

**STANDARD SPECIFICATIONS
FOR
HIGHWAY AND BRIDGE
CONSTRUCTION**

NEW MEXICO STATE
DEPARTMENT
OF
TRANSPORTATION

2014 EDITION

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SECTION 101: ABBREVIATIONS, SYMBOLS, TERMS, AND DEFINITIONS

101.1 ACTIVE VOICE, IMPERATIVE MOOD, REFERENCES, USE OF LANGUAGE

The New Mexico Department of Transportation publishes 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.

The word "shall" is used in a mandatory or imperative sense and signifies that the Department is imposing a duty on a person or body that is the subject in the sentence. The word "may" is used to signify the conferring of a discretionary power, privilege, or right. However, use of the term "may not" signifies that a right, privilege, or power is intended to be denied.

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.

The Contractor, having an obligation to comply with, observe, and comply with all federal and State law and regulations, any reference to any federal or State law or regulation shall constitute a reference to any applicable amendment or successor law or regulation.

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 101.2:1 Acronyms and Abbreviations	
Acronym or short form	Full name or meaning
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AI	Aggregate Index
AMRL	AASHTO Material Reference Laboratory
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers' Association
AWWA	American Water Works Association
CBC	concrete box culvert
CCD	closed circuit detection
CD	compact disc

Table 101.2:1 Acronyms and Abbreviations	
Acronym or short form	Full name or meaning
CFR	Code of Federal Regulations
CMP	corrugated metal pipe
CN	control number
CPM	critical path method
CTR	certified test report
CWB	concrete wall barrier
DBE	disadvantaged business enterprise
EA	entrance angle
ESAL	equivalent single axle loading
FHWA	Federal Highway Administration
GRT	gross receipt tax
HDPE	high density polyethylene
HFE	high-float emulsion
HID	high-intensity discharge
HMA	hot-mix asphalt
HMWM	high molecular weight methacrylate
IES	Illuminating Engineering Society
IMC	intermediate metallic conduit
ITE	Institute of Transportation Engineers
JMF	job mix formula
LCD	liquid crystal display
LL	liquid limit
MSDS	Material Safety Data Sheet
MTR	mill test report
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NEC®	National Electrical Code®
NEMA	National Electrical Manufacturers Association
NMAC	New Mexico Administrative Code
NMDA	New Mexico Department of Agriculture
NMED	New Mexico Environment Department
NMSA	New Mexico Statutes Annotated
NMSSPWC	New Mexico Standard Specifications for Public Works Construction
NPDES	National Pollutant Discharge Elimination System
NTSC	National Transmission Standards Committee
OA	observation angle
OGFC	open-graded friction course
OSHA	Occupational Safety and Health Administration
PCC	portland cement concrete
PCCP	portland cement concrete pavement
PCI	Prestressed Concrete Institute
PCT	process control technician
PE-P	penetrating emulsified prime
PI	plasticity index
PTL	private testing laboratory
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QCT	quality control technician
QLA	quality level assurance
RAP	reclaimed asphalt pavement
ROW	right of way
SSPC	Society of Protective Coating (formerly Steel Structures Painting Council)

Table 101.2:1 Acronyms and Abbreviations	
Acronym or short form	Full name or meaning
SWPPP	storm water pollution prevention plan
TERO	Tribal Employment Rights Organization
TTCP	Technician Training and Certification Program
TV	target value
UBC™	Uniform Building Code™
UL	Underwriters Laboratories
USEPA	United States Environmental Protection Agency
UV	Ultraviolet
VMA	voids in mineral aggregate
VTM	voids in total mix
WMA	warm mix asphalt

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		
Physical Characteristic	Unit name	Symbol
Length	microinch	μin
	mil (0.001 inch)	Mil
	inch	In
	foot	Ft
	yard	Yd
	mile	Mi
Area	square inch	in ²
	square foot	ft ²
	square yard	yd ²
	square mile	mi ²
	acre	Acre
Volume	pint	Pt
	quart	Qt
	gallon	Gal
	cubic inch	in ³
	cubic foot	ft ³
	cubic yard	yd ³
Mass (weight)	ounce	Oz
	pound	Lb
	ton, short (2,000 lb)	Ton
Temperature	degree Fahrenheit	°F
Time	millisecond	Ms

Table 101.3:1 Measurement Symbols		
Physical Characteristic	Unit name	Symbol
	second	S
	minute	Min
	hour	H
Speed	miles per hour	Mph
Pressure	pound-force per square inch	Psi
Power, energy and electricity	watt	W
	kilowatt	kW
	milliampere	mA
	ampere	A
	volt	V
	voltampere	VA
	ohm	Ω
	hertz	Hz
	joule	J
	lumen	Lm
	footcandle	Fc
	horsepower	Hp
Force	pound-force	Lbf
	1,000 pounds-force	Kip
Torque	pound-force foot	lb•ft
Viscosity, dynamic	centipoises	cP
	poise	P
Viscosity, kinematic	centistokes	cSt
Flow	gallons per minute	Gpm
Concentration	parts per million	Ppm
Inductance	Henries	H
Frequency, concrete consolidation	vibrations per minute	Vpm
Sound	Decibel, A-Scale	dbA

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	
Symbol	Unit of measure or meaning
LS	Lump Sum
EACH	Each
ALLOW	Allowance
L.F.	Linear Foot
MILE	Mile
S.F.	Square Foot

Table 101.3.1:1
Symbols for Engineer's Estimate

Symbol	Unit of measure or meaning
S.Y.	Square Yard
SYIN	Square Yard Inch
ACRE	Acre
C.Y.	Cubic Yard
LB	Pound
TON	Ton

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:

Acceptance. (Also called **Accept, Accepted and Acceptable**) 1) The determination by the **Department** that Materials and Work are in compliance with the Contract. 2) The process by which the **Department** determines whether or not the quality of produced Material or Work is **Acceptable** pursuant to the Contract, including sampling, testing, certifications and assessment of test results.

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 who's **Bid** may later be subject to rejection, recalculation or other modification that may change the order of **Bidders**.

Assistant District Engineer (ADE) - Construction. The **Engineer** in charge of the construction operations in a designated portion of a **Department District**.

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 **Progress 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**. A **Bid Item Unit Price** reflects a **Bidder's** actual and direct costs for the item plus a reasonable proportionate share of the Bidder's anticipated profit, overhead costs, and other indirect costs.

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. Listing or table 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 or extreme ends of openings for Culverts placed in series with a spacing between Culverts not exceeding $\frac{1}{2}$ the diameter, 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**.

Business Hours. The **Department's** Business Hours are from 7:45 a.m. to 4:30 p.m., Monday through Friday, official State **Holidays** and emergency closures excluded.

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 issued to the **Contractor** by the **Department** covering contingencies, **Extra Work**, increases or decreases in **Contract** quantities, payments for items for which there is no **Bid Item Unit Price**, additions or alterations to the **Plans** or **Specifications** within the scope of the **Contract**, and establishing the **Basis of Payment** and time adjustments for the **Work** affected by the changes, or adjustments to the original **Contract**. A **Change Order** may consist of a **Supplemental Agreement** or **Field Sheet**. A **Change Order** is the only method authorized for changing the **Contract**.

Chief Engineer. The **Engineer** in charge of the planning and design of **Projects** for the **Department** or the individual's designee.

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

Claim. A **Contractor** request or demand for a **Contract** adjustment, equitable adjustment, additional time or compensation and other contractual damages, **Delay** damages, an extension of **Contract Time**, pass-through Subcontractor Claims, or for any other remedy arising from a dispute, disagreement, or controversy concerning respective rights and obligations under the **Contract**.

Commercial Material Source. A **Material** source that has been utilized by a private producer in a commercial operation from which **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 entire and integrated written agreement between the **Department** and the **Contractor** setting forth the obligations of the parties, including, but not limited to, the performance of the **Work** and the **Basis of Payment**.

The Contract includes the **Advertisement, Bid 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 (1) 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 remains, 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 (4) 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.

Delay. Any event, action or factor that extends the time for the performance of the **Work** or that negatively affects the critical path for the **Project**, whether it be excusable, inexcusable, nonexcusable, concurrent, compensable or noncompensable.

Deleterious Material. Unsuitable material harmful to final product.

Department. The New Mexico Department of Transportation as constituted under the laws of the State 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 (vehicular or otherwise) around a closed portion of a **Road**.

Disadvantaged Business Enterprise (DBE). As defined in title 49 CFR part 26.

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**.

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 Professional. An individual qualified to perform hazardous material investigations. This individual must possess the qualifications described in 40 CFR Part 312(4)(E), the USEPA's Standards and Practices for All Appropriate Inquiries.

Environmental Program Manager. The individual in charge of the Environmental Bureau of the **Department**.

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

Environmental Specialist. An individual with at least four (4) 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. **Work** not provided for in the **Contract** but found by the **Project Manager** to be essential to the satisfactory completion of the **Contract** within its intended scope. **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 (1) of two (2) grounds as provided in Section 109.5, "Payment for Changes, Differing Site Conditions, and Extra Work," by **Bid Item Unit Price**, negotiated price agreement, or by **Force Account**.

Fabricator. A **Supplier** that fabricates or supplies **Structural Steel** or other structural items.

Field Sheet. A type of **Change Order** that 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 (GO). 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 all 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.

Independent Assurance. A construction management tool in which a third party, not directly responsible for process control or **Acceptance**, provides an independent assessment of the Work, Materials, or the reliability of test results obtained from process control and **Acceptance** testing.

Incentive/Disincentive Provision. Predetermined adjustments to the **Contract** price.

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.

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**, **Contractor** or any other testing **Laboratory** that may be designated by the **Engineer** and is **AASHTO** Materials Reference Laboratory (AMRL) Certified.

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.

Luminarie. 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.

Lump. The mathematical quantity for a **Lump** sum item is one (1).

Machine Vision Vehicle Detection System. A system that tracks vehicles on a **Roadway** via processing of video images and provides detector outputs to a traffic controller.

Mandatory Pre-Bid Conference. A meeting or conference to be conducted prior to the **Bid Opening** at which all **Bidders** are required to attend. A **Mandatory Pre-Bid Conference** is conducted for the purpose of discussing **Contract** requirements, to inform **Bidders** of important information relating to the performance of the **Work**, to answer questions of prospective **Bidders** in order to better facilitate proper bidding, compliance with the **Contract**, performance of the **Work**, to reduce job-in-progress disputes between the **Department** and **Contractor**, and to reduce the potential for **Change Orders**, **Claims**, **Liquidated Damages**, added costs and cost overruns. The requirement to attend a Mandatory Pre-Bid Conference shall be set forth in a **Notice to Contractors**, **Special Provision** or **Addendum**. A **Bidder's** failure to attend shall result in its **Bid** being rejected as non-responsive.

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 ten percent (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 (1) sieve size larger than the first sieve that retains ten percent (10%) or more of a given **Material**.

Non-Conformance. Contractor's failure to comply with the **Contract** or to provide **Acceptable Work** to the **Department**. **Non-Conformances** are subject to a withholding of 25% of the **Progress Payment**. **Non-Conformance** withholdings will be paid at the subsequent **Progress Payment** following resolution of all **Non-Conformances**.

Notice to Proceed. (Work Order) Written notice to the **Contractor** to proceed with the **Contract Work** including 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 is **Accepted** by the **Project Manager**. All documentation required by the **Contract** and by law shall 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, 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**.

Pre-Construction Conference. A meeting between the **Department** and the **Contractor** prior to any **Work** taking place to review and discuss **Contract** requirements, construction details, the **Baseline Schedule**, **Contract** administration issues, and any items peculiar to the **Project**. See Section 108.2 "Notice to Proceed and Pre-Construction Conference" for specifics associated with the **Pre-Construction Conference**.

Pre-Pave Conference. A meeting between the **Department** and the **Contractor** prior to the commencement of paving operations to review, discuss and coordinate the **Work** associated with paving operations.

Pre-Fabrication Conference. A meeting between the **Department** and the **Contractor** prior to any fabrication **Work** taking place.

Pre-Deck Conference. A meeting between the **Department** and the **Contractor** prior to the commencement of deck placement operations to review, discuss and coordinate the **Work** associated with the deck placement.

Pre-Bid Due Diligence. The **Bidder's** exercise of due diligence before submittal of a **Bid** which includes the careful, independent examination of the site of the proposed **Work**, including Materials pits and haul **Roads**, the **Bid Package**, all **Contract** documents including **Standard Specifications**, **Special Provisions**, **Supplemental Specifications**, and standard and serial drawings and boring logs which are representative of the condition at the precise location where each boring was made but conditions may vary between boring locations.

Professional Service. A **Subcontractor** who provides a specialized service requiring professional licensure by the State of New Mexico, e.g. Professional Engineers, Professional Surveyors and Attorneys.

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.

Progress Payment. A monthly payment provided by the **Department** to the **Contractor** for **Work**, subject to withholdings for **Non-Conformances** and **Retainage**.

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**.

Punch List. A list, prepared by the **Project Manager**, of corrective **Work** items to be completed by the **Contractor** after **Substantial Completion** but before **Contractor's** request for final inspection. The **Punch List** is limited to items of the **Work** that are necessary to correct minor imperfections, deficiencies and deviations from the requirements of the **Contract** but which have no material or adverse effect on the full operability of the **Project** for its intended purpose and may be safely and effectively used by the public without delay, disruption, or impediments.

