td>CMU (other than AC power)</td>
<td>Violet</td>
<td>22</td>
</tr>
<tr>
<td>Controller I/O</td>
<td>Blue</td>
<td>22</td>
</tr>
<tr>
<td>AC + (power panel to main panel)</td>
<td>Black</td>
<td>8</td>
</tr>
<tr>
<td>AC + (main panel)</td>
<td>Black</td>
<td>10</td>
</tr>
<tr>
<td>AC - (power panel to main panel)</td>
<td>White</td>
<td>8</td>
</tr>
<tr>
<td>AC - (main panel)</td>
<td>White</td>
<td>10</td>
</tr>
<tr>
<td>Chassis ground (power panel)</td>
<td>Green</td>
<td>8</td>
</tr>
<tr>
<td>DC ground</td>
<td>Grey</td>
<td>22</td>
</tr>
<tr>
<td>Flash programming</td>
<td>Orange</td>
<td>14</td>
</tr>
</tbody>
</table>

Meet MIL-W-16878/1, type B/N, 600 V, 29-strand tinned copper for 14 AWG and thinner wire. Ensure that the wire has at least 0.02 in thick PVC insulation with clear nylon jacket and rated to 220 °F, 600 V.

Secure all connecting cables and wire runs with mechanical clamps. Do not use stick-on type clamps. Isolate logic ground and chassis ground from each other within the cabinet. Do not tie chassis ground and AC together within the cabinet. Hook or loop all wire around the eyelet or the terminal block post before soldering to ensure circuit integrity. Do not use lap...
joint soldering, butt type connections, or splices. Ensure that all cabinet wiring is continuous from its origin to its termination point.

Permanently number and label all back panel, D interface panel, and detector panel terminal blocks. Make all pedestrian push button inputs from the field to the controller opto-isolated or relay-isolated to prevent transients and AC from entering the controller.

714.2.3.2.1 Back Panel

Use a back panel to terminate all DC logic wiring. Locate this panel on the back of the cabinet below the equipment shelves and include the load bay and the flasher-flasher relays. Ensure that all terminals and plug-in units are accessible without moving any equipment.

Permanently pre-wire the back panel to the controller harness, conflict harness, and detector inputs. Make DC wiring connections ¼ in quick-connect tab type, 300 V and 20 A rated. Mechanically strip the wire ¼ in, and solder or firmly crimp the tab covering the wire and insulation. Solder AC connections on the panel back and all connections to the load switch/flasher receptacles.

Bring all NEMA functions to the front of the panel with a screw type connector. Ensure that it is possible to program, using jumpers such as clips or wires, the signal outputs for all the types of phasing operations possible for the specified controller, and to access all NEMA functions on the front for future auxiliary equipment. Clearly mark the terminal functions on the back panel with the appropriate NEMA designation. When the auxiliary equipment logic is specified in the contract, make connections on the front of the panel.

Mount the panel with clearance between the cabinet wall and the panel's back connections. Ensure that it is possible to drop the panel in the field (access back wiring) using simple hand tools. Rack mount the load bay, including flasher. Adequately support the load switches and flasher after insertion to prevent falling out due to vibrations.

The minimum positions for plug-in units are listed in Table 714.2.3.2.1:1, “Load Switch/Flasher Unit Positions.”

<table>
<thead>
<tr>
<th>Type of cabinet</th>
<th>Load switch positions</th>
<th>Flash relay positions</th>
<th>NEMA flasher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase single ring</td>
<td>8</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8-phase dual-ring</td>
<td>16</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

714.2.3.2.2 Power Distribution Panel

Locate the power distribution panel on the lower right-hand side of the cabinet and fully enclosed to prevent accidental shock. Include the main power feed terminal (barrier type), the required AC protection from lightning (EDCO SPA-300 surge arrester or approved equal), filter (RFI), MOV to ground, with a removable cover, and any National Electrical Code® requirements in the power panel.

714.2.3.2.3 Detector Panel and Rack

Provide a detector panel on the left-hand side of the cabinet. Provide terminal blocks (barrier type) with removable buss bars for all detectors and pedestrian push-button field conductors. Include the “J” pin conductor appropriately terminated for extend/delay operation on the detector rack.

Provide detector rack positions in accordance with Table 714.2.3.2.3:1, “Required Detector Rack Positions,” Table 714.2.3.2.3:2, “4-Phase Single-Ring Operation 16-Channel Detector Rack Order of Positioning,” Table 714.2.3.2.3:3, “8-Phase Dual-Ring Operation 16-Channel Detector Rack Order of Positioning,” and Table 714.2.3.2.3:4, “8-Phase Dual-Ring Operation Additional Detector Rack.” The Department will not require detector racks when video vehicle detection is used.
### Table 714.2.3.2.3:1
**Required Detector Rack Positions**

<table>
<thead>
<tr>
<th>Type of cabinet</th>
<th>Detector rack positions</th>
<th>Detector terminal blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-phase single-ring</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>8-phase dual-ring</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>8-phase dual-ring</td>
<td>Up to 32</td>
<td>Up to 32</td>
</tr>
</tbody>
</table>

### Table 714.2.3.2.3:2
**4-Phase Single-Ring Operation 16-Channel Detector Rack Order of Positioning**

<table>
<thead>
<tr>
<th>PH1</th>
<th>PH2</th>
<th>PH4</th>
<th>PH2EC</th>
<th>PH1</th>
<th>SD1</th>
<th>SD2</th>
<th>SD4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH3</td>
<td>PH2</td>
<td>PH4</td>
<td>PH4EC</td>
<td>PH3</td>
<td>SD3</td>
<td>SD2</td>
<td>SD4</td>
</tr>
</tbody>
</table>

### 714.2.3.2.3:3
**8-Phase Dual-Ring Operation 16-Channel Detector Rack Order of Positioning**

<table>
<thead>
<tr>
<th>PH1</th>
<th>PH2</th>
<th>PH6</th>
<th>PH2EC</th>
<th>PH3</th>
<th>PH4</th>
<th>PH8</th>
<th>PH4EC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH5</td>
<td>PH2</td>
<td>PH6</td>
<td>PH6EC</td>
<td>PH7</td>
<td>PH4</td>
<td>PH8</td>
<td>PH8EC</td>
</tr>
</tbody>
</table>

### Table 714.2.3.2.3:4
**8-Phase Dual-Ring Operation Additional Detector Rack**

<table>
<thead>
<tr>
<th>PH1</th>
<th>PH3</th>
<th>SD1</th>
<th>SD2</th>
<th>SD6</th>
<th>SD3</th>
<th>SD4</th>
<th>SD8</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH5</td>
<td>PH7</td>
<td>SD5</td>
<td>SD2</td>
<td>SD6</td>
<td>SD7</td>
<td>SD4</td>
<td>SD8</td>
</tr>
</tbody>
</table>

*Provide only additional channels required on plans*

### Table 714.2.3.2.3:5
**Connector/Pin Assignments**

<table>
<thead>
<tr>
<th>Connector/pin</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>DC (-) common</td>
</tr>
<tr>
<td>1</td>
<td>Call delay inhibit (Channel 1)</td>
</tr>
<tr>
<td>B</td>
<td>DC (+) power</td>
</tr>
<tr>
<td>2</td>
<td>Call delay inhibit (Channel 2)</td>
</tr>
<tr>
<td>C</td>
<td>Reset</td>
</tr>
<tr>
<td>4 and D</td>
<td>Loop # 1</td>
</tr>
<tr>
<td>5 and E</td>
<td>Loop # 1</td>
</tr>
<tr>
<td>F</td>
<td>Output # 1A Opto-coupler (Collector)</td>
</tr>
<tr>
<td>H</td>
<td>Output # 1A Opto-coupler (Emitter)</td>
</tr>
<tr>
<td>8 and J</td>
<td>Loop # 2</td>
</tr>
<tr>
<td>9 and K</td>
<td>Loop # 2</td>
</tr>
<tr>
<td>L</td>
<td>Chassis ground</td>
</tr>
<tr>
<td>S</td>
<td>Output 1B AccuCount FET (Drain)</td>
</tr>
<tr>
<td>W</td>
<td>Output # 2A Opto-coupler (Collector)</td>
</tr>
<tr>
<td>X</td>
<td>Output # 2A Opto-coupler (Emitter)</td>
</tr>
<tr>
<td>Y</td>
<td>Output # 2B AccuCount FET (Drain)</td>
</tr>
<tr>
<td>Z</td>
<td>Output # 1C Fail FET (Drain)</td>
</tr>
<tr>
<td>19</td>
<td>Output # 2C Fail FET (Drain)</td>
</tr>
</tbody>
</table>
714.2.3.2.4 “D” Connector Panel
Provide a “D” connector panel and harness with each cabinet assembly on the left-hand side of the cabinet and fully wired to provide all functions. Ensure the panel contains provisions for mounting two 120 V AC relays for preempt inputs 1 A, 2 A, and ¼ A fuse for each relay.

714.2.3.2.5 Terminal Labeling
Number and identify all terminals. Do not use the same nomenclature used on the controller assembly-wiring diagram, such as phase numbers.

714.2.3.2.6 Telemetry Interface Panels
Provide each cabinet assembly with a telemetry interface harness and printed circuit board interface panel. Ensure the following inputs/outputs are accessible from the telemetry interface panel:
1. Local controller command lines 1 and 2;
2. Local controller read back lines 1 and 2;
3. Master controller command lines 1 and 2;
4. Master controller read back lines 1 and 2;
5. Chassis grounds;
6. Four special function outputs;
7. Eight system detector inputs;
8. Flash input; and
9. CMU flash input.
Provide the telemetry interface panel with a socket-mounted, communication line transient protection device wired in series with the telemetry communication circuit. Match the communication line impedance with the transmitter output impedance to minimize line noise.

714.2.3.2.7 Wiring Diagrams
Provide four sets of wiring diagrams for each cabinet. Provide one set on mylar and in an electronic format approved by the State Traffic Services Engineer. Provide a plastic envelope in the cabinet to house one or more cabinet wiring diagrams. Submit these wiring diagrams with the equipment to the Department Signal Laboratory before testing begins.
Show the connectors for all equipment and switches, relays, and flashers on the cabinet wiring diagrams. Show a complete intersection sketch with street names and north arrow, labeling of signal heads and detectors, and a signal sequence chart identified and related to the intersection sketch on the diagrams.

714.2.3.2.8 Additional Required Terminals, Protection Devices, and Switches
Provide the following additional terminals, protection devices, and switches for all cabinets:
1. A UL-listed 50 A circuit breaker for filtered AC power serving all solid-state devices including load switches;
2. A separate 20 A circuit breaker for AC circuit serving the ground fault circuit interrupter (GFCI) outlets, fan, and light;
3. A separate 30 A circuit breaker for advance warning flasher, if specified in the contract;
4. Copper ground strip, mounted and ground to cabinet wall, for connection of all common conductors;
5. Terminate all field signal output circuits on an unfused terminal block with a minimum rating of 15 A. Provide AC field terminals with a screw with diameter at least 7/16 in;
6. Provide terminal blocks to terminate a special equipment harness. Locate these terminals on the right-hand side of the cabinet, above the power distribution panel;
7. Terminals for connecting interconnect cable tie points and inter-cabinet, termination when required. Provide transient protection on all external lines;
8. One duplex GFCI convenience outlet for test equipment, tools, and lighting. A second duplex GFCI convenience outlet, wired to filtered AC power, for telemetry equipment. Use NEMA Type 5-15R outlets;
9. Switches behind police auxiliary door including:
9.1. Main switch, identified “On-Off,” wired to turn off signal light power when switched to off position and to de-energize the field lighting. Provide a 50 A minimum rated switch and connecting wiring;

9.2. Auto flash switch, identified “Auto Flash,” wired to keep controller energized and to place signals on flash when switched to flash position. Provide a controller with stop timing that applies, when in the flash position;

10. Interior cabinet switches including:

10.1. Interior Switches and Convenience Outlet. Combine on a single panel and mount on the inside of the cabinet door, unless otherwise noted. Provide heavy duty and rated at least 15 A switches, except for the main switch. Cover any exposed terminals or switch solder points with a nonflexible shield. Permanently label switch functions. Protect wire routed to the police door, in door, and test push button panel against damage from opening and closing of the main door;

10.2. Test Switch. A two-position switch, labeled “Auto Flash,” wired to de-energize the signal light power when switched to flash position, and to allow the controller to cycle through its normal sequences while displaying flash indications on signals;

10.3. “Controller On/Off” Switch. A two-position switch, labeled “Controller On/Off,” wired to de-energize the controller and auxiliary equipment when switched to the off position;

10.4. Vehicle and Pedestrian Detector Switches. Two-position momentary switches labeled “ON, TEST,” wired to each vehicle and pedestrian detector input to allow the substitution of manual call into each controller detector input. Identify switches as to phase or function;

10.5. Preemption Test Switches. Provide test switches to allow a manual preempt input. Provide each preemption phase with a separate switch with each phase that is appropriately identified;

10.6. Door Ajar/Open Switch. Include a door switch for each cabinet to log an event to the system master that the door is open or ajar;

10.7. Fluorescent Light Door Switch. Include a door switch for each cabinet that turns the cabinet fluorescent light on when the cabinet door is open;

10.8. Load switches and flashers shall be discrete;

11. Radio line filter (RFI) for filtering AC lights and to control power for solid-state light control and controller operation; and

12. Pedestrian push-button isolation (field circuit) to protect solid-state devices from transient voltages, (to prevent transients from being induced in the open pedestrian push-button circuits by isolation transformers, or by opto-isolation).

714.2.3.2.9 Additional Cabinet Features

Provide the following additional cabinet features:

1. Cabinet Fan. Mount a thermostatically controlled, manually adjustable fan in the controller cabinet, set to turn on at cabinet temperatures of from 70 °F to 160 °F. Locate the fan near cabinet vent holes to direct the airflow over the controller unit. Cover the inside opening with a maximum ¼ in mesh screen to prevent the operator from contacting the fan blades. Provide a filter for the cabinet intake fan vent;

2. Fluorescent Light. Mount a fluorescent fixture and lamp in the cabinet over the door; position to minimize damage when sliding equipment off shelves. Provide fluorescent fixtures that accommodate an F20T12 lamp in all ground-mounted cabinets and an F15T12 lamp in pedestal cabinets. Package the lamp separately when transporting to avoid breakage. Provide a door switch for the fluorescent light;

3. Door Stops. Provide a stop for each controller cabinet door of 22 in or greater width, or 6 ft or greater area to lock the door opening at both 90° and 180°, ± 10°. Provide the stop with a catch for the 180° position, so it stays open until released.

714.2.3.2.10 Solid State Signal and Pedestrian Load Switches

Provide signal load switches external to the controller and carried in the back panel load bay. Provide signal control load switches in accordance with NEMA Standards.

Provide a signal control assembly consisting of a separate plug-in unit containing the control circuitry for the operation of three separate signal lamp circuits. Provide interchangeable vehicle and pedestrian control assemblies. Do not use any unused output of each control assembly for any other function or phase.
Provide circuitry consisting of solid-state electronic components. Do not use mechanical relays for the opening and closing of signal light circuits or for any other purpose. Provide a design life of five years or more for all components operating 24 h a day in their circuit application.

Rate all load switches at least 15 A. Include three LED indicators on the face of each load, visible through the door opening of the cabinet, and connected to the input functions.

**714.2.3.2.11 Solid-State Flasher**

Provide each controller cabinet with a NEMA type 3, 15 A minimum per circuit, dual-circuit, solid-state flasher external to the controller and carried in the back panel load bay. Provide solid-state flashers in accordance with NEMA standards.

Provide open, multi-contact plug type flasher transfer relays. Provide enough relays to allow any combination of flashing RED or YELLOW indications. Wire one RC network in parallel with each group of three flash transfer relays, and any other relay coils. Make all flash transfer relay sockets Cinch-Jones #2408SB or equivalent. Ensure that it is possible to isolate the controller’s DC signals to and from the load switches by the use of removable links. The Department prohibits modifications on the back of the main panel.

**714.2.3.2.12 Malfunction Management Unit (MMU-16)**

A malfunction management unit shall be furnished with each traffic signal controller cabinet. All (MMU-16 units shall be the self-contained, shelf mounted type with the appropriate NMEA MS, Port 1 SDLC and RS232 Connector(s). The specification sets forth the minimum requirements for a shelf-mountable, sixteen channel, solid-state Malfunction Management Unit (MMU). The MMU shall meet, as a minimum, all applicable sections of the most current NEMA Standards Publication. Where differences occur, this specification shall govern.

1. Monitoring Functions
   The following monitoring functions shall be provided in addition to those required by the NEMA Standard Section 4;
2. Dual Indication Monitor
   Dual Indication monitoring shall detect simultaneous input combinations of active Green (Walk), Yellow, or Red (Don't Walk) field signal inputs on the same channel;
3. Dual Indication Monitoring
   Sixteen switches labeled FIELD CHECK/DUAL ENABLES shall be provided on the MMU front panel to enable Dual Indication Monitoring on a per channel basis;
4. GY-Dual Indication Monitor
   GY-Dual Indication monitoring shall detect simultaneous inputs of active Green and Yellow field signal inputs on the same channel;
5. Field Check Monitoring
   Sixteen switches labeled FIELD CHECK/DUAL ENABLES shall be provided on the MMU front panel to enable Field Check Monitoring on a per channel basis;
6. Field Check Monitor
7. Field Check Status
8. Recurrent Pulse Monitoring
9. External Watchdog Monitor
   The MMU shall provide the capability to monitor an optional external logic level output from a Controller Unit or other external cabinet circuitry;
10. Walk Disable Option
    The MMU shall provide the capability to exclude the Walk inputs from the Red Fail fault detection algorithm when operating in the Type 12 mode;
11. Type Fault Monitor
12. Configuration Change Monitor
13. CVM Log Disable
    The MMU shall provide a means to disable the logging of CVM fault events;
14. Display Functions
    The following display functions shall be provided in addition to those required by the NEMA Standard Section 4;
15. Full Intersection Channel Status Display
16. Fault Channel Status Display
17. Field Check Status Display
18. Recurrent Pulse Status Display
19. Type 12 Mode Indicator
The Type 12 Indicator shall illuminate when the MMU is programmed for Type 12 operation;

20. **Type 12 Mode Indicator**
   The DUAL INDICATION indicator shall illuminate when a DUAL INDICATION Fault is detected;

21. **Power Indicator**
22. **Port 1 Receive Indicator**
23. **Port 1 Transmit Indicator**
24. **RS232 Receive Indicator**
25. **Program Card/CF Indicator**
26. **Y+R Clearance Indicator**
27. **Field Check Fail Indicator**

28. **Operating Modes**
   The MMU shall operate in both the Type 12 mode and Type 16 mode as required by the NEMA standard;

29. **Hardware, Enclosure**
   Overall dimensions, including mating connectors and harness, shall not exceed 10.5” x 4.5” x 11” (H x W x D).
   a. The enclosure shall be constructed of sheet aluminum with a minimum thickness of 0.062”, shall be finished with an attractive and durable protective coating. Model, serial number, and program information shall be permanently displayed on the top surface;

30. **Electronics**
   A microprocessor shall be used for all timing and control functions. Continuing operation of the microprocessor shall be verified by an independent monitor circuit, which shall force the OUTPUT RELAY to the de-energized “fault” state and indicate and error message if a pulse is not received from the microprocessor within a defined period not to exceed 500 ms.
   a. High speed sampling techniques shall be used to determine the true RMS value of the AC field inputs. Each AC input shall be sampled at least 32 times per line cycle. The RMS voltage measurement shall be insensitive to phase, frequency, and waveform distribution;
   b. In the interest of reliability, only the PROM memory device for the microprocessor firmware shall be socket mounted. The PROM Memory socket shall be a precision screw machine type socket with gold contact finish providing a reliable gas tight seal. Low intersection force sockets or sockets with “wiper” type contacts shall not be acceptable;
   c. All user programmed configuration setting shall be stored in an electricity erasable programmable read-only memory (EEPROM) or front panel DIP switches. Designs using a battery to maintain configuration shall not be accepted;
   d. All 120 VAC field terminal inputs shall provide an input impedance of at least 150K ohms and be terminated with a resistor having power dissipation rating of 0.5 Watts or greater;
   e. All electrical components used in the MMU shall be rated by the component manufacturer to operate over the full NEMA temperature range of -34ºC to +74ºC;
   f. All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:
   1. All plated-through holes and exposed circuit traces shall be plated with solder;
   2. Both sides of the printed circuit board shall be covered with the solder mask material;
   3. The circuit reference designated for all components and the polarity of all capacitors and diodes shall be clearly marked adjacent to the component. Pin #1 for all integrated circuit packages shall be designated on both sides of all printed circuit boards;
   4. All electrical mating surfaces shall be gold plated;
   5. All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.

31. **Front Panel & Connectors**
All displays, configuration switches, and connectors shall be mounted on the front panel of the MMU. All MMU configuration inputs beyond those required by the NEMA Standard shall be provided by front panel mounted DIP switches and shall be clearly labeled. Configuration DIP switches shall be provided for the following functions:

Field Check / Dual Enables 1-16
a. GY-Dual Indication Enable (GY ENABLE);
b. Recurrent Pulse Test Disable (RP DISABLE);
c. External Watchdog Enable (WD ENABLE);
d. Walk Disable (Type 12);
e. Configuration Change Fault Enable (CF ENABLE);
f. CVM Log Disable.

32. MS Connectors

33. EIA-232 Port

The EIA-232 port shall be electricity isolated from the MMU electronics using optical couplers. The connector shall be an AMP 9721A or equivalent 9 pin metal shell D subminiature type with female contacts. Pin assignments shall be as shown in the following table:

<table>
<thead>
<tr>
<th>PIN</th>
<th>FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DCD*</td>
</tr>
<tr>
<td>2</td>
<td>TX DATA</td>
</tr>
<tr>
<td>3</td>
<td>RX DATA</td>
</tr>
<tr>
<td>4</td>
<td>DTR (Data Terminal Ready)</td>
</tr>
<tr>
<td>5</td>
<td>SIGNAL GROUND</td>
</tr>
<tr>
<td>6</td>
<td>DSR*</td>
</tr>
<tr>
<td>7</td>
<td>DSR*</td>
</tr>
<tr>
<td>8</td>
<td>CTS*</td>
</tr>
<tr>
<td>9</td>
<td>NC</td>
</tr>
</tbody>
</table>

*Jumper options shall be provided to allow the connection of Pin #4 to be made with Pin #7, and the connection of Pin #8 to be made with Pin #1 and or Pin #6.