Quality Assurance (QA). The **Department's** sampling, testing, inspection, and other activities to determine payment and make **Acceptance** decisions.

Quality Control (QC). The Contractor's actions and considerations necessary to assess production and construction processes so as to control the level of quality being produced in the end product. Quality control includes sampling and testing by the Contractor to monitor and adjust its process. Quality Control does not include **Acceptance** sampling and testing by the **Department**.

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.

Resource Loading. The Contractor's assigning of resources necessary to develop an Acceptable CPM for the **Project**. **Resource Loading** shall include personnel, **Contract** dollars earned, **Materials**, facilities and **Equipment** associated with each activity within the CPM.

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** and the **Contract** documents, including **Notice to Contractors**, **Special Provisions**, **Supplemental Specifications**, and **Addenda** and which has not been rejected. 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.

Retainage. Five percent (5%) of the **Total Original Contract Amount** as amended by **Change Order**. The five percent (5%) shall be retained when the **Progress Payments** equal 95% of the amended **Contract** amount. The **Retainage** shall be withheld until **Physical Completion** to assure that the **Contractor** shall satisfy its obligations and complete the **Work**.

Right of Way (ROW). 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**.

Roadway Prism. The **Roadway** construction limits between the outside limits of the side slopes.

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 5 USC Section 601 and 15 USC 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 Asphalt Engineer. The **Engineer** in charge of the **Department's** Asphalt Unit of the State Materials Bureau.

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

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

State Construction Engineer. The **Engineer** in charge of the State Construction 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.

State Transportation Commission. The six (6) member policy board for the **Department**.

State Transportation Commissioner. An individual member of the **State Transportation Commission**.

Structures. Bridges, Culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end-walls, buildings, sewers, service pipes, under drains, 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, other than a **Trucker**, to whom the **Contractor** subcontracts part of the **Contract** who meets the requirements of a **Subcontractor** under Section 108.1, "Subcontracting." The term **Subcontractor** includes first-tier, second-tier and other tiered **Subcontractors** and Sub-subcontractors. A **Subcontractor** has no privity of **Contract** with the **Department** and has no direct or indirect cause of action against the **Department** for any **Claim** or cause of action, including nonpayment by the **Contractor**, arising out of the **Project**.

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

Structure.

Substantial Completion. The point at which:

1. All critical path activities on the **Project** have been completed and **Accepted**;
2. All **Non-Conformance** issues have been resolved without exception;
3. The **Project** is complete such that it can be safely and effectively used by the public without delays, disruption, or impediments;
4. The **Contractor** has requested a determination of **Substantial Completion** from the **ADE - Construction**; and
5. The **ADE – Construction** has made a determination that the **Project** is **Substantially Complete**.

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 (1) application of striping;
7. Traffic barrier;
8. Signalization and Lighting; and
9. 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. A type of **Change Order** that may require **Contractor** signature.

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

Supplier. Any individual, partnership, firm, corporation, or joint venture that 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**

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.

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.

Trucker. (Also called Trucking, Trucking Deliveries, Deliveries and Hauling) A **Trucker** is an individual, partnership, firm, corporation, or joint venture that transports or delivers **Materials** to and from the **Project** and does not perform **Work** on the **Project** site. A **Trucker** transports, but does not place, **Materials** (i.e. pit **Materials**, plant **Materials**, fabricated **Materials**, demolished and milled **Materials**, trash and waste **Materials**).

Unbalanced Bid. A **Bid** which is either materially or mathematically unbalanced. (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**. Areas exempted from **Value Engineering Cost Proposals** are mix designs and traffic control.

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 (6) 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**, frames **Work**, cofferdams, and other items; and
5. Such other similar data required for the successful completion of the **Work**.

SECTION 102: BIDDING REQUIREMENTS AND CONDITIONS

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 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

Prequalification of Bidders is a condition for submitting a Bid as authorized by the New Mexico Procurement Code, NMSA 1978, § 13-1-82 and 13-1-134.

Bidders shall be prequalified in accordance with the requirements of the Department's prequalification regulations, 18.27.5 NMAC. The failure of a Bidder to be prequalified shall render the Bid non-responsive and the Bid shall 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 or perform any Work on Department Projects during the period of its Suspension or Debarment.

A Bidder who is suspended or debarred by a federal agency, (i.e. as identified on the federal excluded parties list) shall be ineligible to Bid or and may be ineligible to perform any Work on any Project subject to federal reimbursement 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 are comprised of the documents 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 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, or the ability to commence the Work within 30 Days of the Notice to Proceed;
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 timely 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 is not Prequalified;
5. A Bidder defaults under a previous Contract, including Contracts with other public entities;
6. A Bidder performs previous Work unsatisfactorily, or fails to comply with Section 108.3, "Schedule;"
7. The Department issues a notice of Suspension or Debarment to the Bidder;
8. A Bidder submits more than one (1) 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 Project;
10. A Bid Item Unit Price results in an Unbalanced Bid to the potential detriment of the public or 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;
11. A Bid Item Unit Price or total Contract Bid price differs significantly from the Engineer's estimate or from other Bids to the potential detriment of the public or the Department;
12. A Bid Item Unit Price does not include reasonable actual costs plus a reasonable proportionate share of the Bidder's anticipated profit, overhead costs, insurance, and other indirect costs including any insurance or overhead expenses necessary to complete that Bid Item to the potential detriment to the public or the Department;
13. A Bidder contacts or communicates with any State Transportation Commissioner or any Department personnel responsible for Bid review and the Award of the Contract in relation to the Bid review or Award process at any time prior to the notification that the Contract has been awarded to the lowest Responsible Bidder, except for exercising a Bidder's right to file a written protest pursuant to Section 103.3 "Bidding Dispute Resolution Procedures" or in response to an inquiry from the Bid review committee;
14. A potential benefit to the public or the Department exists if the Contract is re-advertised;
15. Failure to attend a Mandatory Pre-Bid Conference when so required by a Notice to Contractor, Special Provision or Addendum;
16. A Bidder is subject of a judgment or verdict imposing a civil or criminal penalty under either the Federal False Claims Act or the New Mexico Fraud against Taxpayers Act;
17. To redesign the Project or change Project Specifications;
18. If the Department becomes aware of an error in the quantity of a Bid Item shown in the Bid Schedule, Plans, or other Contract documents which may call into question the Department's ability to determine which Bid will result in the lowest ultimate cost to the Department; or
19. When it is in the best interests of the public or the Department to do so.

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 shall be made only for the actual quantities of Work performed and Accepted, or Materials furnished, or as otherwise specified (e.g., Computed Quantities) in the Contract.

102.7 EXAMINATION OF CONTRACT, 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 may enable any

competent Contractor to construct the Work. The submission of a Bid shall be considered prima facie evidence that the Bidder has exercised Pre-Bid Due Diligence and accepts the conditions to be encountered in performing the Work and accepts the provisions and 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 warrant the sufficiency of such subsurface investigation documentation, and the Department furnishing such subsurface investigation documentation does not relieve the Bidder from, at its own expense, performing its own site investigation, considering geotechnical data from previous Projects performed by the Bidder in the vicinity of the Project, and determining how subsurface conditions may affect the means, methods and cost of the Work;
3. Requests for Contract interpretation shall be in writing, addressed to the Chief Engineer, and must be received by the Chief Engineer at least 48 hours prior to the date fixed for the opening of Bids in order to receive a written response to the request. No interpretation of the meaning of the Contract shall be made to any Bidder orally. The Contractor shall not rely on oral statements and shall only rely on written responses provided by the Chief Engineer or designate. Any and all such interpretation and any supplemental instructions if issued by the Department will be in the form of an Addendum or posted to Bid Express. Such Addendum will be provided to all prospective Bidders for such purposes and shall, whenever practicable, be issued no later than twenty-four (24) hours prior to Bid Opening. The Bidder agrees that it will make no Claim because of misinterpretation or misunderstanding of the Contract or because of lack of information; and,
4. The Contractor is not entitled to a written response by the Chief Engineer when Contract interpretation requests are received less than 48 hours before Bid Opening. If a written response by the Department to a request for Contract interpretation is not provided, the Bidder shall Bid the Contract according to the Contract documents.

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 shall include, and shall be conclusively presumed to include, reasonable actual costs plus a reasonable proportionate share of the Bidder's anticipated profit, overhead costs, insurance, and other indirect costs 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. For paper Bid submittals 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 (3) decimal places. Truncate additional decimal places in excess of three (3);
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;

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; and,
9. Except in the exercise of a Bidder's right to file a written protest pursuant to Section 103.3, "Bidding Dispute Resolution Procedures," or in response to an inquiry from the Bid review committee, a Bidder shall not contact or communicate with any State Transportation Commissioner or any Department personnel in relation to the Bid review, Award process, or awarding of the Contract at any time prior to the notification that the Contract has been awarded to the lowest responsive and Responsible Bidder.

102.9 INNOVATIVE CONTRACT INCENTIVES

The Department may include innovative Contract Incentives in the Special Provisions, Notice to Contractors, or Addenda. The Department reserves the right, as may be provided in the Contract, to escrow Bid Documents, to request information for informational purposes only, and to use innovative bidding approaches, including requiring Bidders to bid a daily overhead rate (cost / Day) as a Bid Item Unit Price.

102.10 IRREGULAR BIDS

A Bid will be deemed irregular and shall 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;" or,
10. Fails to provide in its Bid the certification required by Section 102.7, "Examination of Contract, Plans, Specifications, Special Provisions, and Site of Work."

102.11 BID GUARANTY

A Bidder shall submit with the Bid, a Bid Guaranty in the amount of at least five percent (5%) of the Total Bid Amount. The Bid Guaranty shall be in the form of one (1) of the following:

1. Bid bond;
2. Certified check; or
3. Postal or Bank money order.

102.12 DELIVERY OF BIDS

A Bidder shall submit the Bid in a sealed envelope and plainly marked 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 is in writing, facsimile or electronically in portable document format (PDF) and is received by the Department before the Bid Opening in accordance with the 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 facsimile, 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 (1) 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 Engineer's Estimate shall be confidential and is not subject to the Inspection of Public Records Act and shall 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, a Bid review committee 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 Department's Bid Review Committee shall review and evaluate Bids for a number of factors, which may include: comparison of Bids against the Engineer's Estimate; number of Bids submitted; unbalancing of Bids; Bid prices for the Project versus Bid prices for similar Projects; Unit Bid Price differences between a Bid, the Engineer's Estimate, and other Bids; Bid irregularities; whether a Unit Bid Price substantially reflects reasonable actual costs plus a reasonable proportionate share of the Bidder's anticipated profit, overhead costs, insurance, and other indirect costs necessary to complete that Bid Item; justification for any differences; and, any other factors the Department has determined to be in the public's interest. The results of the completed analysis will be available to the public after preliminary Award of Contract.

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 shall be rejected.

If a discrepancy exists between a Bid Item Unit Price and its extension, the Bid Item Unit Price shall govern. If two (2) 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 shall 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 and the Department would be promoted thereby. Any or all Bids may be rejected when it is in the best interest of the public and the Department at any time prior to execution of the Contract. If all Bids are rejected the Department may request a new Invitation for Bids. A Department decision to cancel the Award of Contract or to reject all Bids and issue a new Invitation for Bids is wholly an exercise of executive discretion not subject to review at an informal hearing pursuant to Section 103.3, "Bidding Dispute Resolution Procedures".

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 cancel the Invitation for Bids or 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 provide the Contract to be executed by the Contractor and returned to the Department.

103.3 BIDDING DISPUTE RESOLUTION PROCEDURES

103.3.1 Pre-Award

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:
 - a. Disputes arising from the Department's pre-bid opening process and solicitation of Bids, including issues arising from Invitation for Bids, Prequalification, irregularities with the Department's Bid Package, and irregular Bids must be raised by written protest no later than seven (7) Days from the date of the Bid Opening.

103.3.2 Post-Award

1. A Bidder disputing the preliminary Award process or Award of a Contract must file a written protest with the Cabinet Secretary.
 - a. Disputes relating to the preliminary Award or Award of a Contract or any Department decision regarding the issuing, receiving, or opening of any Bid, or rejection or non-rejection of any Bid, must be brought within 12 Days of the date of the preliminary Award of Contract;
 - b. The written protest must include facts supporting the protest, any pertinent contractual provisions, law, rules or regulations, and other legal authorities supporting the protest and a requested action;
 - c. Written protests filed prior to the Department's preliminary Award of Contract may be deferred at the sole discretion of the Department and not considered until the Department has preliminarily Awarded the Contract.