34. Event Logging Functions

35. Monitor Status Report (CS)

36. Previous Fault Log (PF)

37. AC Line Event Log (AC)

38. Monitor Reset Log (MR)

39. Configuration Change Log (CF)

40. Signal Sequence Log (SSQ)

714.2.4 Remove and Reset Signal Controllers and Controller Cabinets

If the Contract requires the Contractor to remove or reset signal controllers or controller cabinets, use materials for new foundations in accordance with Section 708, “Foundations for Signal and Lighting Installations.” Use new anchor bolts for resetting controller cabinets. Provide anchor bolts fabricated from high strength steel bars with minimum yield strength of 55,000 psi, or steel in accordance with AASHTO M 314.

714.3 CONSTRUCTION REQUIREMENTS

714.3.1 General

If the contract specifies new traffic-actuated controllers and controller cabinets, provide controllers and cabinets from the same manufacturer. If the contract requires a system master, provide a system master and controller from the same manufacturer.

Install traffic signal controller cabinets on concrete bases, if specified in the contract, or as directed by the Project Manager. Face the cabinet door away from the street, unless otherwise specified in the contract. Upon installation of a ground-mounted controller cabinet, place the necessary grout or caulking between the cabinet and concrete base to create a weather-resistant and dust-tight seal. Do not place conduit entries into the side of the cabinet.

714.3.1.1 Foundations

Install foundations and anchor bolts for control cabinets in accordance with Section 708.3.2, “Control Cabinet Foundations.”
Transport the controllers and cabinets, and any specified auxiliary equipment to the Traffic Services Signal Laboratory in Santa Fe. The controller Cabinet including all associated internal components shall be assembled and tested at the manufactured point of origin. Documentation and/or certification of tests performed at the factory shall be provided for each Controller Cabinet, including make, make model number(s), and serial number(s). Controller Cabinets and internal components shall be shipped as one (1) unit. The equipment will have appropriate written documentation including project identification, signal plan sheets, and transmittal letter(s). After receipt of all controller equipment and associated internal components with supportive documentation that satisfy the fore-mentioned requirements, NMDOT signal laboratory personnel with begin testing of the Controller Cabinet(s) for a minimum 14 day or Maximum 30 day test. The testing will be completed prior to the Project Manager’s acceptance of compliance with these specifications:

1. Visual inspection to ensure compliance with Contract requirements for arrangement of equipment, specified markings, and workmanship;
2. Operational testing including:
   2.1. Specified phasing;
   2.2. Various timings;
   2.3. Indicators;
   2.4. Pedestrian phasing;
   2.5. Auxiliary functions and interconnects;
   2.6. Flash mode;
   2.7. Possible conflicts for fail safe;
   2.8. Preemption interruption with every function and phase, when applicable;
   2.9. Load switches at 1,800 W;
   2.10. Interrupted power test;
   2.11. Timings and operation at input voltage of 105 V and 130 V AC; and
   2.12. Air temperature of 160 °F ± 30 °F for no more than 14 days.

The Project Manager will reject the controller if its operation or components do not pass these tests. If a component fails, all testing will stop and the Department will require the removal and replacement, or repair, of the component and repair of the controller. Submit new equipment or resubmit repaired equipment for testing, and the Project Manager will determine the length of this new test period, which will not exceed 30 days. Once the lab test is completed and the equipment accepted, transport the controller and cabinet from Santa Fe to the project site.

In addition to the lab test, the Project Manager will final accept of all controllers and cabinets in accordance with Section 705.3.5.2, “Operation Tests.”

Do not turn-on controllers and auxiliary equipment after installation, until the Project Manager inspects and approves the entire signal system.

Provide the Project Manager, Traffic Services Signal Laboratory, Signal Design Engineer, and the maintaining agency written notice at least five working days before the anticipated turn-on time. Personnel of the Department signal laboratory, Signal Design Engineer, and the maintaining agency must be present during the initial turn-on. If specified in the contract, ensure that the qualified manufacturer’s representative is present at the turn-on and conducts a training session for special controller equipment.

Remove conflicting traffic control signing after turn-on, as directed by the Project Manager.

If the contract requires modifications or additions to an existing cabinet, use a qualified signal manufacturer’s representative to perform this work.

Cabinet wiring diagrams from the Traffic Services Signal Laboratory in Santa Fe are available. Return proposed modifications to these wiring diagrams to the Department’s Signal Design Engineer and obtain approval before starting any cabinet modification work. Signal Lab personnel or delegated representatives must inspect the work before the system is re-energized.
714.3.5 Removing and Resetting of Signal Controller
If the contract specifies the removal or reset of a signal controller, disconnect the existing controller from the cabinet, remove the controller and relocate it to the new location, and reinstall the controller in a new or used controller cabinet.

714.3.6 Remove and Reset Signal Controller Cabinet
Construct a new foundation at the specified location, then remove the existing cabinet and relocate the signal controller cabinet to the new foundation, using new anchor bolts.
Reconnect field wiring including loop lead-in cables, power, pedestrian pushbuttons, signals, and signal controllers, to provide a complete and operational signal.

714.4 METHOD OF MEASUREMENT—Vacant

714.5 BASIS OF PAYMENT
Pay Item Pay Unit

<table>
<thead>
<tr>
<th>Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic-Actuated Controller</td>
<td>Each</td>
</tr>
<tr>
<td>System Master</td>
<td>Each</td>
</tr>
<tr>
<td>(type) Controller Cabinet</td>
<td>Each</td>
</tr>
<tr>
<td>Closed Loop Traffic Control System</td>
<td>Lump sum</td>
</tr>
<tr>
<td>Remove and Reset Signal Controller</td>
<td>Each</td>
</tr>
<tr>
<td>Remove and Reset Controller Cabinet</td>
<td>Each</td>
</tr>
<tr>
<td>Controller Interconnect System</td>
<td>Each</td>
</tr>
</tbody>
</table>
Section 715: Beacons and Temporary Signal Equipment

715.1 DESCRIPTION
This Work consists of providing and installing intersection control, hazard identification beacons, and temporary signals. The following items are included in this Work:
1. Lamps;
2. Framework and mounting brackets;
3. Anchor bolts; and
4. Other Material in accordance with the Plans.

715.2 MATERIALS

715.2.1 Beacon Assembly
Provide beacon assemblies of single section 12 in lens traffic signal assemblies in accordance with Section 712.2.1, “Traffic Signal Assembly.”
Provide beacon assemblies that normally display a flashing RED or YELLOW indication in accordance with the Contract.

715.2.2 Span Wire Installation
Provide span wire consisting of a set of poles and guy wire support system over a Roadway normally used for flashing beacons. Span wire installations include poles, guy wire, down guys (if required), and miscellaneous hardware and turnbuckles.

715.2.2.1 Poles
Provide free-standing steel strain poles or guyed timber poles capable of supporting the span and specified attached equipment without noticeable bending.

715.2.2.1.1 Steel Strain Poles
Provide steel strain poles of round or octagonal tapered steel tube that is the length specified in the Plans having a 3-gauge wall thickness (approximately 1/4 in or thicker), as required by the design span specified in the Contract. Steel strain poles shall be designed in accordance with the 1994 AASHTO specification utilizing an 80 mph isotach wind velocity. Provide steel with yield strength of 55,000 psi or greater. Provide strain poles that are galvanized inside and out in accordance with ASTM A 123.

715.2.2.1.2 Timber Poles
Provide treated timber poles in accordance with AASHTO M 133.

715.2.2.2 Anchors
Design the anchor base to develop the maximum strength of the shaft. Provide anchor bolts that have a diameter of 1 1/2 in, are 5 ft long with minimum tensile strength of 85,000 psi, unless otherwise specified in the Plans. Provide two leveling nuts and washers for each anchor bolt.

715.2.2.3 Guy Strand Wire
Provide guy strand wire (7-wire) with an approximate weight of 273 lb per 1,000 ft and minimum breaking strength of 10,000 lb. Run electrical cable inside steel poles and exit the pole at the top in a weatherproof manner, for wood pole installations protect the cables with IMC conduit mounted on the poles.

715.2.3 Flasher Controller
Provide a flasher controller assembly including a flasher, cabinet, and time clock. The Contractor may mount the assembly on the side of the pole or place it in a ground-mounted cabinet. Provide a meter in accordance with the Plans.

715.2.3.1 Flasher
Provide a flasher unit with an alternating two-circuit (115 V AC), solid-state plug-in type with a 15 A or greater rating per circuit. Design the unit to plug into a pre-NEMA electromechanical base of either the Econolite/Singer (4-banana jack, female base) type or the Crouse-Hinds (5 socket, male base) type. Ensure the units are interchangeable among the types used.
Provide flasher units in a solid state with no moving parts. Provide units that use zero
voltage switching with 50% on time, and a flash rate of from 50 to 60 per minute. Provide flasher units designed to operate at full capability in air temperatures ranging from −30 °F to 160 °F.

715.2.3.2 Pole-Mounted Beacon Control Cabinet

Provide a cabinet made of sturdy, cast or sheet aluminum housing with a hinged main door equipped with a lock for a police key. Provide two police keys with each cabinet. Provide a cabinet at least 12 in wide × 10 in high × 6 in deep, or as required to house the specified equipment. Ensure switches and controls are accessible through the front door. Provide side-of-pole mounting cabinets. Provide access to the cabinet through a hole located in the bottom and top, drilled and threaded to accept a 1 1/2 in galvanized rigid conduit, unless otherwise specified in the Plans.

All cabinets (inside and outside surfaces) shall be finished as follows:
1. First Coat. Four-stage iron phosphate coating;
2. Second Coat. TGIC polyester powder coat paint matching Federal Standard 595A Color Chip 27886, with a minimum thickness of 2 mm;

Provide neat and firm cabinet wiring. Lace or, bind together, wiring and harnesses with Ty wrap or an equivalent. Number and identify terminals in accordance with a cabinet-wiring diagram provided by the Supplier. Ensure that the flasher cabinet includes the following terminals, protection devices, and switches:
3. Terminal (barrier type) for 115 V AC power feed;
4. Main power supply circuit breaker with at least a 15 A rating;
5. One terminal (barrier type) for each circuit for field conductor to beacons;
6. Signal shutdown switch that does not affect clock power;
7. Copper ground strip grounded to the cabinet for connection of common conductors;
8. Terminal (barrier type) for time switch opening and closing;
9. Radio line filter for filtering AC power; and
10. Lightning arrester for filtering lighting or high voltages to the ground for protection of equipment.

If specified, provide a flasher controller including a time switch. Provide a time switch using a weekly time clock programmable for the on/off function up to eight times a day and 40 times a week. Ensure the switch/controller allows a user to vary or omit a day program.

Provide time switches that a user can program with a keyboard and/or digital switches. Provide an LED display of the time of day and keyboard entered data.

715.2.3.3 Ground-Mounted Beacon Control Cabinet

Provide NEMA 3R and 12, raintight ground-mounted beacon control cabinet, electrically welded and reinforced where specified in the Plans. Provide stainless steel nuts, bolts, screws, and hinges. Provide phenolic nameplates. Mark control wiring at both ends with permanent wire markers and attach a plastic covered wiring diagram to the inside of the front door. Provide a factory-wired cabinet in accordance with NEMA Standards, and bearing a UL 508 label.