103.3.3 Informal Hearing Procedures

1. Failure to file a timely protest shall constitute a waiver of the Bidder's right to protest;
2. Service of the written protest shall be made only upon the Cabinet Secretary, with a copy contemporaneously transmitted and separately served upon the Office of General Counsel for the Department, during the Department's regular Business Hours by delivery in person, or by certified mail, postage prepaid, return receipt requested, or by delivery by a nationally recognized overnight or same-day courier service that obtains receipts. Electronic communication (i.e. e-mail, facsimile) shall not be considered. Service of a written protest made after the Department's regular Business Hours shall not be effective until the next business Day. Copies of the protest shall be contemporaneously transmitted by the disputing Bidder to every Bidder when the protest is served upon the Cabinet Secretary and the Office of General Counsel; and,
3. Any Bidder, other than the disputing Bidder, that considers itself to be an interested party to the Bidding dispute may submit a written response to the protest in advance of the informal hearing. The response shall include a statement of the requested action, a rebuttal of any of the factual matters in the protest, facts supporting the response, and any contractual provisions, laws, rules, or regulations, or other authority supporting the response.
4. 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 or until the Cabinet Secretary determines that the Award of the Contract is necessary to protect the substantial interests of the public and the Department. The Cabinet Secretary retains the right to cancel the Award of Contract or to reject all Bids and issue a new Invitation for Bids when it is in the best interest of the public and the Department;
5. 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, subject to other provisions in the Specifications, Award the Contract within 45 Days of the Bid Opening;

6. Within seven (7) Days of receiving a timely Bid protest, the Cabinet Secretary or the Cabinet Secretary's designated informal hearing officer will cause to be delivered by mail, postage prepaid, or by facsimile copy or by email transmission a letter notifying all parties to the grievance of the date, time and place to appear with all necessary material evidence for an informal hearing in the Department's General Office or elsewhere as identified. Such letter shall include a copy of the written protest. Whenever practicable the parties shall be afforded at least seven (7) Days notice of the scheduled informal hearing. If an informal hearing officer is designated by the Cabinet Secretary, the designee shall not be a person who made or approved the decision under review or a subordinate of such person during the past 12 months;
7. The informal hearing officer has absolute discretion in establishing the degree of formality for the informal hearing. The formal rules of evidence or civil procedure do not apply to the informal hearing. While parties to an informal hearing may call their own witnesses they are not afforded the opportunity to subpoena or cross-examine witnesses. Parties are permitted to submit documentary evidence and written arguments at the informal hearing. Parties may supplement the record or provide supplemental written arguments after the initial hearing date provided that such Materials are provided to the informal hearing officer at least three (3) Days prior to the deadline to issue a determination letter. The presentation of evidence and argument may be limited by the informal hearing officer. The informal hearing officer shall have the authority to question any party or witness. The informal hearing officer may limit the time for oral argument; exclude the participation or testimony of any person who becomes belligerent or unruly, or any representative who attempts to harass any witness; and, refuse to hear testimony or argument if it is cumulative, not relevant or is immaterial to the issues. At disposition, the informal hearing officer is not restricted to considering only those documents and testimony introduced at the informal hearing but may consider evidence that is reliable, accurate, and competently obtained from either party. When such information is obtained the hearing officer shall provide it to both parties and provide 24 hours for rebuttal before the final decision. The informal hearing officer is responsible for maintaining a complete record of the informal hearing including all evidence, transcripts of the hearing, and written arguments submitted by the parties. A complete record of the testimony and argument at the informal hearing shall, whenever practicable, be either stenographically or electronically recorded by a certified court reporter or monitor. Transcripts or recordings of the proceeding, if available, may be supplied to any party at their own expense upon request to the court reporter or monitor;
8. Within seven (7) Days of the initial hearing date, the Cabinet Secretary or the Cabinet Secretary's designated informal hearing officer will issue 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 the issuance of the adverse determination. The determination letter shall constitute the final Department decision or order;
9. The Award of the Contract to the lowest Responsible Bidder, based upon the Department's determination letter, shall be 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, shall bind the lowest Responsible Bidder to accept the Contract or to reject the Contract and forfeit the Bid Guaranty it has provided;
10. If an appeal is filed pursuant to 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 proceed with the Award to the lowest Responsible Bidder if the Cabinet Secretary determines that the Award of the Contract is necessary to protect the substantial interests of the public and the Department, or may cancel the Award of the Contract, or reject all Bids and issue a new Invitation for Bids when it is in the best interest of the public and the Department;

11. If a Bidder successfully prevails on appeal, a Bidder is limited to one (1) of two (2) remedies arising from a Bidding dispute, Award of the Contract or, if the Contract can no longer be practicably awarded to the Bidder or it is not in the best interest of the public and the Department to Award the Contract to the Bidder, the Contractor's reasonable, documented Bid preparation costs; and,
12. Each party shall bear its own attorneys fees and costs.

103.4 CANCELLATION OF AWARD

The Department may cancel the Award of any Contract or reject all Bids and issue a new Invitation for Bids at any time prior to the execution of the Contract by all parties without incurring liability where such cancellation is deemed by the Cabinet Secretary to be in the best interests of the public and the Department. No Bidder has a contractual, equitable, implied, or any other right to the Contract until executed by both parties.

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 (2) lowest Bidders. The Department will return the Bid Guaranty of the unsuccessful of the two (2) lowest Bidders, if submitted in the form of a check, within ten (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.

All bonds shall be procured from Sureties with an A.M. Best Company financial strength rating level of A- or better, Class VII or better, unless otherwise approved in writing by the Department. In no event shall the Department approve the use of a Surety with an A.M. Best Company financial strength rating level of B or worse.

103.7 EXECUTION AND APPROVAL OF CONTRACT

The successful Bidder shall sign and return the Contract and provide Contract Bonds and lists of all 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, reject all bids, reject all bids and issue a new Invitation for Bids 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 manner and 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."

Unless otherwise specified in the Contract, the Contractor is vested with the discretion and is wholly and solely responsible for selecting and managing the means and methods for performing the Work including determining the suitability of Equipment, experience of labor and staff, construction management and scheduling, production rates, Materials, and compliance with all Federal, State and local laws and regulations.

The Contract is a final, complete and exclusive statement of the written and executed agreement of the parties. No modifications, limitations, waivers or discharge of the Contract or any of its terms shall bind the Department unless made in a written Change Order signed by the Project Manager. A course of performance or course of dealing on this Contract or any other contract between the Department and a contractor shall not constitute a modification or waiver of the Contract and shall not give rise to any Claim including any cause of action based upon promissory estoppel, estoppel, waiver, or detrimental reliance.

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 additional 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 including the Critical Path; or,
2. Increase or decrease a Major Contract Item by twenty-five percent (25%). Adjusted compensation shall apply only to the following:
 - a. For quantity in excess of one hundred twenty-five percent (125%) of the original Contract item quantity, or,
 - b. For the case of a decrease, below seventy five percent (75%) of the original Contract item quantity, the adjusted compensation will apply to the total quantity placed.
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 shall 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 each other with prompt written notice, not to exceed two (2) Working Days, 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. Pursuant to Section 108.3.2 "Schedule Format," the Contractor shall provide a revised schedule to the Project Manager within seven (7) Days of the discovery or notice of a differing site condition; this timeframe may be extended in writing by the Project Manager.

The Project Manager will decide, within a two (2) Working Days, 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 differing site conditions 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 profit in accordance with Section 109.11, "Compensation for Claims." No Contract adjustment or additional compensation or time which results in a benefit to the Contractor will be allowed if a differing site condition could have been discovered or anticipated by the Contractor through the exercise of Pre-Bid Due Diligence.

The Contractor is not entitled to a Claim due to a differing site condition unless the Contractor has provided the required written notice pursuant to Section 105.19, "Notice of Potential Claim."

If the Contractor or the Project Manager fails to provide prompt written notice which results in additional costs to the Department which could have been mitigated, the Department shall adjust the Contract accordingly.

104.4 EXTRA WORK

The Contractor shall perform Extra Work at the Department's written direction and in accordance with the Specifications. The Department shall 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

The Contractor shall 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 and the Accepted vehicular and pedestrian traffic control plan and Division 700, "Traffic Control Devices." The Contractor shall provide flaggers with proper training and Equipment in accordance with the MUTCD, current edition. The Contractor shall keep flagging Equipment clean and in good repair. The Contractor shall 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 Project Manager will coordinate snow removal with the Contractor and the maintenance patrol. 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 Contractor shall furnish warning devices, take protective and safety 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 of the deficiency and the Contractor shall take corrective action within the time frame specified by the Project Manager. If the Contractor does not take corrective action 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 Department incurred costs of such corrections plus an additional ten percent (10%) for administrative costs.

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

The Contractor shall 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, the Contractor shall 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.

The Contractor shall re-vegetate Borrow Pits, haul Roads, and all occupied ground in accordance with Section 632, "Revegetation" 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.

The Contractor shall 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. The Contractor shall spread stockpiled waste that is not covered by a land owner agreement over the stripped area prior to placing the topsoil. Stripping, stockpiling, and replacement of topsoil and spreading of stockpiled waste shall be Incidental to completion of the Work unless a Bid Item for them exists in the Bid.

The Contractor shall 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, the Contractor shall where practicable leave all pits well drained.

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

104.8.1 Content Requirements

The Contractor shall provide, at a minimum, the following information, in writing, 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 the Department's 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 of the Contractor's share. The Project Manager may approve a schedule for Progress Payments of the Lump sum; and,

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 109.10, "Project Closure," 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

105.1.1 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 cause, e.g., weather conditions, discovery of Cultural Resource, and utility conflicts.

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 and the Department. Failure by the Contractor to suspend Work immediately may result in the Contractor being in default of Contract pursuant to Section 108.9, "Default of Contract." The Department will pay for 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."

105.1.2 Department Authority to Suspend Work

The Department has the authority to wholly or Partially Suspend the Work and to prepare and post a zero dollar (\$0.00) Progress Payment if the Contractor:

1. Fails to correct unsafe conditions;
2. Fails to comply with any term or condition of the Contract;
3. Fails to observe and comply with any Federal or State law or regulation;
4. Fails to carry out directions of the Project Manager; or,
5. Fails to perform satisfactory Work.

Failure by the Contractor to suspend Work immediately may result in the Contractor being in default of Contract pursuant to Section 108.9 "Default of Contract." The Contractor shall not receive additional compensation or time for these failures.

If, during the course of the Project the Contractor's personnel are not performing satisfactory Work, the Project Manager may order the Contractor to suspend operations until the Contractor corrects the problem, at no cost to the Department.

The Department's ability to withhold Progress Payments in part or in their entirety as part of a suspension as authorized by this Section, supplements the Department's ability, pursuant to Section 109.8, "Progress Payments," until the Contractor complies with the Contract.

105.1.3 Contractor Request for Suspension

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

105.2 PLANS AND WORKING DRAWINGS

The Contractor shall 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 furnishing of all Working Drawings is Incidental.

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 may determine if the nonconforming Work is nonetheless Acceptable. If Accepted, the Project Manager will document the basis of Acceptance by 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, and correct the Work or Materials at no additional cost to the Department.

The Contractor has an affirmative duty to perform all Work and provide Materials in compliance with the Contract. The Department's failure to discover or reject Materials or Work not in accordance with the Contract during the progress of Work shall not be considered an Acceptance of the Work or Materials, or a waiver of defects. The failure to properly perform inspections, tests or approvals by the Department shall not relieve the Contractor from its obligation to perform the Work and provide Materials in strict conformance with the Contract.

105.4 COORDINATION OF CONTRACT DOCUMENTS

The following documents are essential parts of the Contract, and in their totality constitute 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,
9. Standard Drawings.

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

If a Contract or plan discrepancy is discovered after the Award of the Project, the Contractor shall, upon discovery, promptly notify in writing the Project Manager of errors or omissions in the Plans, contradictions within these documents or contradictions between the Contract documents and the worksite. Unless otherwise directed by the Project Manager, the Project Manager will resolve the discrepancy in writing before the Contractor proceeds further with performance of the affected Work.

The Project Manager and the Contractor may agree that the Contractor shall 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

The Contractor shall monitor the Work at all times, select and manage the means and methods for performing the Work, facilitate the timely 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 and qualified 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 and other meetings associated with the Project as directed by the Project Manager.

The Department will provide a 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.

The Contractor shall recognize the Project Manager as the Department's contact for all matters relating to the Project and promptly submit all documentation or notice required by the Contract to the Project Manager.

105.6 COOPERATION WITH UTILITIES

The Contractor shall copy the Project Manager on all communications with affected utilities. For telephonic communications a summary of the communication shall be provided to the Project Manager.

The Department will notify all utility companies, all pipeline owners, or other parties who may be 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.

The Contractor shall be responsible for complying with the provisions of NMSA 1978, § 62-14-1, et seq., during the performance of the Work. Those duties include providing telephonic advance notice of the commencement, extent and duration of the excavation work to the one-call notification system operating in the intended excavation area, notifying appropriate one-call notification center or underground facility owner or operator of planned excavation in order to allow the location and marking of the location of underground facilities, requesting owners or operators of underground facilities to reaffirm line locations every ten (10) Working Days after an initial request to locate, not moving or obliterating utility location markings, and immediately notifying the owner of any underground facilities which may have been damaged or dislocated during the excavation work.

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,
13. Traffic Signals.

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, and the Contractor shall perform such Work under Force Account basis in accordance with Section 104, "Scope of Work," and Section 109.5, "Payment for Changes, Differing Site Conditions, and Extra Work."

Subject to compliance with Section 105.19 "Notice of Potential Claim," Section 105.20 "Administrative Remedy," and Section 108.3.2, "Schedule Format," 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.