715.2.4 Changeable Traffic Signs

715.2.4.1 General

Provide changeable traffic signs capable of displaying either one of two messages as specified and controlled automatically by a time switch or other remote signal. Provide a sign face that can be mechanically changed by an electrically powered drive mechanism. Ensure that after receiving an electric signal, the drive mechanism of a double message sign changes the existing displayed message from “SPEED LIMIT (numeric value in accordance with the Plans),” to the alternate message “SCHOOL, SPEED LIMIT 15,” unless otherwise specified in the Plans. Ensure that after receiving an electric signal, the drive mechanism of the single message sign opens the panels to the alternative message. Design the drive mechanism so that each movable spring-loaded sign panel returns to its programmed position, if moved by hand. Ensure this feature is prevalent regardless of panel position.

Provide each changeable traffic sign with housing, sign faces, drive mechanism, and mounting hardware; completely assembled and ready for use.
715.2.4.2 Basic Unit
Provide an aluminum housing. Provide a drive module of weatherproof aluminum housing that contains the components of the drive mechanism, including the drive motor. Provide a non-reversing drive motor with a ventilated cover for use with 115 V. The Department will not allow solenoid switches in the energizing unit. Ensure the entire housing is coated in accordance with the manufacturer’s recommendation.

715.2.4.3 Sign Wiring
Terminate complete internal sign wiring on a UL-approved terminal strip located inside the drive module. Provide a wiring diagram with each unit. Number and identify terminals in accordance with the diagram. Ensure external wiring exits the sign unit through the bottom mounting hub.

715.2.4.4 Sign Faces
Provide 30 in × 36 in sign faces in accordance with the MUTCD, unless otherwise specified. Make both sign faces the same size. Provide silk-screen sign faces on reflective sheeting with heat-activated type adhesive, and apply the sign faces to the face panels in a heat-vacuum type applicator. Provide enclosed-lens reflective sheeting in accordance with Section 701, “Traffic Signs and Sign Structures.”
Provide each complete sign face with clear mylar overlay to protect against vandalism and to help prevent snow and freezing rain from sticking to the sign faces.

715.2.4.5 Mounting Hardware
Bolt two mounting hubs onto the back of the sign housing with four bolts per hub. Weld the four fastening bolts to the sign housing in a 3.74 in × 2.24 in bolt pattern capable of connecting to a 1 1/2 in standard iron or aluminum pipe.

715.2.4.6 Package Requirements
Pack each sign unit separately to prevent damage or defacement.

715.3 CONSTRUCTION REQUIREMENTS
Mount beacons, flasher controllers, and changeable message signs on the specified support.
Provide span wire pole installation, including erecting poles, installing anchor bolts in a foundation, and leveling the pole. After raking, place at least 4 in of grout between the anchor base and the top of the foundation. Tension the complete span wire with the specified sag.
If the Plans specify a temporary (construction related) span wire, remove Material after completion of the work. Removed temporary span wire Material will become the property of the Contractor, unless otherwise specified in the Plans.

715.4 METHOD OF MEASUREMENT—Vacant

715.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beacon Assembly</td>
<td>Each</td>
</tr>
<tr>
<td>Flasher Controller</td>
<td>Each</td>
</tr>
<tr>
<td>Flasher Controller with Time Clock</td>
<td>Each</td>
</tr>
<tr>
<td>Span Wire Installation</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>

The Department will pay for accepted temporary signal span at the Bid Item Unit Price when it is complete, in place, and operational for the period specified.
716.1 DESCRIPTION
This Work consists of providing and installing Luminaires on Standards, Bridge Structures, or sign supports. This Work also includes lamps, ballasts, necessary mounting hardware, and specified wiring.

Install outdoor lighting in accordance with the New Mexico Night Sky Protection Act (NMSA 1978, § 74-12-1 et seq.); as detailed in the latest applicable UBC™. Obtain the UBC™ from the State Construction Industries Division.

716.2 MATERIALS
716.2.1 Roadway Luminaire
Provide horizontal-burning, cobra-type Roadway Luminaires with 2 in slip fitters on the house side for mounting on a Type V Standard.

Provide the lamp type (metal halide or high-pressure sodium), lamp wattage, and line voltage in accordance with the Contract.

Provide ballasts pre-wired to the lamp socket (may use quick-disconnect plugs), requiring only connection to the power supply terminal block (screw type).

Provide a polycarbonate-type terminal block.

Provide light distribution in accordance with Illuminating Engineering Society of North America (IESNA)/ANSI Type M-CO-II or as specified in the Contract. Submit photometric data in IES format to the Project Manager for approval.

716.2.1.1 Glassware
Provide flat, borosilicate glassware.

716.2.1.2 Reflector and Socket
Provide anodized aluminum reflectors, Alzak®, ALGLAS® or an approved equivalent.

Provide high-grade porcelain sockets with both axial and vertical adjustment.

716.2.1.3 Mounting Requirements
Mount the reflector in a doorframe assembly, hinged to the Luminaire at the house side, and fastened at the street side with an automatic latch. Secure the reflector and lamp socket to the upper housing.

Ensure the reflector and doorframe assembly are forced upward at the street side by spring pressure against a gasket seat when in the closed and latched position.

Provide easily removable power-pack ballasts connected with quick-disconnect plugs.

Provide a separate rear door allowing access to the ballast, not disturbing the sealed optical system. A single door allowing access to the ballast, other electrical components and the optical system is acceptable if the ballast and other electrical components are removable with a screw driver.

Provide the slip fitter capable of clamping on 1 in or 2 in pipe brackets without removing the clamping device. Also, provide the slip fitter capable of leveling of the Luminaire horizontally ± 3°.

Provide gaskets of a breathing material capable of filtering and sealing the fixture, capable of withstanding the temperatures created by the Luminaire. Secure the gaskets in place.

Provide die-cast aluminum housings and refractor rings. Provide latch and exposed hinge parts of a non-corrosive material.

If on a Bridge deck, mount poles on vibration-dampening pads. Provide fixtures with lamp stabilizers to reduce the potential for damage from vibration, and certified to withstand a 3G-vibration test.

716.2.1.4 Photocell Controller
If specified, provide an individual photocell controller on the top of the housing, mounted inside, or outside. Provide a polycarbonate photo-control receptacle.

716.2.2 High-Mast Luminaire
Provide area, vertical-burning type, high-mast Luminaires for mounting above 60 ft. Use Luminaires consisting of weatherproof cast aluminum or formed aluminum ballast housing, a cast aluminum slip fitter frame, and a bell-shaped optical assembly. Ensure that the lamp...
Ensure the slip fitter accepts a 2 in bracket and is adjustable 3°, up or down. Provide a pre-wired terminal board to accommodate from No. 6 to No. 14 AWG wire. Provide a mogul multiple pre-wired, porcelain enclosed lamp socket with integral lamp grip that is adjustable to control the angle of maximum lumens.

Provide anodized, aluminum reflectors, ALZAK, ALGLAS, or an approved equivalent.

Provide symmetrical light distribution with IESNA Type V-FCO (Full Cut Off). If the Contract specifies asymmetrical light distribution, provide IESNA Type II or III FCO. Provide other special required distributions as specified in the Contract.

Submit photometric data to the Project Manager for approval.

Provide optical assemblies that allow mounting of an external shield, if necessary.

Unless otherwise specified, provide open, ventilated optical assemblies. If required, provide borosilicate glass for the bottom of the assembly.

If the Contract specifies a closed type, provide an optical assembly with a heat- and shock-resistant glass flat lens on the bottom with a silicone rubber gasket. Provide gaskets of a breathing material capable of filtering and sealing the fixture, capable of withstanding the temperatures created by the Luminaire.

Provide a ballast, easily removable from the top of the Luminaire, using bolts or latches and quick-disconnect electrical leads.

Ensure exposed parts are of a non-corrosive material.

716.2.3 Area Luminaire

Provide area Luminaires that are decorative-type Luminaires mounted on Type IV Standards or ornamental poles for rest areas or similar applications. Unless otherwise specified, use Luminaires that provide symmetrical light distribution.

716.2.4 Sign Luminaire

Provide metal halide sign Luminaires designed to illuminate a retro-reflecting sign face from a horizontal position below the sign. Mount the sign Luminaire with a 1 in pipe slip fitter. Provide a 1 in Schedule 40 steel pipe support bracket securely welded to a 1/2 in steel mounting plate, designed to bolt directly to supports on the back of the sign.

Contain the ballast in a weatherproof capsule designed to bolt to the mounting plate and wire to the Luminaire through the support pipe. Where the additional weight does not require redesigning the detailed support, the Contractor may place the ballast inside the light fixture.

Use a three- or four-bolt pattern where the fixture is mounted on the sign Structure catwalk.

Provide a Luminaire with a maximum uniformity gradient of a 2:1 ratio of illumination of any 1 ft² of sign face to any adjacent 1 ft².

Provide a Luminaire that consists of a die-cast aluminum ballast housing, an anodized aluminum reflector, a tempered glass lens, and a hinged door on reflector.

716.2.5 Underpass Luminaire

Provide underpass Luminaires that mount directly on a wall with surface wiring or over a recessed outlet box. The Contractor may use a flush outlet box stud or three mounting bolts to mount the Luminaire. Provide underpass Luminaires that are weatherproof, self-contained units with integral ballasts. Provide Luminaires that consist of a die-cast aluminum base housing, a borosilicate prismatic glass refractor, and a hinged lens assembly, using a manufacturer’s recommended gasket between the door and housing.

Provide a reflector of anodized aluminum, ALZAK, ALGLAS, or approved equal. Mount aluminum reflector and socket rigidly to the housing.

Provide high-pressure sodium lamps in accordance with Table 716.2.7.1, “High-Intensity Discharge Lamp/Ballast Requirements,” unless otherwise specified.

Provide a cast-aluminum grid guard or a lexan shield over the refractor to protect against vandalism. Provide tamper-resistant latches.

Provide luminaries capable of illuminating an area equal to one mounting height on either side of the fixture, and two mounting heights in front of the fixture.

716.2.6 Ballasts

Provide ballasts for high-intensity discharge lamps for the primary current and types of lamps, as specified. Unless otherwise specified, the ballast shall be an integral part of the Luminaire. Provide ballasts that are in accordance with the appropriate ANSI Standard (see
716.2.6.1 Metal Halide Lamp Ballast
Provide constant-wattage, auto-regulated ballasts for metal halide lamps with a voltage input range of ± 10%, and a transient impulse level of 7.5 kV. Provide ballast of the high power-factor design and with a lamp wattage regulation of ± 10%.

716.2.6.2 High-Pressure Sodium Ballasts
Provide ballasts with isolated primary and secondary windings for 250 W and 400 W high-pressure sodium lamps, and a transient impulse level of 10 kV, voltage input range of ± 10%, and ballast loss of no more than 10%.
If using integrated circuit design ballast, provide isolated primary and secondary lamp circuit windings and transient impulse level of 10 kV.
Provide constant wattage auto-regulation type ballasts for 1,000 W high-pressure sodium lamps. Use ballasts having a transient impulse level of 7.5 kV, a voltage input range of ± 10%, and a ballast wattage loss of no greater than 10%.

716.2.7 Lamps
Provide HID lamps for luminaries in conformance with the requirements shown in Table 716.2.7.1, “High-Intensity Discharge Lamp/Ballast Requirements.”

### Table 716.2.7.1
<table>
<thead>
<tr>
<th>Description</th>
<th>Watts (ANSI)</th>
<th>Minimum Initial Lumens</th>
<th>Minimum Rated Life (h)</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metal Halide:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>175 Coated (M57)</td>
<td>15,000 (h)</td>
<td>7,500</td>
<td>7,500</td>
<td>Sign Lighting</td>
</tr>
<tr>
<td>400 Clear (M59)</td>
<td>32,000 (h)</td>
<td>20,000</td>
<td>20,000</td>
<td>Roadway</td>
</tr>
<tr>
<td>1000 Clear (M47)</td>
<td>115,000 (V)</td>
<td>12,000</td>
<td>12,000</td>
<td>High Mast</td>
</tr>
<tr>
<td><strong>Sodium:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 Clear (S62)</td>
<td>6,300</td>
<td>24,000</td>
<td>24,000</td>
<td>Underpass, Rest Area</td>
</tr>
<tr>
<td>100 Clear (S54)</td>
<td>9,500</td>
<td>24,000</td>
<td>24,000</td>
<td>Rest Area</td>
</tr>
<tr>
<td>150 Clear (S55)</td>
<td>16,000</td>
<td>24,000</td>
<td>24,000</td>
<td>Underpass, Rest Area</td>
</tr>
<tr>
<td>200 Clear (S66)</td>
<td>22,000</td>
<td>24,000</td>
<td>24,000</td>
<td>Roadway, Rest Area</td>
</tr>
<tr>
<td>250 Clear (S50)</td>
<td>27,500</td>
<td>24,000</td>
<td>24,000</td>
<td>Roadway, Rest Area</td>
</tr>
<tr>
<td>400 Clear (S51)</td>
<td>50,000</td>
<td>24,000</td>
<td>24,000</td>
<td>Roadway, Rest Area</td>
</tr>
<tr>
<td>1000 Clear (S52)</td>
<td>140,000</td>
<td>24,000</td>
<td>24,000</td>
<td>High Mast</td>
</tr>
</tbody>
</table>

*Vertical or horizontal bulb position indicated where different.*

716.3 CONSTRUCTION REQUIREMENTS
Properly align and level Luminaires in accordance with the manufacturer’s and Contract design requirements. Include two single conductors, No. 10 or as specified, to the Standard pole base, or to the nearest splice point into main distribution feed, for the installation of Luminaires.
Provide conduit and wiring to the nearest pull box (splice point into the main distribution feed) and necessary mounting devices for the installation of underpass luminaries.
Place ornamental poles and luminaries in accordance with the Contract requirements and the manufacturer’s recommendations, as approved by the Project Manager.

716.4 METHOD OF MEASUREMENT—Vacant

716.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway Luminare Type</td>
<td>Each</td>
</tr>
<tr>
<td>Area Luminare Type</td>
<td>Each</td>
</tr>
<tr>
<td>Underpass Luminare</td>
<td>Each</td>
</tr>
<tr>
<td>High Mast Luminare Type</td>
<td>Each</td>
</tr>
<tr>
<td>Ornamental Pole and Luminare</td>
<td>Each</td>
</tr>
</tbody>
</table>

The Department will specify the Luminare type by lamp watts and lamp type.
abbreviations as follows:
M—Metal Halide
S—Sodium
Example: Type 400S specifies a Luminaire with a 400-watt high-pressure sodium lamp.

716.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:
A. Wiring;
B. Conduit;
C. Mounting hardware and ballast; and
D. Photo-control units.
SECTION 720: VEHICULAR IMPACT ATTENUATOR UNITS

720.1 DESCRIPTION
This Work consists of providing and installing vehicular impact attenuator units and sand barrel vehicular impact attenuator units.

720.2 MATERIALS
Provide Materials from the Department’s Approved Products List for vehicular impact attenuator units, which the Contractor may obtain from the State Maintenance Bureau. Use Materials of the manufacturer's latest approved design. Use Materials of a uniform type and from a single manufacturer. Do not mix component parts.

Suppliers of vehicular impact attenuator units proposed for including on the Department's Approved Products List shall submit certification for approval to the Traffic Services Engineer. The certification shall be a signed and notarized statement prepared by the manufacturer stating that the Materials proposed for use have met the testing requirements in accordance with NCHRP Report 350.

Submit manufacturers' certificates, literature, and shop drawings to the Project Manager for approval before fabrication and installation of the units.

Provide Class A concrete, if required by the Contract for foundations and anchors, in accordance with Section 510, “Portland Cement Concrete.”

Provide reinforcing steel in accordance with Section 540, “Steel Reinforcement.”

720.2.1 Vehicular Impact Attenuator Units
720.2.1.1 Manufacturer Identification and Marking
Provide vehicular impact attenuator units identifying the type of unit permanently stamped on each unit. The permanent stamp shall correspond with those shown on the shop drawings.

720.2.2 Sand Barrel Vehicular Impact Attenuators
Install sand barrel vehicular impact attenuators in accordance with the manufacturer's recommendations and the traffic control plan.

720.2.2.1 Color
Provide yellow modules for sand barrel vehicular impact attenuators, unless otherwise specified.

720.2.2.2 Sand
Provide well-graded, dry aggregate for filling ballast attenuator barrels. Provide sand in accordance with gradation limits of AASHTO M 6, unless otherwise specified on the Plans or as recommended by the manufacturer. Ensure the moisture content of the sand does not exceed 3%.

720.2.2.3 Foundation Pads
Place sand barrels in accordance with the following:
1. On pallets of wood or wood composite construction that are not more than 4 in high. Ensure the lateral dimensions of the pallets are large enough to allow spacing and configuration of the sand barrels in accordance with the manufacturer's recommendations.
2. On a hard, dense, and level surface no more than 4 in above adjacent Roadway grade; or
3. As otherwise recommended by the manufacturer.

720.2.3 Reflective Sheeting
Provide the sheeting in accordance with Section 701, “Traffic Signs and Sign Structures.”

720.3 CONSTRUCTION REQUIREMENTS
Fabricate, assemble, and install vehicular impact attenuators in accordance with the manufacturer's recommendations and the approved shop drawings.

If in-place components of impact attenuators are damaged by traffic before acceptance, immediately repair or replace damaged impact attenuators.

Obtain on-site assistance from the manufacturer during installation, unless the Contractor can prove previous experience with the installation of vehicular impact attenuator units.
Ensure a manufacturer's representative is present for final acceptance of the vehicular impact attenuator unit installation, as directed by the Project Manager.

720.3.1 Sand Barrel Vehicular Impact Attenuator

One sand barrel vehicular impact attenuator unit consists of the number of sand-filled barrels, as recommended by the manufacturer.

If using pallets, place no more than two sand barrels on each pallet.

Unless otherwise specified, sand barrel vehicular impact attenuators shall remain the property of the Contractor.

720.4 METHOD OF MEASUREMENT—Vacant

720.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Vehicular Impact Attenuator Unit</td>
<td>Each</td>
</tr>
<tr>
<td>Vehicular Impact Attenuator Unit Work Zones</td>
<td>Each</td>
</tr>
<tr>
<td>Sand Barrel Vehicular Impact Attenuator Unit</td>
<td>Each</td>
</tr>
<tr>
<td>Remove and Reset</td>
<td>Each</td>
</tr>
</tbody>
</table>

720.5.1 Work Included in Payment

The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately:

A. Hardware;
B. Pallets;
C. Sand;
D. Concrete;
E. Reinforcing steel;
F. Bolts;
G. Cables;
H. Steel plates;
I. Foundation materials; and
J. Foundation preparation.
721.1 DESCRIPTION
This Work consists of removing existing pavement stripes and markings.

721.2 MATERIALS—Vacant

721.3 CONSTRUCTION REQUIREMENTS
Use Equipment that is capable of completely removing pavement stripes 1/4 in ± 1/8 in deep and at least twice the width of the stripe.
Remove temporary pavement stripes and markings when the Project Manager determines that they are no longer required for traffic control. Do not use nonreflective black removable marking tape or overpainting to obliterate temporary pavement markings.
Provide traffic control in accordance with Section 104.5, “Maintenance of Traffic,” and Section 618, “Traffic Control Management.”
Remove and dispose of debris as directed by the Project Manager.

721.4 METHOD OF MEASUREMENT—Vacant

721.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of Pavement Stripe</td>
<td>Foot</td>
</tr>
<tr>
<td>Removal of Pavement Marking</td>
<td>Each</td>
</tr>
</tbody>
</table>

721.5.1 Work Included in Payment
The following work and items will be considered as included in the payment for the main items and will not be measured or paid for separately: repair of damaged pavement.
SECTION 801: CONSTRUCTION STAKING BY THE CONTRACTOR

801.1 Description
801.1.1 General
This Work consists of construction staking, essential for the control and completion of the project.

801.1.2 Department-Supplied Documents and Services
The Department will provide the Contractor with survey data sufficient to layout, control, and complete the project. Survey data includes, but is not limited to, the following:
1. Location notes;
2. Design grades;
3. Elevations;
4. Slopes;
5. Projected locations of slope stake catch points; and
The Department will supply the data as printout sheets, field books, electronic files (when available), Right of Way maps, or plans. Contractor will locate and verify all data points.

801.1.3 Contractor-Supplied Personnel & Services
Provide qualified personnel who are experienced in Highway construction staking to perform the staking. Locate and establish control points with the data given in the Plans. Verify Department-provided survey data, and submit changes or adjustments (including to recorded data) to the Project Manager for approval at no cost to the Department.

801.2 MATERIALS—Vacant

801.3 CONSTRUCTION REQUIREMENTS
801.3.1 General
Do not disturb, cover, or remove reference marks without providing written documentation of the disturbed, covered, or removed reference mark to the Project Manager for approval. Reference marks include the following:
1. Triangulation stations;
2. Benchmarks;
3. Corners;
4. Monuments;
5. Stake;
6. Witness marks; or
7. Other reference marks located within the construction limits (including the limits of Temporary Construction Permits) or on the Right of Way line of this project.
Coordinate the reestablishment of removed or destroyed markers with the Department. When directed, reset destroyed reference markers, at no additional cost to the Department, in accordance with 12.8.2 NMAC, Minimum Standards for Surveying in New Mexico and the Geodetic Mark Preservation Guidebook, as prepared by the National Geodetic Survey.
Submit notes regarding the referencing of monuments to the Project Manager. The Department will charge the Contractor $1,000 for each monument the Contractor improperly referenced before disturbing, covering, or removing.

801.3.2 Construction-Staking Documentation
Complete construction-staking field notes and other documentation in accordance with the Department’s current NMDOT Survey Handbook and accepted industry methods achieving required accuracy.
Keep field notes in a standard field notebook in a clear, orderly, and neat manner, consistent with professional surveying practices, unless stated otherwise in the Contract.
Construction-staking documentation will become the property of the Department when the Work is complete. Provide construction-staking documentation to the Project Manager. Submit earthwork quantities, slope staking, surface extracted cross sections, and earthwork calculations to the Project Manager for review before completing that phase of the work. Ensure a New Mexico licensed professional surveyor or professional engineer stamps and certifies the quantities and all submittals. The Department will not accept earthwork quantities until the Project Manager reviews and approves these quantities.
Submit earthwork quantity information in hard copy using double-end area or prismoidal computations, or using Department-approved computer software.

801.3.3 Control Points
The Contractor shall use the reference control points provided by the Department or set by the Contractor's personnel to establish construction-staking points and to layout and control the work.

Notify the Project Manager of errors and omissions discovered in the control points before beginning affected work.

Move and re-establish benchmarks, control points, or monuments belonging to agencies of the United States, state, or local governments in accordance with the accepted procedures of the respective agency. If the Project Manager directs the Contractor to perform this work, the Department will, unless due to Contractor operations or if detailed in the Contract, pay in accordance with Section 104.4, “Extra Work.”