Subject to compliance with Section 105.19 "Notice of Potential Claim," Section 105.20 "Administrative Remedy," and Section 108.3.2 "Schedule Format," the Contractor may receive compensation under Section 109.11 "Compensation for Claims," 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; Work in other areas of the Project shall continue.

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 shall 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 adjustment in the Contract Time and price in accordance with Section 108.3 "Schedule" and Section 109.6 "Force Account".

The Contractor shall:

1. Plan, 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 or adjacent 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 Third Party Claims and Duty to Defend."

If the Contractor and one (1) or more other Contractors are unable to agree upon the sequence of Work or other matters, the Contractor(s) 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 seven (7) Days of receiving such information.

105.8 AUTHORITY AND DUTIES OF THE PROJECT MANAGER

105.8.1 Project Manager Authority

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 unaccepted Work and Material.

105.8.2 Contractor Inquiries to Project Manager

The Contractor shall submit Project issues to the Project Manager who will resolve all questions regarding:

1. The quality and Acceptance of Materials provided;
2. The quality and Acceptance of Work performed or planned;
3. Rate of progress of the Work;
4. Interpretation of the Contract;
5. Acceptable performance of the Contract requirements;
6. Administration of payments; and,
7. Other Contract inquiries.

The decision of the Project Manager will be in writing and delivered to the Contractor's Superintendent as soon as reasonably practicable.

105.9 DUTIES OF THE INSPECTOR

105.9.1 Inspector Authority

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.

105.9.2 Inspector Authority Limitations

The Department does not authorize its Inspectors to:

1. Alter or waive any provision of the Contract;
2. Issue instructions contrary to the Contract;

3. Act as the foreman for the Contractor; or,
4. Suspend the Work, except for safety reasons.

105.10 INSPECTION OF WORK

The Contractor shall provide the Department with 48 hour notice for inspection of the Work. Failure by the Contractor to provide the proper notice may result in the Department directing the Work performed without inspection to be removed at no cost to the Department.

The Contractor shall provide the Department access to the Work and provide all information and assistance requested or required to make a complete and detailed inspection of Materials and Work. All Materials and each part or detail of the Work shall be subject to inspection by the Department. The Department shall be allowed access to all parts of the Work and shall be furnished with such information and assistance by the Contractor as is required by the Department to make a complete and detailed inspection.

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 Contract 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 absence or presence of a Department Inspector shall not relieve the Contractor from any responsibility under the Contract for Acceptable Work in conformity with the Contract. The failure to properly perform inspections, tests or approvals by the Department shall not relieve the Contractor from its obligation to perform the Work in strict conformance with the Contract.

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 shall have the right to inspect the Work. This inspection shall not make the unit of government or political subdivision or the railroad corporation a party to the Contract and shall not interfere with the rights of either party.

105.11 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK

Work that does not conform to the requirements of the Contract shall be unacceptable, unless it is determined by the Project Manager to be Acceptable under the provisions of Section 105.3, "Compliance With Plans and Specifications."

The Contractor shall 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 shall not pay for the following under the provisions of the Contract:

1. Work performed contrary to the Project Manager's direction or as provided in the Contract;
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 replaced 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

The Contractor shall 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, provided the Contractor has obtained the proper oversize and overweight permits. The Contractor is liable for damage that may result from moving Equipment, even with the issuance of a special permit.

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

The Contractor may exceed legal loads on treated base under construction with approval from the Project Manager. 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 in accordance with Section 105.17, "Contract Adjustments for Suspension of Work." Within seventy two (72) hours of the notice, the Project Manager will decide on one (1) or more of the following solutions:

1. Change the haul route;
2. Reduce the allowable load limit; and,
3. Allow the operations to continue with the requirement that the Contractor repair all damaged areas at ½ Unit Bid prices.

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 use established Material sources and haul Roads the Department will determine what preservation or restoration of the existing Roadway or Structures is necessary, payment shall be made pursuant to 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; and,
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

105.13.1.1 Change in Haul Route

If the Project Manager changes the haul route, the Department will modify the Contractor's payment per the following equation:

$$P = R \times t \times (d_1 - d_0) \quad (1)$$

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

105.13.1.2 Change in Allowable Load Limit

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

$$P = \frac{QF \times R \times d \times (LA - LR)}{LA} \quad (2)$$

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

The Contractor shall 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. The Contractor shall be responsible for maintaining the Project free and clear of Deleterious Materials including debris, weather related remnants, snow, loose Materials and trash. The Department shall be responsible for snow removal operations on travel lanes open and utilized by the public.

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.

All maintenance Work during construction and before the Project is Accepted shall be Incidental. The Department shall 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 shall notify the Contractor in writing of the failure. If the Contractor does not begin maintenance after such notice, the Project Manager may begin maintenance of the Project. If the Contractor does not take corrective action in this period, the Project Manager may make corrections or terminate the Contract in accordance with Section 108.9, "Default of Contract." For corrective actions implemented by the Project Manager the Contractor shall reimburse the Department for Department incurred costs of such maintenance plus an additional ten percent (10%) for administrative costs.

105.17 CONTRACT ADJUSTMENT FOR SUSPENSION OF WORK

If the Work is suspended by the Project Manager in writing pursuant to Section 105.1.2, "Department Authority to Suspend Work" for an unreasonable time (not originally anticipated, customary, or inherent to the construction industry), the Contractor may submit to the Project Manager a Notice of Intent to Claim in accordance with Section 105.19, "Notice of Potential Claim" which must be accompanied by a proposed revised schedule pursuant to Section 108.3.2 "Schedule Format."

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 conditions, the Project Manager will make an adjustment in accordance with Section 109.11 "Compensation for Claims" 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, without waiving the provisions in Section 105.3, "Compliance with Plans and Specifications," and Section 109.10, "Project Closure" 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. CWB;
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 Overrun / Underrun 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 shall not Accept prematurely constructed items until they may be used for their intended purposes.

105.19 NOTICE OF POTENTIAL CLAIM

1. The Contractor shall only make Claims in accordance with the Contract pursuant to the exclusive administrative remedy and procedures set forth in this Section and Section 105.20, "Administrative Remedy."
2. The Contractor shall not be entitled to pursue a Claim if the Project Manager determines the Work ordered is Extra Work in which case payment shall be made in accordance with Section 109.5, "Payment For Changes, Differing Site Conditions, and Extra Work."
3. The Contractor shall promptly notify the Project Manager in writing of the intent to make a Claim and shall provide a contemporaneous statement of estimated damages or delay before beginning the Work on which the Claim is based, but, in no event shall notice be given later than seven (7) Days of the Contractor discovering the condition or issue giving rise to the Claim, or within seven (7) Days of receipt of a notice of a differing site condition from the Project Manager, 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. A notice of intent to Claim shall include, when relevant to the intended Claim (e.g., when the Contractor intends to seek a Contract adjustment for time, Delay damages, or reduction in Liquidated Damages, etc.), a revised schedule pursuant to Section 108.3.2, "Schedule Format"; failure to include a revised schedule shall render the notice of intent to Claim incomplete.
4. Such notice of intent to Claim shall be given in order that the Department can assess the situation, make an initial determination as to the causes of the potential Claim, institute appropriate changes or procedures to resolve the matter, to document issues related to the potential Claim, to track costs and possible Delay, and facilitate resolution of the potential Claim. The failure of the Contractor to provide timely written notice of intent to make a Claim and a contemporaneous statement of estimated damages or Delay shall constitute a waiver or abandonment of the Claim. The Contractor waives the right to assert a Claim if the Contractor fails to provide proper and complete notice of intent to Claim.
5. The Contractor shall provide the Project Manager proper facilities to keep account of the actual cost of a Claim; the Contractor waives the right to assert a Claim if the Project Manager is not afforded proper facilities to keep account of actual cost. The Project Manager may, in the Project Manager's discretion, in writing, waive the

requirement regarding the furnishing of proper facilities to keep account of actual cost upon a showing of adequate justification by the Contractor.

6. This Section and the deadlines stated herein do not modify any of the deadlines for submitting revised schedules as provided in Section 108.3, "Schedule."
7. Neither proper Notice by the Contractor nor the Project Manager's accounts of the cost shall be construed to prove or validate the Claim or be construed as an admission of liability.

105.20 ADMINISTRATIVE REMEDY

Once the Contractor has provided timely and proper notice of intent to make a Claim pursuant to Section 105.19, "Notice of Potential Claim" the entire and complete administrative remedy and procedure to resolve all contractual disputes is provided by this Section.

The complete administrative remedy is sequential in nature, exclusive, and consists of the following steps:

- Step I. Notice of Intent to Claim;
- Step II. Submittal of the Claim to the Project Manager;
- Step III. District Level review and decision;
- Step IV. Service of Request for Reconsideration of Claim to Secretary;
- Step V. Secretary's review, which may include referral to Claims Board for an informal hearing, and Secretary's decision;
- Step VI. Service of Request for Arbitration or Service of Summons and Complaint in State District Court.

No contractual dispute or Claim shall be accorded any level of review unless the dispute has been properly submitted, reviewed and decided at the preceding level and the Contractor rejects the decision by providing the requisite notices and submittals in writing to the proper Department officials or employees within the time periods proscribed in this Section and Section 105.19, "Notice of Potential Claim."

The complete terms of a resolved Claim, regardless of the level of the administrative remedy, shall be documented and memorialized via a Change Order executed by the Contractor and the Department. The executed Change Order shall represent a final agreement to the total amount and time due for any and all Work and items pertaining to the Work associated with the Change Order. Unless otherwise provided, in writing, in the executed Change Order, the executed Change Order shall operate as an accord and satisfaction of the Claim and shall operate as a bar to any further Claim by the Contractor.

The Department shall dismiss a Contractor's Claim for failure to comply with the time limitations, requirements and procedures set forth in this Section and Section 105.19, "Notice of Potential Claim."

Each party shall bear its own attorneys' fees, costs, and expert fees.

105.20.1 District Level

The Contractor shall submit the Claim in writing to the Project Manager and include justification for the Claim and the total amount requested within 30 Days of the date that the Work associated with the Claim has been completed but, in no event later than within 30 Days of receipt of the Departments proposed final payment statement (estimate) pursuant Section 109.10 "Project Closure". The Contractor may submit a Claim only once. Once a Claim is submitted to the Project Manager, nothing in this section shall be construed as permitting the Contractor to revive, modify, supplement, enlarge, or amend the Claim other than providing additional documents and information in support of the Claim. The Contractor shall be prohibited from amending either the bases of entitlement or the amount of any compensation or time stated for any and all issues claimed in the Contractor's written Claim submitted hereunder, and all further proceedings shall be limited solely to the bases of entitlement and

the amount of any compensation or time stated for any and all issues claimed in the Contractor's written Claim submitted hereunder. This shall not, however, preclude a Contractor from withdrawing or reducing any of the bases of entitlement and the amount of any compensation or time stated for any and all issues claimed in the Contractor's written Claim submitted hereunder at any time.

1. The Contractor has the burden of fully justifying and documenting the Claim and shall provide to the Project Manager the following supporting documentation and information in support of the Claim:
 - a. Description of the issue upon which the Claim is based;
 - b. Location where the issue arose;
 - c. Time and date the issue was identified and the dates impacted;
 - d. Clear explanation of why the issue requires additional compensation or time or a change to the Contract, including references to the relevant portions of the Contract;
 - e. Copies of all written communications including correspondence and emails related to the issue;
 - f. A detailed compilation of the amount of additional compensation sought and a breakdown of the amount sought as follows: documented additional job site labor expenses; documented additional cost of Materials and supplies; a list of additional Equipment costs claimed, including each piece of Equipment and the Blue Book rental rate claimed for each; any other additional direct costs or damages and the documents in support thereof; any additional indirect costs or damages and all documentation in support thereof;
 - g. Where a Claim seeks additional time, time and compensation for Delay, adjustment of Contract Time, or the reduction or elimination of liquidated damages, previously submitted Baseline Schedule and revised schedules that comply with the requirements of Section 108.3, "Schedule";
 - h. Invoices identifying the labor, Materials, and Equipment used or proposed to be used;
 - i. Financial Statements. If the amount claimed by the Contractor exceeds \$100,000.00, or if requested by the Project Manager, job cost reports and financial statements for the time periods relevant to the Contract and the performance of the Work. The Contractor shall make the Contractor's documents available for inspection by the Project Manager at the Contractor's project office. The Project Manager may waive this requirement;
 - j. Bid Documents. If the amount claimed by the Contractor exceeds \$100,000.00, or if requested by the Project Manager, the Contractor shall make the Contractor's documents available for inspection by the Project Manager at the Contractor's project office, information and calculations used to prepare and determine its bid for the Contract prior to submission of the Bid. The required bid preparation documents, as maintained by the Contractor, to be produced shall include: clear itemization of the costs for each pay item broken down into components sufficient to allow a detailed cost estimate; the costs allocated to each component broken down into the Contractor's usual estimate categories such as direct labor, Equipment, Materials, and Subcontractor cost; indirect costs, including the indirect cost allocations made to each bid item; quantity takeoffs; the construction and progress schedule and any conceptual schedules upon which the Bid was based; rates of production and progress; marked up plans, sheets and Working Drawings ; calculations, copies and quotes from Subcontractors and Suppliers; memoranda, narratives, and all other information used by the Contractor to arrive at all of the prices contained in the Bid. The Project Manager may waive this requirement;
 - k. Total amount of Claim in terms of time and compensation; and,
 - l. The failure of the Contractor to provide the Project Manager all required supporting documentation and information shall constitute a waiver or abandonment of the Claim and a failure to exhaust its administrative remedy.