801.3.4 Accuracy Requirements
Meet accuracy requirements dictated by the individual elements of the Work.

801.3.5 Accuracy Verification
The Project Manager will spot check the accuracy of the construction stakes, lines, grades, and layouts but will assume no responsibility for the accuracy or the final result. The Project Manager will inform the Contractor of discrepancies immediately.

801.3.6 Non-Specified Re-staking and Re-establishment of Control
The Contractor shall perform re-staking due to the following conditions, at no additional cost to the Department:
1. Errors or omissions by Contractor personnel, or
2. The Contractor’s negligence.

The Department will review re-staking in accordance with Section 104.2, “Significant Changes in the Character of Work,” Section 104.3, “Differing Site Conditions,” and Section 104.4, “Extra Work” when due to the following conditions:
1. Resulting from errors or omissions by the Department;
2. At the Department's request, or
3. Circumstances beyond the Contractor's control.

801.3.7 Construction Staking
801.3.7.1 Locations and Elevations
Verify locations and elevations of control points and benchmarks provided. Establish as necessary.

801.3.7.2 Centerline
Establish necessary construction centerline project stationing and reference stakes for use in setting the grade and finishing stakes, and re-establishing the centerline.

801.3.7.3 Slope Stakes, Initial Ground Topographic Survey, and Clearing Stakes
Set slope stakes, and stationing at intervals no greater than 100 ft. Perform initial ground topographic survey before beginning construction.

801.3.7.4 Grade Finishing Stakes
Set grade finishing stakes (blue tops) to establish grade elevations and horizontal alignment at the top of Subgrade, top of Base Course, and top of Subbase. Set the finish stakes at intervals no more than 50 ft. If the Contractor uses automatic grade Equipment, the Contractor shall provide Equipment specifications that will allow interval adjustments as per manufactures recommendation.

801.3.7.5 Drainage Structures
Survey and plot drainage Structure locations and prepare Structure drawings to verify the accuracy of the Structure sections shown on the Plans. Submit the plotted drainage Structure profiles, along with a revised Structure list, to the Project Manager for review and acceptance prior to drainage Structure construction.
801.3.7.6 Bridges
Perform all Bridge staking using the vertical and horizontal control points provided by the Department. Stake, plot, and submit a Profile Grade for the Roadway approaches, departures, approach slabs, and Bridges. Identify any necessary adjustments before submitting to the Project Manager.

801.3.7.7 Sign Structures
Stake all new sign locations. Stake and plot locations for extruded and overhead sign Structures. Submit the plotted profile to the Project Manager for acceptance before submitting shop drawings for extruded and overhead sign Structures, and before ordering the Materials.

801.3.7.8 Slope Stake Changes
Perform slope stake changes required to blend slopes into the existing terrain as approved by the Project Manager and as per Section 104.2, “Significant Changes in the Character of Work,” Section 104.3, “Differing Site Conditions,” and Section 104.4, “Extra Work.”

801.3.7.9 Curbs and Gutters
Perform staking using vertical and horizontal control points provided by the Department.

801.3.7.10 Miscellaneous Staking
The Contractor shall perform miscellaneous staking using vertical and horizontal control points provided by the Department. Miscellaneous staking includes staking for the following:
1. Material and Borrow Pits required for contract payment;
2. Guardrails;
3. Riprap;
4. Construction signs;
5. Delineators;
6. Pavement markings;
7. Cattle guards;
8. Turnouts;
9. Ditches;
10. Fences;
11. Traffic control devices;
12. Permanent and major signs; and
13. Other miscellaneous work the Project Manager deems necessary to properly control the work.

801.3.7.11 Other Staking Changes
Perform unexpected work and construction staking changes as directed by the Project Manager necessary for the completion of the Work.

801.3.7.12 Fence Station Markers
Provide a shop-made station marker every fifth station. The marker shall be 1 in × 5 in × 14 in black on white with 3 inch stenciled numbers. Mount the markers on the fence or on an appropriate shop-made post 4 ft above the ground.

801.3.8 Removal and Disposal of Stakes
After project completion and before final acceptance, remove and dispose of stakes and markers.

801.4 METHOD OF MEASUREMENT
Submit a construction-staking schedule of values as part of CPM or monthly progress schedule to the Project Manager for approval.

801.5 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Staking by the Contractor</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>

The Department will make partial payments in accordance with the approved construction-staking schedule of values.
802.1 DESCRIPTION

802.1.1 General
This Work consists of providing Post Construction Plans to show in detail increases or decreases in quantities and alterations in the details of the Plans, including alterations in the grade or alignment of the road, Structures, or both.

802.1.1.1 Contractor-Supplied Documents and Services
Provide qualified personnel to perform Post Construction Plan submittal in a professional, timely and accurate manner. Ensure the personnel supervising the operation are knowledgeable and experienced in surveying and mapping of Post Construction Plans.

If the Contractor has been given electronic data for surveying/construction staking the submittal will be required to be electronic & paper copy or both. If there is no electronic data submitted for survey, the Post Construction Plans will be paper copy submittals on the format required by the most current version of the Standard Specifications procedures manual.

802.2 CONSTRUCTION REQUIREMENTS

802.2.1 General
The As-Built submittal shall include but not be limited to the following:
1. Length of project in miles;
2. B.O.P. and E.O.P. in stationing and milepost location;
3. Station equations; all equations shall be listed;
4. Major Structures with Structure Number and span length;
5. Typical section changes and locations, including subexcavation limits, and cut and fill limits;
6. Final quantities in appropriate columns on the plan set;
7. Widths and locations of turnouts and median openings, with radii indicated, on Plan and Profile sheets;
8. All line and grade changes on plan and profile sheets, and Structure location sheets;
9. All fencing, gates, and cattle guards remaining and built, on the Structure Quantity Sheets. Specify types of fencing and width of gate(s) and cattle guard(s);
10. Relocation and clearance of utility lines on utility sheets including offsets, depths, or elevations. Service lines to private property are not required;
11. Depth of surfacing in place of each plan and profile sheet. The actual station to station with the depth of each type of surfacing (subexcavation, subbase, Base Course, HMA, etc.);
12. All Structures, as built, shall be shown on the plan and profile sheets and Structure sheets;
13. Bridges: All changes shall be shown on Structure location sheets and detail sheets. Show the top elevation of the longest and shortest pile in each pier and abutment on the Structure location sheet. Also show changes in Bridge decks thickness;
14. All build notes shall be edited identifying changes made. Build notes not requiring edit shall be check marked.

802.3 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Construction Plans</td>
<td>Lump Sum</td>
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</tr>
<tr>
<td>920</td>
<td>Evaluation of Properties for HMA</td>
<td>603</td>
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</table>
DEFINITIONS:

Direct Supervision. The required supervision of a TTCP trainee by a certified TTCP technician who is on a project with the trainee and who is both signing off and is personally responsible for all of that trainee’s sampling and testing procedures, results and reports.

Qualified Sampling and Testing Technician. A technician who has been certified under TTCP to independently perform inspections, sampling, and testing in specified Materials testing area(s) for either quality control or acceptance testing. The term “qualified” and “certified” have the same meaning.

TTCP Trainee. A technician who has attended the appropriate TTCP training class and has a certificate of completion, and is receiving required “on-the-job-training” under the direct supervision of a TTCP certified technician, as such is eligible to take a particular TTCP certification exam.

Validation. A procedure using statistical methods to compare the Contractor’s and the Department’s test results, specifically, the $F$-test to compare variances and $T$-test to compare means.

901.1 INSPECTIONS AND TESTING OF MATERIALS

901.1.1 General

Materials are subject to inspection, sampling, and testing before acceptance of the work. References in the Contract to test methods or specifications are to the latest versions as of the Bid Advertisement date, unless otherwise noted. Test methods may be subject to modification at the discretion of the State Materials Bureau. The Department’s current TTCP Manual contains AASHTO and ASTM test method modifications. The Department will sample and test Materials for acceptance unless otherwise specified in the Contract. The Department will provide acceptance test results to the Contractor within 2 Working Days after sampling, but only after Contractor QC tests have been received for the same sublot, and will provide other test results to the Contractor upon request. Department testing is not intended for quality control.

901.1.2 Technician Certification

Ensure that testing is performed under the direct supervision of an individual certified by the State Materials Bureau’s TTCP. Certification is based on demonstration of abilities for test methods and procedures, and a written test. The TTCP Board of Directors, in conjunction with the State Materials Bureau and the State Construction Bureau, will establish term and expiration date of certification and requirements for renewal of certification. If the competence of a certified individual is questioned, the question of competence must be documented in accordance with the TTCP Manual. The TTCP Manual requires a written complaint be addressed to the TTCP Administrator or the State Materials Engineer. The State Materials Bureau will investigate the concern through the TTCP. If this investigation substantiates the concern, disciplinary action such as probation, revocation, or suspension of certification will be implemented in accordance with procedures established by the TTCP Board of Directors.

901.1.3 Acceptance Sampling and Testing

The Department will sample and test in accordance with Table 901.7-6, “Minimum Acceptance Guidelines,” or at a lesser sublot size for acceptance purposes as determined by the Project Manager before production of material begins. If Material appears defective, or if the Project Manager determines that a change in the process or product has occurred, additional sampling and testing may occur. When additional informational sampling and testing is performed, the results will be used only to determine if corrective actions need to be taken by the Contractor and will not be incorporated into the quality level analysis.

The Department will conduct acceptance testing independently from the Contractor’s quality control testing. If the Department’s acceptance testing validates in method and property to the Contractor’s quality control testing, the Department will use both for acceptance and pay factor determination. Use of the Contractor’s test results is dependent on the following conditions:

Section 901: Quality Control/Quality Assurance (QC/QA)
1. The Contractor uses quality control procedures as described in Section 901.2, “Contractor Quality Control;”
2. The Department validates the Contractor’s test results against the Department’s test results using the F-test and T-test, conducted at a level of significance of 0.01;
3. The Contractor will use all test results from the Contractor’s random sampling plan as detailed in the quality control plan per Section 901.2.1, “Quality Control Plan.” Do not include informational test data obtained by test results beyond the Contractor’s random sampling plan locations. If a split sample is taken to determine deviations between Contractor and Department process, only data obtained from a random sampling plan location can be utilized in the quality level analysis. If a split sample is tested by the Contractor and Department for informational purposes and the location does not represent either the Contractor’s or Department’s random sampling plan locations, neither test data results are to be included in the quality level analysis.

If the Department cannot validate the Contractor’s test data at any time during the project, the Project Manager and quality control technician will investigate to determine why and make corrections if possible. If the discrepancy cannot be resolved, then the Department will determine the pay factor using the Department’s test values only for characteristics that do not validate. Characteristics that do validate will use both Contractors and Department data to determine pay factors.

901.2 CONTRACTOR QUALITY CONTROL

Perform quality control sampling, testing, and inspection in accordance with Table 901.7:3, “Minimum Process Control Guidelines for Aggregates and Base Course,” Table 901.7:4, “Minimum Process Control Guidelines for Hot Mix Asphalt and OGFC,” and Table 901.7:5, “Minimum Process Control Guidelines for Portland Cement Concrete Pavement.”

901.2.1 Quality Control Plan

Provide a quality control plan to control the quality of the product. At the pre-construction conference, be prepared to discuss quality control responsibilities for specific Contract Items. Submit the quality control plan to the Project Manager at least two weeks before starting work. Itemize inspections, testing procedures, sampling and testing frequencies, and corrective action strategies that the Contractor will use to control the work. Develop the quality control plan using the Department’s Contractor Process Quality Control Plan Guidelines available from the Project Manager or State Construction Bureau. Do not begin work that requires quality control testing for acceptance without a quality control plan that has been reviewed and approved by the Project Manager and the District Laboratory Supervisor. Provide written certification that testing Equipment is calibrated and meets the applicable specifications.

901.2.2 Quality Control Laboratory

Perform the quality control testing using a private testing Laboratory or a Contractor provided Laboratory. Use a portable or permanent quality control Type II Laboratory in accordance with Section 622.3.2.2, “Field Office Equipment.” Calibrate or check testing Equipment in accordance with AASHTO R 18 and any time the equipment is moved. Maintain calibration documentation at the Laboratory and provide this to the Project Manager upon request. The Project Manager will determine acceptability of the quality control Laboratory. Allow the Department unrestricted access to the Laboratory. The Department will conduct independent inspection of the Contractor’s field Laboratory. The Project Manager will provide the Contractor a written accounting of Laboratory deficiencies.

901.2.3 Plan Administration and Technician Qualification

A qualified and experienced individual will administer the plan. The individual will have full authority to take actions necessary for the successful operation of the plan. Quality Control Technician (QCTs) performing the actual sampling, testing, or inspection will be TTCP certified as described in Section 901.1.2, “Technician Certification.” Cease production if certified personnel are unavailable on the project.

901.2.4 Sampling

The sampling plan shall contain a random sampling selection technique in accordance with specified Department, AASHTO, or ASTM procedures, as modified by the State Materials...
901.2.5 Testing
The Department will use test results from the random sampling plan only in the quality level analysis for pay factor determination. Additional informational test results will not be used in the quality level analysis. The Contractor shall provide quality control test results (on approved forms) to the Project Manager within 2 Working Days of sampling.

901.2.6 Records
Maintain a complete set of original quality control test records (written in non-black ink), including supporting documents (calculations, scratch sheets, internal forms etc.) and, upon request, make them available to the Project Manager within 4 hours. No hard copy laboratory testing documentation will be destroyed for any reason, even after the data is entered into the computer spreadsheet for analysis. If complete records are not provided as requested, the Department may determine the pay factor using the Department's test values only for all testing characteristics. Maintain all original test documentation for a minimum of three years after the Physical Completion Date.

901.2.7 Control Charts
Update Department-approved test control charts daily on all tests in accordance with Table 901.7.3, “Minimum Process Control Guidelines for Aggregates and Base Course,” Table 901.7.4, “Minimum Process Control Guidelines for Hot-Mix Asphalt and OGFC,” and Table 901.7.5, “Minimum Process Control Guidelines for Portland Cement Concrete Pavement.” Keep at a location approved by the Project Manager. Provide at least the following information on the charts:
1. Project number;
2. Contract Item number;
3. Test number;
4. Each test parameter;
5. Upper and lower specification limit applicable to each test parameter; and
6. The Contractor's test results.
Use the charts for identifying product and Equipment problems, and potential pay factor reductions. Notify the Project Manager of any identified problems within 4 hours.

901.3 INDEPENDENT ASSURANCE TESTING
TCP certified independent personnel will perform independent assurance testing on split samples from quality control and acceptance programs to ensure that the Contractor and Department field personnel are using correct and accurate procedures and the proper Equipment. These personnel will not have direct responsibility for quality control or acceptance testing.

901.4 EVALUATION OF MATERIALS FOR ACCEPTANCE
The Department will analyze lot acceptance test results collectively and statistically using the Quality Level Analysis method. Quality Level Analysis is a statistical procedure for estimating the percent compliance with a specification; it is affected by shifts in the arithmetic mean, and by the sample standard deviations. The Department will use this analysis to estimate the total percent of the lot that is within specification limits. As an incentive to produce higher quality Material, the Contractor may attain pay factors greater than 1.00. The maximum pay factor is 1.05.

The Department may accept a lot containing Material below a pay factor of 1.00 at a reduced price, in accordance with the following criteria:
1. The composite pay factor is at least 0.75;
2. There are no rejectable individual criteria; and
3. The Project Manager does not identify isolated defects (i.e., segregation, or other construction related material defects).

The Department will consider a written request to accept a Material lot below the Target Value (TV) that does not meet the above criteria, but at a composite pay factor not to exceed 0.50. The Contractor shall include an engineering analysis showing expected Material performance. The Project Manager will decide if the Material may remain in place and the reduced price.
If less than three samples are obtained at the time a lot is terminated, the lot may be accepted at full contract price if the test results of the one or two samples are within specification limits; the Department will consider a written request to accept the lot. The Contractor shall include an engineering analysis showing expected material performance. The Project Manager will decide if the material may remain in place and the reduced price.

The Project Manager may reject material that appears to be defective based on visual inspection.

901.5 QUALITY LEVEL ANALYSIS

Use the following steps to calculate the standard deviation:

1. Do not include test results for material not used in the work;
2. Calculate the arithmetic mean of the test results using the following equation:

\[ \bar{x} = \frac{\sum x}{n} \]  

(1)

where
\( \bar{x} \) is the arithmetic mean
\( \sum \) is the summation of
\( x \) is the individual test value
\( n \) is the number of test values

3. Calculate the sample standard deviations using the following equation:

\[ s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} \]

(2)

where
\( s \) is the sample standard deviation
\( \sum \) is the summation of
\( x \) is the individual test value
\( \bar{x} \) is the arithmetic mean
\( n \) is the number of test values

4. Calculate the upper quality index using the following equation:

\[ Q_U = \frac{USL - \bar{x}}{s} \]

(3)

where
\( Q_U \) is the upper quality index
\( USL \) is the upper specification limit, or TV plus allowable deviation above TV
\( \bar{x} \) is the arithmetic mean
\( s \) is the sample standard deviation
TV is the Target Value

5. Calculate the lower quality index using the following equation:

\[ Q_L = \frac{\bar{x} - LSL}{s} \]

(4)

where
\( Q_L \) is the lower quality index
\( \bar{x} \) is the arithmetic mean
6. Determine $P_U$ (the percent of test values below the upper specification limit, which corresponds to a given $Q_U$) from Table 901.7:1, “Quality Level Analysis by the Standard Deviation Method Upper Quality Index $QU$ or Lower Quality Index $QL$. If a USL is not specified, $P_U$ is 100.

7. Determine $P_L$ (the percent of test values above the lower specification limit, which corresponds to a given $Q_L$) from Table 901.7:1, “Quality Level Analysis by the Standard Deviation Method Upper Quality Index $QU$ or Lower Quality Index $QL$. If an LSL is not specified, $P_L$ is 100.

8. Calculate the quality level (the total percent within specification limits) using the following equation:

$$Q = (P_U + P_L) - 100$$  \hspace{1cm} (5)

where

- $Q$ is the quality level
- $P_U$ is the percent of test values above the upper specification limit which corresponds to a given upper quality index ($Q_U$)
- $P_L$ is the percent of test values above the lower specification limit which corresponds to a given lower quality index ($Q_L$)

9. Using the quality level, determine the lot pay factor from Table 901.7:2, “Pay Factors.”

10. Calculate the composite pay factor for each lot, using the following equation:

$$CPF = \frac{\left[ f(P_L + f(P_U)) \left( f(P_L) \right) \left( f(P_U) \right) \right]}{\left[ f + f \left( f(P_U) \right) \right]}$$  \hspace{1cm} (6)

where

- $CPF$ is the composite pay factor
- $f$ is the price adjustment factor specified for the applicable Material
- $j$ is the number of evaluated components
- $PF$ is the individual pay factor determined for each component

Carry the numbers in the above calculations to significant figures and round them in accordance with AASHTO R 11.

901.6 METHOD OF MEASUREMENT—Vacant

901.7 BASIS OF PAYMENT

The Department will pay for Contractor Process Quality Control as follows:

1. 25% of the lump sum pay item or 0.5% of the Total Original Contract Amount, whichever is less upon approval of the quality control plan; and

2. The remaining lump sum prorated based on total job progress.

The Department will withhold payment if the Contractor does not provide test result documentation in accordance with the contract.

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### Table 901.7-1
Quality Level Analysis by the Standard Deviation Method

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Note: For negative values of QU or QL, Pu or Pl is equal to 100 minus the table value for Pu or Pl. If the value of QU or QL does not correspond exactly to a figure in the table, use the next lower figure.
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Reject Values less than those shown above.
### Table 901.7:3

**Minimum Process Control Guidelines for Aggregates and Base Course**

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<th>Testing frequency</th>
<th>Test method</th>
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<tbody>
<tr>
<td></td>
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<td>As specified</td>
<td>AASHTO T 2, 248</td>
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<tr>
<td></td>
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<td>Aggregate for</td>
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<td>Base Course, Hot Mix, Asphalt, PCCP, and Open Graded Friction Course</td>
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<td>Atterberg Limits</td>
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<td>Section 910</td>
<td>Per Section 910</td>
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<tr>
<td>Moisture Content</td>
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<td>As needed to control operations</td>
<td>AASHTO T 255</td>
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<td><strong>HMA</strong></td>
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<td>As needed to confirm quality</td>
<td>AASHTO T 96, 104, 85</td>
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<td>Soundness Loss</td>
<td>Based on AASHTO TP 58</td>
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<td>PCCP</td>
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\(^a\)For gradations to control crushing operations, the Contractor may, at its own risk, modify AASHTO T 146 to improve the test result timelines. Modified method tests will not be considered in acceptance determinations by the Project Manager.

\(^b\)Take measurements at a randomly selected location. Determine thickness by removing all of the in-place compacted Material, placing a straight edge tool (i.e. a survey lath) across the hole, measuring the thickness to the nearest 1/4 in using a measuring tape, and then replacing and recompacting the removed material.
### Table 901.7:4
Minimum Process Control Guidelines for Hot Mix Asphalt and OGFC

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<td>AASHTO T 304</td>
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<td>AASHTO T 308</td>
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<tr>
<td>Gradation</td>
<td></td>
<td></td>
<td>AASHTO T 30, 164, or 308</td>
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<td>HMA</td>
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<td>Air Voids</td>
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<tr>
<td>Gradation</td>
<td></td>
<td>1 per 500 ton(^d)</td>
<td>AASHTO T 11, 27</td>
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\(^a\)Take measurement at a randomly selected location. Determine thickness by coring the in-place compacted Material and measuring the thickness to the nearest 1/4 inch using a measuring tape.

\(^b\)Daily calculation will use the daily average of Contractor and Department maximum specific gravity as validated by F-test and T-test in the daily calculation.

\(^c\)Minimum of one test per day, except for maximum specific gravity. Obtain a minimum of two tests per day.
### Table 901.7:5
Minimum Process Control Guidelines for Portland Cement Concrete Pavement

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<td>Air Entrainment</td>
<td>1 per 125 yd&lt;sup&gt;3&lt;/sup&gt;</td>
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<td>Slump</td>
<td>1 per 125 yd&lt;sup&gt;3&lt;/sup&gt;</td>
<td>AASHTO T 119</td>
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<tr>
<td>Compressive Strength</td>
<td>1 per 125 yd&lt;sup&gt;3&lt;/sup&gt;</td>
<td>AASHTO T 22, 23, 231</td>
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<tr>
<td>PCCP in Place</td>
<td>Thickness&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2 per 2,400 yd&lt;sup&gt;3&lt;/sup&gt;</td>
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<sup>a</sup>Complete corrective work specified in Section 450.3.5.2, "Surfacing Smoothness Requirements," before determining pavement thickness

<sup>b</sup>Determine thickness by actual survey conducted before and after the construction of the PCCP at fixed, randomly selected locations.