The Project Manager retains the right to request additional information and documents from the Contractor to support the Claim. The Contractor shall provide such additional information and documents.

2. Subcontractor Claims shall not be considered, except when timely submitted and certified by the Contractor as the Contractor's Claim.
3. The District Engineer or designee has 30 Days from the date the Claim is received by the Project Manager, or additional time if 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 is deemed denied by the District Engineer. The parties may engage in informal mediation to resolve the Claim at the District level prior to the expiration of the time in which the District Engineer or its designee may render a decision.

105.20.2 Secretary Level

Within ten (10) Days of the District Engineer's or designee's denial of its Claim or a written notice that the attempted mediation of its Claim was unsuccessful, the Contractor may serve a written request upon the Cabinet Secretary to reconsider the Claim. Service shall not be considered effective unless the request includes all supporting documentation provided at the District Level and, when applicable, a copy of the District Engineer's written denial of 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 21 Days of service of the request for reconsideration; this deadline may be extended in writing by the Cabinet Secretary. Failure to timely serve a written request to reconsider the Claim constitutes acceptance of the District Engineer's decision and a waiver and relinquishment of the Claim. If the Contractor does not timely serve a written request to reconsider the Claim, the Department may, within 30 Days of the District Engineer's decision, execute a unilateral Change Order implementing the District Engineer's decision.

1. Service of Process at the Secretary Level. Service of all notices and required documentation and information at the Secretary Level shall be made upon the Cabinet Secretary with a copy contemporaneously transmitted to both the District Engineer and the Department's Office of General Counsel. Service upon the Cabinet Secretary shall be made during the Department's regular Business Hours by delivery in person, or by certified mail, postage prepaid, return receipt requested, or by delivery by a nationally recognized overnight or same-day courier service that obtains receipts. The copy contemporaneously transmitted to the Office of General Counsel may be served by the means for serving the Cabinet Secretary or, with prior written agreement of the Office of General Counsel, by facsimile copy or by email transmission. Service of notice or documents made after the Department's regular Business Hours shall not be effective until the next business Day. Service upon the District Engineer may be made by the means for serving the Cabinet Secretary or by facsimile copy or by email transmission and need not include the documentation previously submitted at the District level.
2. Certification of Claim. The written request to reconsider the Claim shall include a notarized statement from an authorized representative or agent of the Contractor certifying: "under penalty of perjury, I have actual knowledge of the truth and accuracy of the Claim and the supporting information and records; the Claim and submittals are true and correct; the Claim made for Work on this Contract is true and is made in good faith to the best of my personal knowledge; and, the Claim and the remedies sought are supported by the terms of the Contract." Where a Claim is a Subcontractor pass-through Claim, the certification shall further include: "the Contractor certifies that the Claim being passed through to the Department is passed through in good faith, has been independently verified by the Contractor, and is accurate and complete to the best of my knowledge and belief."
3. Claims Board. If the Claim is referred to a Claims Board, an informal dispute resolution board, by the Cabinet Secretary, the Secretary shall appoint three (3) independent panelists with relevant experience in highway and transportation design, construction management, engineering, surveying, construction contract

administration, construction oversight work, or law. The Claims Board shall not include any current employees of the Department or the Contractor. The Claims Board shall apply the Contract to the Claim and shall conduct an informal hearing in order to facilitate the expeditious and informal resolution of the Claim. Attorneys representing the parties are permitted to attend the informal hearing; however, attorneys shall not participate in the informal hearing unless the Claims Board specifically addresses an issue to them or unless agreed to by both parties. Notification shall be provided by both parties a minimum of five (5) Days prior to the hearing if legal representation will be attending the hearing. The Claims Board shall issue a final, written recommendation to the Cabinet Secretary to resolve the Claim.

4. **Secretary Decision.** If the Claim is referred to the Department's Claims Board, the Cabinet Secretary will provide a written decision within 21 Days of the Secretary's receipt of a final, written recommendation on the Claim from the Claims Board; If the Cabinet Secretary does not provide a written decision within 21 Days, unless extended by the Secretary in writing prior to expiration of time to issue a decision, the Claims Board's recommendations shall be deemed to have been adopted by the Cabinet Secretary and shall operate as the Secretary's decision.
5. **Payment.** Contractor is only entitled to payment of its Claim pursuant to the Cabinet Secretary's decision if Contractor fully accepts the decision and executes an accompanying Change Order. If the Contractor fails to execute a Change Order within 21 Days of the Cabinet Secretary's decision, the Department may process a unilateral Change Order implementing the Cabinet Secretary's decision. The Contractor's proceeding with litigation in State District Court or arbitration shall operate as a waiver by the Contractor to recover or receive payment pursuant to the Cabinet Secretary's decision.
6. **Additional Information.** The Secretary retains the right to request additional information from the Contractor to support the Claim including information as is provided by Section 105.20.1, "District Level" (i) and (j), regardless of the Project Manager's previous waiver of those subsections.

105.20.3 Arbitration

1. The Contractor and Department may agree to arbitrate the Claim instead of proceeding to litigation in State District Court. Arbitration may only be had at the mutual agreement of the Contractor and the Department. Arbitration shall be conducted in accordance with the New Mexico Uniform Arbitration Act (NMSA 1978, § 44-7A-1, et seq.) and this Section.
2. The Contractor may, within ten (10) Days of the issuance of the Cabinet Secretary's decision pursuant to Section 105.20.2, "Secretary Level," serve upon the Department a written request that the Claim be submitted to arbitration. Service of the request to arbitrate the Claim by the Contractor shall be made pursuant to Section 105.20.2, "Secretary Level." If either the Contractor or the Department fails to provide written notice agreeing to arbitrate the Claim within ten (10) Days of the request, the request shall be deemed denied. By the parties electing arbitration, the Contractor waives the right to redress through litigation filed in State District Court. The Contractor's proceeding with arbitration shall operate as a waiver by the Contractor of recovery under any written decision issued by the Cabinet Secretary. Denial of a request, or failure to agree, to arbitrate a Claim by any party does not modify any of the deadlines contained in this Section.
3. If the Contractor and Department agree to arbitrate the Claim the arbitration panel shall consist of three (3) members.
4. Within 15 Days of the agreement to arbitrate the Claim, the Contractor shall submit the name of a panelist. The Contractor's panelist shall:
 - a. Not be an employee of the Contractor;
 - b. Have 15 years experience in Highway construction management, methods, techniques, or law; or have an active professional license with the state of New Mexico as an Engineer, Surveyor or Attorney with ten (10) years experience in Highway construction management, methods, techniques, or law;

- c. Be either a resident of the state of New Mexico or identify New Mexico as the panelist's principal place of business; and,
 - d. Agree to serve on the panel;
- 5. Within 15 Days of receiving notice of the Contractor's panelist, the Cabinet Secretary shall submit the name of a panelist. The Cabinet Secretary's panelist shall:
 - a. Not be an employee of the Department;
 - b. Have 15 years experience in Highway construction management, methods, techniques, or law; or have an active professional license with the state of New Mexico as an Engineer, Surveyor or Attorney with ten (10) years experience in Highway construction management, methods, techniques, or law;
 - c. Be either a resident of the state of New Mexico or identify New Mexico as the panelist's principal place of business; and,
 - d. Agree to serve on the panel;
- 6. Within 30 Days after the Cabinet Secretary panel appointment, the two (2) panelists will choose a third panelist. The third panelist shall:
 - a. Be a professional arbitrator who is a member or diplomat of a nationally recognized professional arbitration organization, such as the National Academy of Arbitrators or the American Arbitration Association; or is a retired federal or New Mexico district or appellate judge; or be a former employee of FHWA;
 - b. Not be an employee or a contractor of either the Department or the Contractor; and
 - c. Agree to serve on the panel;
- 7. If the two (2) panelists are unable to agree, a district judge from the First Judicial District shall choose the third panelist from a list of four (4) prospective panelists who meet the requirements of the preceding paragraph, two (2) each provided by the Department and the Contractor. Application to the court for this appointment shall be made by either or both parties within 15 Days of the impasse; the parties may agree in writing to extend this deadline.
- 8. The panel shall hold the arbitration hearing in Santa Fe County, unless otherwise approved by the Department, no later than 90 Days after the panel is selected. If the panel fails to meet this deadline or if the parties agree to extend the deadline, the panel retains jurisdiction to hear and resolve the issues in dispute.
- 9. 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.
- 10. 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.).

105.20.4 Litigation

If the Contractor does not fully accept the Cabinet Secretary's decision and the Contractor and the Department do not agree to arbitrate the Claim, the Contractor may, within 45 Days of the issuance of the Secretary's decision, proceed with litigation in State District Court by filing a summons and complaint. The Contractor shall properly serve the summons and complaint within 30 Days of the filing of the Complaint in State District Court. The Contractor shall, however, exhaust the mandatory mediation procedures of the New Mexico Public Works Mediation Act (NMSA 1978, § 13-4c-1, et seq.) before seeking judicial relief in State District Court. The Contractor shall provide no less than seven (7) Days notice of the convening of a mediation session. Service of notice of a mediation session shall be made upon both the Cabinet Secretary and the Office of General Counsel and shall otherwise comply with the New Mexico Public Works Mediation Act. Failure to timely notice and

convene a mediation session and to timely file and serve a summons and complaint shall operate as a waiver and abandonment of Contractor's Claim, shall act as an acceptance of the Cabinet Secretary's decision, and shall bar the Contractor from proceeding to litigate the Claim. Upon expiration of the time in which to mediate and file a summons and complaint, or if a summons and complaint has been filed the expiration of the time in which to properly serve the summons and complaint, the Department may process a unilateral Change Order implementing the Cabinet Secretary's decision based on the Contractor's abandonment or waiver of its Claim.

106.1 CONTRACTOR-FURNISHED AGGREGATE AND BORROW SOURCES

The Department may reject Material sources, or specific areas within sources as identified in the Bid Package.

The Contractor shall provide Acceptable Materials and shall notify the Project Manager of the Material source prior to delivery to the Project. The Project Manager may approve Materials at the source prior to delivery. The Department may reject sources, or specific areas within sources, due to failure to provide Acceptable Materials or due to environmental, social, or cultural concerns. If the Project Manager determines 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. No additional compensation or time shall be provided to the Contractor for unacceptable Materials or for developing alternate source locations.

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.

Exploration and development of Material sources by the Contractor including related GRT and Tribal Taxes shall be Incidental.

Requests for approval of sources of Material are subject to environmental acceptability requirements. The Contractor shall 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.

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 by the Contractor.

Prior to delivery of Materials to the Project from an aggregate or borrow source, the Contractor shall 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;
4. Plans for restoration, including contouring and re-vegetation if necessary; and,
5. Testing results from a Department-approved Laboratory.

No Material shall be delivered to the Project until the Project Manager notifies the Contractor in writing that the Materials source is Acceptable for use.

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 be adequately inspected for the production or fabrication of the Material; and,
4. Ensure adequate safety measures are implemented 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

The Contractor shall not incorporate into the Work unacceptable or unapproved Materials. The Project Manager may direct the Contractor to remove unapproved or unacceptable Materials 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

The Contractor shall submit Certificates of Compliance to the Project Manager before incorporating Material in the Work, and shall ensure each Certificate of Compliance contains the following information:

1. The Control 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;
12. The printed name, signature, and job title of the company official who certified the document;
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 the above noted documents for 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 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. The Materials shall be in accordance with standards, methods, or Specifications, current on the Advertisement date.

The Contractor shall 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, the Contractor shall deliver Materials manufactured outside the United States to approved locations within the state, where they shall remain until sampling and testing are complete.

The Contractor shall 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.

The Contractor shall 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.

106.6 STORAGE OF MATERIALS

The Contractor shall store Materials to preserve quality and fitness for the Work and to protect against vandalism or theft. The Contractor shall be responsible for the replacement or repair of Materials affected by inadequate protection. Unless otherwise specified in the Contract the Contractor may with the written approval of the Project Manager use the ROW for storage of Material for any duration of the Project.

The Contractor shall request from the Project Manager written approval to store Equipment within the ROW for the adequate execution of the Work.

106.7 HANDLING AND TRANSPORTING MATERIALS

The Contractor shall handle Materials in a manner that preserves the Acceptability for the Work. The Contractor shall transport aggregates from the storage site to the Work site in vehicles constructed and operated to prevent loss or segregation of Materials. The Contractor shall ensure the transportation of Materials is in accordance with state and federal regulations,

and prevent leakage of, scattering of, or damage to Materials. Materials damaged or lost in transportation shall be deemed unacceptable and are not subject to payment by the Department.

106.8 DEPARTMENT-PROVIDED MATERIALS

The Department will list Department-provided Materials in the Contract. The Pay Item in which the Contractor uses the Materials includes the cost of hauling, handling and installing the Materials. The Contractor is responsible for loss or damage to Department provided Materials. The Contractor shall replace lost or damaged Materials at no additional cost to the Department.

106.9 MATERIALS DESIGNATED BY TRADE NAME

The Contract may require Material or Equipment by trade or manufacturers' names. The Department may Accept the substitution of Materials or Equipment of equal or greater quality provided the proposed substitute is fully documented and submitted to the Project Manager, and prior written approval of the Project Manager is given.

If allowed 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. No additional Contract Time or compensation will be allowed for substitution of Materials.

106.10 EQUIPMENT AND MATERIAL GUARANTEES AND WARRANTIES

Obtain and assign to the Department manufacturer and producer guarantees or warranties for Materials and Equipment. Warrant, for six (6) 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.

106.11 MATERIAL SAFETY DATA SHEETS (MSDS)

The Contractor shall submit to the Project Manager the most current MSDSs for all Materials that require MSDSs upon delivery of the Materials to the Project. The MSDS shall conform to current Federal requirements and contain the following information:

1. Product identification:
 - a. Name, address, and phone number of chemical manufacturer;
 - b. Trade name of the product; and,
 - c. Chemical name and formula of the product.
2. Hazardous ingredients:

- a. Substances present in the product that are listed as hazardous in the Hazard Communication standard (29 CFR § 1910.1200) (1900 Subpart Z); and,
 - b. Exposure limits for the hazardous ingredient.
3. Physical hazard data:
 - a. Fire and explosion data; and,
 - b. Proper extinguishing Equipment;
4. Health hazard information:
 - a. Estimate of the hazard of the product;
 - b. Routes of entry of the product;
 - c. Acute and chronic health effects of exposure; and,
 - d. Emergency first-aid procedures;
5. Reactivity data;
6. Spill and leak procedures;
7. Personal protective Equipment necessary for safe handling of the chemical; and,
8. Special precautions.

106.12 PREFERENCE FOR DOMESTIC MATERIALS

The Contractor shall provide Materials in accordance with the Buy America Requirements (23 CFR § 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 iron and steel products and Materials.

**SECTION 107: LEGAL RELATIONS, ENVIRONMENTAL REQUIREMENTS, AND
RESPONSIBILITY TO THE PUBLIC**

107.1 LAWS TO BE OBSERVED

The Contractor shall be 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, including those 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. The Contractor shall 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.

The Contractor shall 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

The Contractor shall 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 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.

The Department shall be promptly reimbursed or repaid for any tax, including GRT, that is refunded to the Contractor, including any refund received by the Contractor after final payment, to the extent such tax was paid by the Department to the Contractor. The Contractor shall keep and maintain all documents, applications for tax refund, and forms filed with, submitted to, received from, or required by the New Mexico Taxation and Revenue Department which relate to the payment or refunding of any tax paid pursuant to this Section for five (5) years following final payment. All of the above material shall be made available to the Department or FHWA for review, audit, inspection, and copying and shall be produced, upon request, at the Department General Office, the District in which the Work was performed, or an FHWA office, as directed.

107.4.2 Tribal Taxes

All Bids submitted shall exclude any tribal 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.

The Department will reimburse the Contractor for payment of any Tribal Tax directly related to the performance of the Work within the Project imposed by a tribe upon tribal verification that the tax was paid by the Contractor.

107.5 PATENTED DEVICES, MATERIALS, AND PROCESSES

The Contractor shall 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. The Contractor shall defend, indemnify and hold 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, the Contractor shall observe and be subject to 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 and oversight by the appropriate federal agency. Such inspection or oversight 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

The Contractor shall 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.

The Contractor shall comply with federal, State, and local health rules and regulations. The Contractor shall ensure that working conditions are sanitary, non-hazardous, and not dangerous to the health or safety of workers or authorized visitors on the Project. The

Contractor shall admit to the Project credentialed Inspectors from OSHA or other agencies responsible for health and safety administration.

107.9 PUBLIC CONVENIENCE AND SAFETY

The Contractor shall 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, the Contractor shall 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

The Contractor shall 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 at the Contractor's request 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; and,
7. Furnish the owner of the railroad Right of Way for approval, five (5) copies of Plans and two (2) 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 New Mexico regulations or rules. In case the use of such shoring will impair said clearance the Contractor shall ensure that application is made to the appropriate

state agency, 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

The Contractor shall 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 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.

The Contractor shall coordinate the Work each Day with the owner of the railroad Right of Way's operations, prior to commencing any construction activity.

The Contractor shall 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

The Contractor shall 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 ten (10) feet horizontally from the centerline of track, 23 feet three (3) inches vertical above top of rail;
2. Construction or maintenance of electric wires:
 - a. For lines carrying less than 750 V, 27 feet vertically above top of rail;
 - b. For lines carrying 750 V, 28 feet vertically above top of rail;
 - c. For lines carrying 15 kV to 20 kV, 30 feet vertically above top of rail;
 - d. For lines carrying more than 20 kV, 34 feet vertically above top of rail.

When the Contractor must maintain or operate Equipment inside the above tolerances, the Contractor shall 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.

The Contractor shall 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, the Contractor shall obtain written permission from the owner of railroad Right of Way, if required by the owner of the railroad Right of Way. The Contractor shall obtain a private crossing agreement if required by the owner of railroad Right of Way. The Contractor shall install all crossings, and provide flagging and protective devices at no additional cost to the Department. The Contractor shall 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, the Contractor shall 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, the Contractor shall furnish one (1) 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. All Work associated with this Section shall be Incidental.

107.11 ENVIRONMENTAL, HAZARDOUS MATERIALS AND CULTURAL RESOURCES APPROVAL

The Department will obtain the environmental, hazardous material, and Cultural Resource approvals for the Project before construction. The Department will describe in the Contract any special environmental, hazardous material and Cultural Resource requirements developed to protect resources.

107.12 ENVIRONMENTAL, HAZARDOUS MATERIALS AND CULTURAL RESOURCE DISCOVERIES

The Contractor shall terminate operations in the immediate area of environmental, Hazardous Materials or Cultural Resources not identified in the Contract and immediately notify the Project Manager. While the Project Manager, Environmental Geology Bureau Manager, Environmental Program Manager, and regulatory authorities complete appropriate mitigation actions the Contractor shall continue Work in other areas. The Project Manager shall provide written notification to the Contractor when Work may commence in the area of terminated operations. Any adjustments shall be made in accordance with Section 109.5, "Payment for Changes, Differing Site Conditions and Extra Work,"

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 the 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"), the Contractor shall obtain the necessary study permits, and employ an Environmental Specialist and a Cultural Resource Professional to conduct environmental and Cultural Resource 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;
7. Surfacing Pits; and,
8. Water sources.

The Contractor shall obtain the environmental and Cultural Resource approvals regardless of land ownership. For the environmental approval, the Contractor shall use the Department-furnished checklist Categorical Exclusion form (or equivalent form furnished by the Department), which shall 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. The Contractor shall 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. The Contractor shall 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), or any other successor statutes.

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

The Contractor shall complete 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 45 Days or more after the Contractor delivers the resource studies to the Department. Adjustments shall only be made in accordance with Section 109.5, "Payment for Changes, Differing Site Conditions and Extra Work," when the time needed to obtain approvals exceeds Federal or State law or regulatory requirements containing time limits.

The Contractor shall 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.

The Contractor shall repair at the Contractor's expense all damage to environmental or Cultural Resources caused by the Contractor's failure to meet the requirements for environmental acceptability or abide by Department directives issued to protect resources identified during the environmental and Cultural Resource 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.

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 (1) 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.

The Contractor shall 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. The Contractor shall 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. The Contractor shall 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 USC § 1251 et seq.).

The Contractor shall 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 USC § 1251 et seq.), the regulations and requirements of other authorities with jurisdiction.

107.14.4 Minimization of Soil Disturbance

The Contractor shall minimize damage to or removal of vegetation and trees, except as approved in Section 104.6, "Rights in and Use of Materials Found on the Work." The Contractor shall not clear, grub, disturb, or excavate land beyond what is authorized by the Contract. The Contractor shall 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

The Contractor shall perform dust abatement on the Project. The Contractor shall 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 USC § 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 6; 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).

The Contractor shall dispose of removed asphalt pavement Material, not including minor sweepings, belonging to the Department using one (1) 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. The Contractor shall break down asphalt surfacing removed from the Project to a nominal two (2) inch size, or smaller, haul and stockpile the Material at a location approved by the Project Manager or as indicated in the Contract.

If the Material is to be permanently placed within the Shoulder or Median, it shall be treated by using one (1) of the following methods:

- a. Machine-compacted; or
- b. Sealed with an approved rejuvenating agent.

107.14.8 Disposal of Other Materials and Debris

The Contractor shall 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. The Contractor shall not place any items in wetland areas or areas that may impact endangered species or Cultural Resources. The Contractor shall 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

The Contractor shall comply with applicable New Mexico and federal regulations governing the discovery and removal of underground storage tanks (UST). The Contractor shall 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 NMED Petroleum Storage Tank Bureau (PSTB). The Contractor shall remove USTs in accordance with NMED PSTB regulations. Any adjustments shall be made in accordance with Section 109.5, "Payment for Changes, Differing Site Conditions and Extra Work,"

107.14.10 Hazardous Waste Material, and Reporting and Cleanup of Spills

The Contractor shall immediately report all spills regardless of cause or association with the Work to the Project Manager if on the Right of Way, or to the property owner if outside of the Right of Way. The Contractor shall clean up and bear all costs of spills associated with the Work including gasoline, diesel fuel, motor oils, solvents, chemicals, toxic and corrosive substances, and other Materials that may threaten public health or the environment. Failure to report a pre-existing spill or spill not associated with the Work shall result in the Contractor bearing the full cost of remediation and cleanup.

107.14.11 Prime Coat, Tack Coat, and Soil Sterilants

The Contractor shall not contaminate soils outside the Roadway Prism when applying prime coat, tack coat and soil sterilants. The Contractor shall not contaminate arroyos, irrigation supplies (acequias and ditches), 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, the Contractor shall 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. The Contractor shall 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

The Contractor shall prevent forest and grass fires. The Contractor shall notify appropriate officials at the earliest possible moment of the location and extent of any fire. The Contractor shall comply with fire regulations applicable to the area of Work, and furnish and maintain firefighting Equipment and tools required in the Contract. The Contractor shall suspend fire-hazardous operations when necessary at the direction of the Project Manager and in accordance with Section 105.17, "Contract Adjustments for Suspension of Work."

107.17 USE OF EXPLOSIVES

The Contractor shall exercise extreme care when use of explosives is necessary for the prosecution of the Work. The Contractor shall not endanger life or property, including new Work. The Contractor shall 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 30 CFR Part 15.32 whichever is more restrictive. The Contractor shall clearly mark explosives and store them securely. If no local laws or ordinances apply, the Contractor shall store explosives not closer than 600 feet from Roads, buildings, camping areas, or places of human occupancy. The Contractor shall 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 PUBLIC AND PRIVATE PROPERTY

The Contractor shall preserve public and private property including 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.

The Contractor shall restore public or private property damaged by the Contractor 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 and 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.

The Contractor shall 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 THIRD PARTY CLAIMS AND DUTY TO DEFEND

The Contractor shall indemnify and hold harmless the Department and its officers, employees and agents from and against any and all Claims and suits, liability, damages, losses or expenses, including attorney fees and costs, to the extent that they arise out of or are in any way connected with any act or omission of the Contractor, or its officers, employees or agents. The Contractor agrees, at its own expense, and upon written request by the Department, to defend any suit, action or demand brought against the Department on any Claim or demand covered herein.

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 the Contractor's expense. During such period of suspension of Work, the Contractor shall properly and continuously maintain in a 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 109, "Measurement and Payment."

107.21 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES

The Contractor shall not begin Work in areas proximate to railroad, telecommunication, or utility company Right of Way or facilities, or other property where damage from the Work might result in expense, loss, or inconvenience to the owner, until arrangements are made with the Project Manager and the owner of the property for the protection of such property or facilities.

The Contractor shall 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.

Where utility conflicts are present, the Contractor shall provide the Project Manager, on a weekly basis, evidence of adequate coordination and cooperation with utilities. Neither time or compensation will be provided where the Contractor fails to provide the Project Manager, on a weekly basis, evidence of continued cooperation and coordination activities with utilities.

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

The Contractor shall contact the owner of the railroad Right of Way and 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 with 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. The 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, including any Subcontractor or Materials Supplier, 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

The Contractor shall 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. Contractor shall 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. All insurance required in this Section shall be procured from insurance or indemnity companies with an A.M. Best Company financial strength rating level of A- or better, Class VII or better, unless otherwise approved in writing by the Department. In no event shall the Department approve the use of an insurance or indemnity company with an A.M. Best Company financial strength rating level of B or worse.

107.25.1 Liability Insurance

1. The Contractor shall obtain General Liability (Bodily Injury Liability and Property Damage Liability) insurance coverage applicable in full to the subject Project in the following minimum amounts:
 - a. Personal and Bodily Injury Liability: \$1,000,000.00 each person; \$2,000,000.00 each occurrence (annual aggregate); and,
 - b. Property Damage Liability: \$2,000,000.00 each occurrence; (annual aggregate);
2. The insurance coverage shall be documented on a Comprehensive General Liability form or Commercial General Liability form, which must include the following:
 - a. Coverage for liability arising out of the operation of independent Contractors;
 - b. Completed Operations Coverage; and,
 - c. 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:
 - a. Excavation, including borrowing, filling, or backfilling in connection therewith;
 - b. Tunneling and cofferdam or caisson Work; and,
 - c. Moving, shoring, underpinning, razing, or demolition of buildings or Structures, or removal or rebuilding of structural supports thereof; and,
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. Personal and Bodily Injury Liability: \$1,000,000.00 each person; \$2,000,000.00 each occurrence; (annual aggregate); and,
2. Property Damage Liability: \$2,000,000.00 each occurrence; (annual aggregate).