---

### Table 901.7:6
Minimum Acceptance Guidelines

<table>
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<tr>
<th>Item</th>
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<th>Point of acceptance</th>
<th>Sublot size</th>
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<td>Per Project</td>
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### Table 901.7:6
Minimum Acceptance Guidelines

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<th>Test method</th>
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<th>Lot size</th>
<th>Test method</th>
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<td>Windrow</td>
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<td>Tank Strap AASHTO T 11, 27</td>
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<td>Air Content</td>
<td>Deliver to grade</td>
<td>1 per 500 yd&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5,000 yd&lt;sup&gt;d&lt;/sup&gt;</td>
<td>AASHTO T 152, T 22, 23, 231</td>
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<td></td>
<td>Per Project&lt;sup&gt;b&lt;/sup&gt;</td>
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</table>

<sup>a</sup>Density calculation will utilize daily average of Contractor and Department maximum specific gravity as validated by F-test and T-test. The Department will obtain a minimum of one maximum specific gravity sample per day.

<sup>b</sup>Minimum of three sublots required.

<sup>c</sup>Minimum of 10 samples per lot.

<sup>d</sup>Complete corrective work specified in Section 450.3.5.2, “Surfacing Smoothness Requirements,” before determining pavement thickness.

<sup>e</sup>Take measurement at a randomly selected location. Determine the thickness by removing all of the in-place compacted material, placing a straight edge tool (i.e. a survey lathe) across the hole and measuring the thickness to the nearest 1/4 in using a measuring tape.

<sup>f</sup>Take measurements at a randomly selected location. At that location, the thickness shall be determined by coring the in-place compacted material and measuring the thickness to the nearest 1/4 in using a measuring tape.

<sup>g</sup>Determine thickness by actual survey conducted before and after the construction of the PCCP at fixed, randomly selected locations.

<sup>h</sup>A lesser sublot size for acceptance purposes as determined by the Project Manager before production of material begins can be established.
910.1 **DESCRIPTION**

The AI combines test values from the Los Angeles Wear Test, Soundness Loss Test, and Absorption Test. The AI is a single value representing the overall quality of the source from which the aggregates are obtained. Do not use to evaluate individual aggregate stockpile quality.

910.2 **Sampling and Testing Procedures**

Determine Los Angeles wear, soundness loss, and absorption values for the AI equation using at least five random test samples obtained from all stockpiles at the source in accordance with AASHTO T 2. Submit all of the five samples to a Department approved private Laboratory for combination into a single sample. The Project Manager or the State Materials Bureau will have a list of approved private laboratories. Extract a representative test sample from the single sample to determine the Los Angeles wear and absorption values. Prepare the sample used to determine the absorption as follows:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Weight (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plus 3/4 in</td>
<td>1000</td>
</tr>
<tr>
<td>3/4 in to 1/2 in</td>
<td>1000</td>
</tr>
<tr>
<td>1/2 in to 3/8 in</td>
<td>1000</td>
</tr>
<tr>
<td>3/8 in to #4</td>
<td>1000</td>
</tr>
</tbody>
</table>

Separate the remaining amount of the single sample into five test samples using the procedures in AASHTO T 248. Calculate a soundness loss value for each of these five samples using Table 910.2:1, "Standard Gradation for Soundness Loss Testing."

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/4 in</td>
<td>100</td>
</tr>
<tr>
<td>1 in</td>
<td>100</td>
</tr>
<tr>
<td>3/4 in</td>
<td>79</td>
</tr>
<tr>
<td>1/2 in</td>
<td>53</td>
</tr>
<tr>
<td>3/8 in</td>
<td>34</td>
</tr>
<tr>
<td>No. 4</td>
<td>0</td>
</tr>
</tbody>
</table>

Average the five soundness loss results to obtain the overall soundness loss value for the subject aggregate pit.

910.2.2 **Testing of Aggregates**

Perform the following tests using a Department-approved private Laboratory or the State Materials Bureau:

1. Los Angeles Wear (in accordance with AASHTO T 96, Method B);
2. Soundness loss (in accordance with AASHTO T 104); and
3. Absorption (in accordance with AASHTO T 85 or NMDOT 001 (20066)).

Use the same private Laboratory for the entire project unless otherwise approved (in writing) by the Project Manager.

Obtain samples under the observation of the Project Manager or Department designee. Split samples into two samples in accordance with AASHTO T 248, if requested by the Project Manager. The private Laboratory and the State Materials Bureau will each test one sample. Send copies of test reports to the Project Manager.

910.2.3 **Frequency of Testing**

Submit samples at least once every year to maintain continuous approval of Commercial Material Sources.

910.2.4 **Equation**

Calculate the AI of a coarse aggregate to the nearest whole number in accordance with the following equation:
\[ AI = \frac{1}{3} \sqrt[1.2]{LA^{2.2} + SL^{3.0} + A^{4.0}} \]  

(1)

where:

- \( AI \) is the aggregate index
- \( LA \) is the Los Angeles Wear, the percent of aggregate wear at 500 revolutions if tested in accordance with AASHTO T 96
- \( SL \) is the soundness loss of the sample if tested in accordance with AASHTO T 104 using magnesium sulfate with a test duration of 5 cycles and a standard gradation
- \( A \) is the absorption, the amount of moisture retained if tested in accordance with AASHTO T 85

Example:

1. Determine the L.A. Wear as a whole number – for example, 25;
2. Determine the Soundness Loss as a whole number – for example, 15;
3. Determine the Absorption as a whole number – for example, 3;
4. Calculate the value of the L.A. Wear taken to the 2.2 power – that is, 25^(2.2) = 1189.8;
5. Calculate the value of the Soundness Loss taken to the 3rd power – that is, 15^3 = 3375;
6. Calculate the value of the Absorption taken to the 4th power – that is, 3^4 = 81.0;
7. Add the value obtained from steps 4, 5, and 6 – that is, 1189.8 + 3375 + 81.0 = 4645.8;
8. Determine the square root of Step 7 – that is, \( \sqrt{4658.8} = 68.2 \);
9. Divide the result from Step 8 by 3 – that is, 68.2 / 3 = 22.7; The A.I. for this sample is 22.7.
SECTION 920: EVALUATION OF PROPERTIES FOR HMA

920.1 SOURCE PROPERTIES
Determine Aggregate Index in accordance with Section 910.

920.2 MIX DESIGN PROPERTIES
HMA mix design properties are listed in Table 920.4.1:1, “Quality Control and Acceptance Properties.” Perform tests and calculations, to determine HMA mix design properties in accordance with current mix design procedures issued by the State Materials Bureau and AASHTO. Follow methods presented in the New Mexico TTCP.

920.2.1 Laboratory Mix Designs
Include test results and calculations that verify specification compliance in the HMA mix design submittal. The Project Manager may reject the HMA mix design if the aggregate properties being used are the same as those designed in the mix design and the mixture fails to meet specification requirements when combined in the proportions determined by the HMA laboratory mix design.

920.2.2 Job Mix Formula Adjustments
The Contractor may request a modification to the JMF based on field testing of Material produced through the plant. It is expected that minor adjustments will be necessary and the Project Manager (with the concurrence of the Department’s District Laboratory supervisor) may approve a new JMF if the adjustment results in a new TV that is within the tolerance from the design TV. (Example: If design TV for No. #4 sieve is 30%, then a new TV may be approved in the field from 23% - 37%). Test results and calculations that verify a proposed JMF adjustment comply with the specifications will be required prior to being reviewed and concurred by the Project Manager and the State Asphalt Engineer. Review and concurrence of a JMF adjustment can only be made after:

1. The Quality Control Plan (including checks for specific gravity) has been submitted and concurred by the DLS for use on the project;
2. Confirmation by the DLS that the Quality Control Plan is being followed;
3. Concurrence of the proposed changes from Project Manager and District Lab Supervisor;
4. Being approved by the Testing Laboratory responsible for the original mix design.

Terminate the previous lot when the adjusted JMF has been reviewed and concurred with by the Project Manager and the State Asphalt Engineer. Begin a new lot for the QLA with the adjusted JMF.

920.2.3 HMA Properties During HMA Production
Deviations from acceptance targets during the HMA production are permissible as long as the HMA remains within production tolerances. Do not evaluate HMA design properties during HMA production, except when a property is defined as a quality control or acceptance property as listed in Table 920.4.1:1, “Quality Control and Acceptance Properties.”

920.3 QUALITY CONTROL PROPERTIES
Quality control properties are listed in Table 920.4.1:1, “Quality Control Acceptance Properties.” Monitor quality control properties for each lot by testing at or above the specified minimum rates during production. The Department may perform its own testing to monitor quality control or verify quality control properties. Perform tests and calculations to determine quality control properties in accordance with AASHTO procedures and as certified by the TTCP.

920.3.1 Evaluation of Quality Control Properties
Continually evaluate quality control properties during aggregate and mixture production. Failure to provide quality control information is grounds for Suspension. Evaluate quality control properties using the following:

1. Mean Value. The mean of test results or values (for a given lot) shall meet specification requirements for that property. Recalculate the mean and standard deviation of test results for a property as new data becomes available. Cease production, investigate the causes of the specification failure, and propose corrective action if the mean falls outside the specification limits. Do not resume
production until proposed corrections are concurred by the Project Manager. Limit
production to 1,000 ton, tested in 500-ton increments. If testing indicates that the
problem has been corrected, resume full operations. If the problem has not been
corrected, perform further trial runs and testing. If the mean of one or more quality
control characteristics is out of specification at the conclusion of production, the
Department will evaluate the Material for acceptance and may reject the Material;

2. Individual Test Results. If an individual test result (for a given lot) falls outside
the specification limits and is two or more standard deviations from the mean of
previously produced Material, cease production, investigate the causes of the
failure, and propose corrective actions. Do not resume production until the
proposed corrections are concurred by the Project Manager. If an individual test is
outside the specification limits but is less than two standard deviations from the
mean of previously produced Material, investigate and propose corrective actions
but production may continue;

3. Consecutive Test Results. If two consecutive test results (for a given lot) fall
outside the specification limits, cease production, investigate the causes of the
failure, and propose corrective action. Do not resume production until the
proposed corrections are concurred by the Project Manager. Limit production to 1,000 ton,
tested in 500 ton increments. If testing indicates that the problem has been
corrected, resume full operations. If the problem has not been corrected, perform
further trial runs and testing.

Remove and replace rejected Material with specified Material at no additional cost to the
Department.

920.3.2 Stockpile Evaluation
The Contractor may evaluate properties for each stockpile such as Fractured Faces,
sand equivalent, fine aggregate angularity, plasticity index, etc., that are typically evaluated on
combined aggregates. If the mean value of each property is within specification limits for each
stockpile, the Department will not require the Contractor to evaluate the combined aggregate
properties. However, if the mean value for each property of each stockpile is not within
specification limits, or if stockpile properties are not evaluated, the Contractor shall provide a
method approved by the Project Manager for sampling the combined Materials before the
addition of hydrated lime or anhydrite based material.

920.4 ACCEPTANCE PROPERTIES
See Table 920.4.1:1, “Quality Control and Acceptance Properties.” Perform tests and
calculations to determine acceptance properties in accordance with AASHTO procedures.
Follow methods presented in the New Mexico TTCP.

920.4.1 Evaluation of Acceptance Properties
Evaluate acceptance properties and pay factors, Incentives, or price reductions, if any, in
accordance with Table 920.4.1:1, “Quality Control and Acceptance Properties.”
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