107.25.3 Worker's Compensation Insurance

The Contractor shall 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 Disabling Law (NMSA 1978, § 52-3-1 et seq.).

107.25.4 Department as Additional Insured

The Contractor shall name the Department and any third party so designated in the Contract as an additional named insured on the comprehensive general liability form or commercial general liability form furnished by the Contractor in accordance with Section 107.25.1, "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. The Contractor shall 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

The Contractor shall 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. The Contractor shall 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 shall 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 excess coverage (Umbrella) as meeting the insurance requirements of Section 107.25.1, "Liability Insurance," if the limits of the Umbrella coverage meet the individual requirements of this Section.

107.25.7 Optimal Insurance

If required by the Contract, Contractor shall 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. If so required, the Contractor shall 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.

107.25.8 Railroad Insurance

If the Work affects railroad property, in addition to the above requirements, unless otherwise specified in the Contract the Contractor shall obtain at its own cost 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

The Department reserves the right to correct measurements, estimates, certificates, or price adjustments made before or after Physical 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

The Contractor shall minimize hazards to the traveling public in the Construction Zone from the commencement of the Work until final Acceptance. Minimizing hazards shall include:

1. Keep Equipment, Materials, and workers out of the travel lanes;
2. Remove hazardous construction debris deposited within the Project limits;
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.

The Contractor shall immediately correct hazards reported by Project inspections, Department employees, or the public. The Contractor shall maintain and publicly post a 24-hour contact number to initiate action quickly.

The Contractor shall 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. The Contractor shall 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. The Contractor shall 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. The Contractor shall provide the status report to the Project Manager upon request.

The Contractor shall 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.

107.28 CONTRACTOR RECORDS

The Contractor, Subcontractors and all Suppliers shall keep and maintain all documents in a useable format, including communications, books, papers, records, files, accounts, tax records, cost records, reports, schedules, Bid documents with backup data, including electronic data, and all other material relating to the Contract, Project, Contract compliance, or any Claim for five (5) years following Physical Completion of the Work. Unless otherwise specified in the contract all of the above material shall be made available to the Department for review, audit, inspection and copying and shall be produced, upon request by the Assistant District Engineer – Construction, at the Department General Office, the District in which the Work was performed, or an FHWA office, as directed. The Contractor shall insert the above requirement in each subcontract and shall also include in all subcontracts a clause requiring Subcontractors to include the above requirement in any lower-tier subcontract. The Contractor's failure to maintain and timely provide all requested documents to the Department waives any Claim the basis of which could have, either in whole or in part, been documented or rebutted by such documents.

Resource Loading documents, financial statements provided by the Contractor, and Escrowed Bid Documents which have been visibly marked by the Contractor as "Confidential Trade Secrets" shall be deemed confidential as trade secrets and not subject to inspection pursuant to the Inspection of Public Records Act, NMSA 1978, § 14-2-4. Such information shall not be disclosed by the Department in response to a request made pursuant to the Inspection of Public Records Act without the written permission of the Contractor. Such documents may be disclosed to the Department, including any Inspector, Project Superintendent, Project Manager, Claim consultant, investigator, or testifying or consulting expert, as necessary to perform their duties or as otherwise required by law.

107.29 ASSIGNING OF CONTRACT

The Contractor may not assign the Contract or assign or delegate any contractual obligation or duty without the prior written consent of the Department and the Surety. Contractor may not make any assignment, in connection with the Contract, including assignment of any payment due Contractor or any Claim, for the benefit of any creditor.

107.30 SEVERABILITY AND CONTRACT INTERPRETATION

If any provision of this Contract is held to be invalid or unenforceable, the remaining provisions, or the application of such provision to either party, shall remain in full force and effect and, if possible, the rights and obligations of the parties are to be construed and enforced as if the Contract did not contain that term.

If any provision of the Contract is found to be superseded by any applicable state or federal law or regulation or court order, in whole or in part, then both parties shall be relieved of all obligations under that provision only to the extent necessary to comply with the superseding law or ruling, provided however, that the remaining provisions of the Contract, or portions thereof, shall be enforced to the fullest extent permitted by law.

The Contractor agrees that any rule of construction to the effect that ambiguities are to be resolved against the drafting party shall not be applied in the construction or interpretation of this Contract.

107.31 CHOICE OF LAW

This Contract is governed by and construed in accordance with the laws of the State of New Mexico.

SECTION 108: PROSECUTION AND PROGRESS

The Contractor is wholly and solely responsible and liable for the performance of all Work or any act by its Subcontractors, Truckers, and Suppliers on the Project.

108.1 SUBCONTRACTING

Any individual, partnership, firm, corporation, or joint venture performing Work on the Project that is not an employee of the Contractor is a Subcontractor unless otherwise excepted in this Section. A Supplier or Fabricator is not a Subcontractor unless Work is being performed on the Project.

The Contractor shall perform with its own organization at least 40% 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 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.

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 is responsible for ensuring that its Subcontractors are prequalified by the Department and are also duly licensed for the Work to be performed on the Project, are registered with all of the state agencies as is required to do business in New Mexico and to perform Work on Public Works Projects including the New Mexico Taxation and Revenue Department and the New Mexico Department of Workforce Solutions or successor agencies, and are in compliance with all applicable state and federal laws and regulations including the New Mexico Public Works Minimum Wage Act. The Contractor shall comply with the New Mexico Subcontractor Fair Practices Act to the extent it is applicable to the Project.

A Trucker is not a Subcontractor unless the Contractor is using the Trucker to meet the DBE requirement associated with the Project. A Trucker is an individual, partnership, firm, corporation, or joint venture that transports Materials to and from the Project and does not perform Work on the Project site. Transportation of Materials within the Project site (e.g. never leaves the Project limits) is Work performed by the Contractor or a Subcontractor. Transportation of Materials on or off the Project site (e.g. leaving the Project) does not require a Subcontract.

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.

The Contractor shall promptly pay its Subcontractors and Suppliers for satisfactory performance of their contracts no later than seven (7) Days after receipt of Progress Payment for the Subcontractor's Work or Supplier's Materials by the Department. For purpose of this section, a Subcontractor's portion of the Work is satisfactorily completed when it is Accepted by the Department. In no event shall the Contractor and its Subcontractors fail to promptly pay their Subcontractors and Suppliers the amounts due for undisputed Accepted Work within seven (7) Days of the Contractor receiving a Progress Payment from the Department. The payment by the Department to the Contractor is not a condition precedent for payment by the Contractor to any Subcontractor or Supplier. A zero dollar (\$0.00) Progress Payment by the Department does not relieve the Contractor from paying the Subcontractor or Supplier for Accepted Work.

The Contractor's failure to make timely or prompt Subcontractor or Supplier payments for undisputed Accepted Work is a Non-Conformance and shall result in the Department withholding 25% of the Progress Payment and may result in the Department 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 AND PRE-CONSTRUCTION CONFERENCE

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 Work and the start of Contract Time. The Contractor's commencement of the Work without a Notice to Proceed may be deemed a waiver of this notice and, in the absence of prior written permission from the Project Manager, shall start the Contract Time. In no event shall the Contractor commence Work until after execution of the Contract by all parties.

After the issuance of the Notice to Proceed, the Project Manager shall provide written notice to the Contractor of the date, time and location of the Pre-Construction Conference. The Contractor shall provide an authorized Contract representative and the Project Superintendent at the Pre-Construction Conference.

The Contractor shall provide the following at a minimum of ten (10) Days before Pre-Construction Conference:

1. Acceptable Baseline Schedule;
2. Letters of assignment (official capacity) for Project;
 - a. Project Superintendent;
 - b. Company and Project Safety Officer;
 - c. Traffic Control Supervisor (include current certifications and copy of wallet card)
3. A list with samples of authorized signatures and assignments for Supplemental Agreements (Change Orders), Progress Payments, Payrolls and related items;
4. Additions, revisions deletions to the Traffic Control Plan;
 - a. Proposed changes to the project;
 - b. Potential problems with the construction of the project;
5. List of Subcontractors and Material suppliers;
6. Lump Sum breakdowns;
7. Weighmasters / Deputy Weighmaster certifications (must be maintained throughout the duration of the Project);
8. Progress Payment cutoff date;
9. Company EEO policy statement;
10. Recruitments letters (attachments E-K of the EEO package);
11. Superintendent's indoctrination letter (attachment D of EEO package);
12. On-the-job training letter (Attachment R of the EEO package);
 - a. The trainee classification letter must include the number of trainees to be trained, the training program to be used, the classification of each trainee and the approximate start date;
13. The completed Civil Rights / EEO Pre-Construction Report. Complete and sign the portions that are applicable Department Project personnel;
14. Pre-Construction safety questionnaire; and
15. Other items and any other documents required by the Contract or as directed in the Project Manager's notice of Pre Construction.

Failure by the Contractor to provide the above listed items a minimum of ten (10) Days before the Pre-Construction Conference may result in the Contractor being in default of Contract pursuant to Section 108.9 "Default of Contract." Contract Time shall commence as indicated in the Notice to Proceed and no additional Contract Time will be granted. The

Contractor shall not commence Work until the required items are provided to the Project Manager and Accepted.

108.3 SCHEDULE

108.3.1 Baseline Schedule

The Project shall utilize a CPM format as the Baseline Schedule unless otherwise specified in the Contract.

The Project Manager will notify the Contractor in writing within ten (10) Days of the submittal of a Baseline Schedule if the schedule is "Accepted," "Accepted as noted", or is "rejected." Unless otherwise specified in the Contract, the Contractor is wholly and solely responsible for construction means, methods or techniques, therefore the Project Manager's review of the Baseline Schedule will be for compliance with the Specifications and Contract requirements. Acceptance by the Project Manager shall not relieve the Contractor of any of its responsibilities for the accuracy or feasibility of the schedule. Any Baseline Schedule which alters Contract Time shall be deemed "rejected." In no event, may approval of a Baseline Schedule revise the Contract Documents, including Contract Time, unless accompanied by a related Change Order. The Contractor shall not commence Work until the Project Manager Accepts a Baseline Schedule.

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. The Contractor shall be responsible for assuring all Work, including all Subcontractor Work, is included in the Baseline Schedule. The Contractor shall be responsible for assuring that all Work sequences are logical and that the Baseline Schedule indicates a coordinated plan. Failure by the Contractor to include any element of Work required for performance of the Contract shall not excuse the Contractor from completing all Work within the required time.

For Baseline Schedules that are "rejected", the Project Manager shall communicate, in writing, to the Contractor all portions of the schedule that are not in compliance with the Contract requirements. The Contractor shall, within seven (7) Days of receipt of the reasons for rejection of the schedule, provide a new Baseline Schedule and all additional information necessary for the Project Manager to "Accept" the Baseline Schedule. The Project Manager will notify the Contractor in writing within seven (7) Days of the submittal of the corrected Baseline Schedule if the schedule is "Accepted," "Accepted as noted", or is "rejected." The Contractor's failure to provide a timely and Acceptable new Baseline Schedule in response to a rejected schedule waives any Claim the basis of which would have been documented by an Acceptable Baseline Schedule.

108.3.1.1 CPM Baseline Schedule

Unless otherwise specified in the Contract the Contractor shall provide a CPM Baseline Schedule which clearly describes the following:

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 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;
5. The milestones or other key dates specified in the Contract; and,
6. Logic diagrams.

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:

1. Activity description;
2. Early start date (each activity);

3. Late start date (each activity);
4. Original duration, in workdays (each activity);
5. Total float and free float (each activity);
6. Sequence and interdependence of activities;
7. Workdays each week;
8. Contractor designated holidays;
9. Number of shifts per Day;
10. Number of hours per shift;
11. Scheduled Completion Date;
12. Anticipated weather events based on historical data; and
13. Resource Loading.

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 cut-off date. Float contained in the CPM Baseline Schedule is not for the exclusive use or benefit of either the Department or the Contractor.

108.3.2 Schedule Format

108.3.2.1 CPM Schedule Format

The Project shall utilize a CPM format as the Baseline Schedule unless otherwise specified in the Contract.

The Contractor shall prepare and submit one (1) electronic copy and two (2) time-scaled color prints of the CPM Baseline Schedule, updated monthly schedule, and revised schedules using a Project scheduling software as directed by the Department 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.

108.3.2.2 Bar Graph Baseline Schedule

If required by the Contract the Contractor shall submit the Baseline Schedule in bar graph form. 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;
7. A plot of the monthly projected percent complete (in dollars) superimposed on the bar chart; and,
8. Any approved Project suspensions and time extensions.

108.3.3 Monthly and Revised Schedules

For this Section "schedule" refers to CPM or Bar Graph as required by the Contract. Each activity in a monthly or revised schedule shall contain the same information required for the Baseline Schedule. The Contractor shall include in the schedule a report of projected percent complete, measured in dollars and time. An Acceptable schedule shall conform to Section 108.3.1 "Baseline Schedule." In no event may Acceptance of a schedule revise the Contract Documents, including Contract Time, unless accompanied by a related Change Order. Any monthly or revised schedule which alters Contract Time shall be deemed "rejected."

If the Contractor fails to timely submit an updated or revised and Acceptable schedule, the Department shall withhold 25% of the Progress Payment as a Non-Conformance. The Department may suspend the Work pursuant to Section 105.1.2 "Department Authority to Suspend Work" for failure to submit the monthly schedule update or revision. Repeated failure to provide timely and Acceptable monthly or revised schedules may result in the Department rejecting the Contractor's future Bids in accordance with Section 102.5, "Refusal or Rejection of Bids." The Contractor's repeated failure to provide timely and Acceptable monthly or revised schedules may lead to Suspension or Debarment in accordance with Section 102.3, "Suspension and Debarment." Failure to timely provide a monthly or revised schedule waives any Claim the basis of which would have been documented by an Acceptable monthly or revised schedule.

Float contained in the updated or revised Schedule is not for the exclusive use or benefit of either the Department or the Contractor, except as follows: float generated on critical path activities due to the acceleration of the Contractor's performance, at the written direction of the Project Manager, shall be for the exclusive use of the Department; and, float generated on critical path activities due to the reduction or elimination of items including any time associated with VECP shall be for the exclusive use of the Department.

The Department may 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.

108.3.3.1 Monthly Schedule Update

The Contractor shall submit an updated schedule monthly a minimum of five (5) Days before the Progress Payment date. Failure by the Contractor is a Non-Conformance and 25% of the Progress Payment shall be withheld.

108.3.3.2 Contractor's Independent Duty to Provide Schedule Revisions

The Contractor shall provide a revised schedule and recovery plan to the Project Manager within five (5) Days of when it becomes apparent, or should have become apparent, to the Contractor that the Contractor cannot complete the Work within the Contract Time, when a noncritical item has become critical, or cannot meet the schedule due to the following: Section 104.2 "Significant Changes in Character of Work", Section 104.3 "Differing Site Conditions", Section 104.4 "Extra Work", Section 107.12 "Environmental, Hazardous Materials and Cultural Resource Discoveries", or any other cause which may give rise to a Claim.

If the Contractor's Work falls behind schedule the Contractor shall take such steps as may be necessary to mitigate damages and improve its progress including development of a recovery plan. For an Excusable Delay, Noncompensable Delay, Concurrent Delay, Nonexcusable Delay, or Inexcusable Delay, as those terms are identified in Section 109.11, "Compensation for Claims," the Contractor shall consider as a minimum the following potential schedule mitigation techniques: increase the number of shifts, begin overtime operations, work extra days including weekends and holidays, or supplement its construction plant and submit, as provided in this Section, a revised schedule with a proposed recovery plan, as may be deemed necessary to demonstrate the manner in which the agreed rate of progress shall be regained, all at no cost to the Department. If the Delay cannot be mitigated, the Contractor shall promptly submit either a written request for an extension of the Contract Time pursuant

to Section 105.19, "Notice of Potential Claim," and Section 105.20, "Administrative Remedy," or request approval of a late completion schedule and shall be liable for liquidated damages.

The revised schedule shall show Contract Time, Project completion date and all additional information necessary for the Project Manager to "Accept" the revised schedule. The Contractor's failure to provide a timely and Acceptable revised schedule waives any Claim the basis of which would have been documented by an Acceptable revised schedule.. The Project Manager will provide the Contractor with a decision in writing within ten (10) Days of receiving the revised schedule. The revised schedule shall become the current Accepted Baseline Schedule.

108.3.3.3 Schedule Revisions at Request of Department:

If it becomes apparent to the Department that the Contractor cannot meet the schedule, or that a noncritical item has become critical, the Project Manager may request a schedule revision and recovery plan from the Contractor. The Contractor shall, within five (5) Days of receipt of the request provide a revised schedule showing Contract Time, Project completion date and all additional information necessary for the Project Manager to "Accept" the revised schedule. The Contractor's failure to provide a timely and Acceptable response waives any Claim the basis of which would have been documented by an Acceptable revised schedule. The Project Manager will provide the Contractor with a decision in writing within ten (10) Days of receiving the revised schedule. The revised schedule shall become the current Accepted Baseline Schedule.

108.3.3.4 Schedule Update and Revision Information

The Contractor's updated monthly and revised schedules shall conform to the requirements of Section 108.3.1 "Baseline Schedule" and shall show:

1. Actual start and finish dates of each activity;
2. Remaining duration of activities started but not yet completed;
3. Delays and changes resulting from the addition, deletion or revisions to activities due to the issuance of a Change Order, change to an activity duration, changes to relationship between activities or changes to the planned sequence of work or the method and manner of its performance; and
4. Narrative report describing;
 - a. Processes during the month;
 - b. Shifts in the critical activities from the previous update;
 - c. Sources of delay;
 - d. Potential problem areas;
 - e. Work planned for the next update period; and
 - f. Changes made to the schedule.

108.4 UNSATISFACTORY PROGRESS OF WORK

The progress of the Work is deemed unsatisfactory when:

1. 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;
2. When the start of an activity on the critical path, as shown on the current Accepted progress schedule, has exceeded its late start date by seven (7) Days;
3. When an activity on the critical path, as shown on the current Accepted progress schedule, has exceeded its original duration by ten (10) or more Days; or,
4. When the Project Manager determines that the progress of work is unsatisfactory.

The Project Manager shall issue a notice of unsatisfactory performance to the Contractor by certified mail and identify the unsatisfactory performance.

When the progress of the Work is deemed unsatisfactory the Project Manager and the Contractor shall meet to address the schedule within five (5) Days. The Contractor shall provide a revised schedule with a narrative addressing Project progress compliance or anticipated liquidated damages. The Department's approval of a late completion schedule will not operate as a waiver of the Department's right to assess liquidated damages. If a resolution cannot be determined within five (5) Days, the Project Manager will issue a notice to the Contractor and Surety of unsatisfactory performance.

The Contractor shall bring progress into compliance in a time frame determined by the Project Manager, not to exceed 30 Days and at no additional cost to the Department. Failure to return the Project into compliance may result in any or all of the following:

1. Suspend or debar the Contractor in accordance with Section 102.3, "Suspension and Debarment";
2. Withhold Progress Payments in the amount of the projected liquidated damages and withhold 25% of Progress Payments pursuant to Section 109.8, "Progress Payments";
3. The Contractor being declared in default pursuant to Section 108.9, "Default of Contract";
4. Rejection of the Contractor's bids; and,
5. Other administrative actions that the Project Manager deems appropriate and in the best interest of the public and the Department.

108.5 CHARACTER OF WORKERS, METHODS, AND EQUIPMENT

108.5.1 Character of Workers

The Contractor shall provide the resources necessary to complete the Work as specified. The Contractor shall ensure workers have the experience and skills to perform assigned Work.

The Contractor shall remove employee(s) who performs the Work in an unskilled manner or who is intemperate or disorderly. The Contractor shall 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

The Contractor shall use Equipment of the size and mechanical condition to produce the Work. The Contractor shall ensure that the Equipment does not damage the Roadway, adjacent property or other Highways, Streets, or Roads.

The Contractor shall 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. The Contractor shall perform Work under original Basis of Payment and Contract Time. The Contractor shall discontinue use of alternate methods or Equipment when Work does not meet Contract requirements. The Contractor shall 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 contains a Mandatory Completion Date, the Project must be Substantially Complete by that date.

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 seven (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 is deemed accepted by the Contractor.

The Contractor is not entitled to a Partial Suspension during periods of traffic control operations or when working on any critical path activities. Partial suspension shall be lifted if the Contractor works on critical path activities and the Project Manager shall commence the Day count.

Quantity overruns in Contract Items that do not significantly change the character of the Work in accordance with Section 104.2 "Significant Changes in the Character of the Work", shall not result in an extension of Contract Time. If completion of the Contract requires Extra Work that impacts the critical path, the Contractor shall provide the Department an updated progress schedule and narrative requesting additional Contract Time associated with the Extra Work. Upon adequate justification by the Contractor the Department will determine if any adjustment in Contract Time is warranted.

Any request for additional Contract Time shall be made pursuant Section 105.19 "Notice of Potential Claim."

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 109.10 "Project Closure", 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 109.10.3 "Termination of Contract Time".

108.7 FAILURE TO COMPLETE ON TIME

Liquidated damages shall be assessed for each Day the Work remains incomplete after Contract Time has expired, including approved time extensions.

The Department may suspend time charges on the Contract when the Project is Substantially Complete.

For Work that remains incomplete after the Contract Time expires, the Department shall 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 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 and the Department if the Contractor does not complete the Project within the Contract Time and does not operate as a penalty to the Contractor:

Schedule of Liquidated Damages	
Total Original Contract Amount (\$)	Charge (\$) per Day
≤100,000	500

>100,000–500,00	1,000
>500,000–1,000,000	1,500
>1,000,000–2,000,000	2,000
>2,000,000–4,000,000	2,500
>4,000,000–7,000,000	3,000
>7,000,000–10,000,000	4,000
>10,000,000	5,000

The Department shall withhold payment under the Contract and may seek performance from the Contractor's Surety to cover the liquidated damages. The Department shall continue to assess liquidated damages until Physical Completion in accordance with Section 109.10 "Project Closure." When the Project Manager issues the notice of completion and final Acceptance, further assessment of liquidated damages will stop.

If the amount of Liquidated Damages meets or exceeds the remaining dollar amount of Work remaining on the Contract the Department shall cease Progress Payments. The Contractor remains contractually obligated to complete the Work remaining on the Project. The Contractor shall reimburse the Department for any Liquidated Damages exceeding the dollar amount withheld from the Contractor within 30 Days of Physical Completion.

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. Fails to begin the Work within the time specified in the Notice to Proceed;
4. Discontinues the Work;
5. Fails to resume discontinued Work after the Department issues a request to resume Work;
6. Becomes insolvent or is declared bankrupt, or files for reorganization under the bankruptcy code, or commits any act of bankruptcy or insolvency, either voluntarily or involuntarily;
7. Allows a final judgment, in a suit filed in connection with this Contract, to stand unsatisfied for 30 Days;
8. Makes an assignment, in connection with the Contract, for the benefit of its creditors;
9. Fails to carry on the Work in an Acceptable manner in accordance with the Contract;
10. Fails to comply with Contract requirements or willfully violates any term or condition of the Contract;
11. Fails to perform the Work or maintain the Project in compliance with Federal and New Mexico Occupational Health and Safety laws and regulations;
12. Fails to observe or comply with Federal and New Mexico laws and regulations, local laws and ordinances,
13. Is debarred or suspended in accordance with the Section 102.3, "Suspension and Debarment", or is suspended or debarred by any federal agency;
14. Communicates that the Contractor may not perform under the Contract; or,
15. Fails to promptly pay a Subcontractor or Supplier for undisputed Accepted Work in accordance with Section 108.1., "Subcontracting".

The Project Manager will provide written notice to the Contractor and the Contractor's Surety of Contractor's delay, neglect, apparent default, or anticipatory repudiation. This notice

will specify the Contract provisions that the Contractor violated and the corrective measures to be taken by the Contractor. When reasonable grounds for insecurity arise with respect to the performance of the Contract by the Contractor, the Project Manager may, in writing, demand adequate assurance of due performance and until such assurance is received may suspend any Department performance. If the Contractor or Surety does not proceed with the corrective measures within ten (10) Days, or when demanded fails to provide adequate assurance of due performance, 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 determines that the Contractor is in default the Surety shall complete the Work at its own expense pursuant to the Contract and receive 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 as a result of the default and the cost of completing the Work from Contract funds due to or which may become due to the defaulting Contractor or Surety. 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 CONTRACTOR

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 Contractor; or
2. That termination would be in the public interest.

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

1. Executive orders of the President of the United States relating to war or national defense;
2. A national emergency that creates a serious shortage of Materials, as deemed by the Secretary;
3. Orders from duly constituted authorities relating to energy conservation;
4. 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; or,
5. To correct any material errors or omissions in the Plans or to correct any discrepancy or contradictions within the Contract discovered after execution of the Contract by both parties and which could not have been discovered through the exercise of Pre-Bid Due Diligence, the failure of which to correct is likely to lead to Contractor Delay, a Claim for additional time, or a Claim for compensation which may exceed the costs recoverable under this Section.

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 "Notice of Potential Claim," and Section 105.20 "Administrative Remedy." The Claim shall be limited to the following cost items:

1. Idle Equipment time using standby-time rental rates at 50% of the Blue Book Equipment rental rate, without the cost of operating personnel;
2. Actual and direct Mobilization costs;
3. Bidding and Project investigative costs;
4. Accounting charges involved in Claim preparation;
5. Unpaid Supplier costs;
6. Idle labor costs if Work is stopped in advance of termination date;
7. Guaranteed payments for private land usage as part of original Contract; and
8. An additional ten percent (10%) of the total of the above items 1, 2, 5, and 6 to cover home office overhead and salaried labor expenses.

The Contractor shall provide those records required by Section 105.20.1, "District Level," to the Department to determine the validity and amount of each Claim item. The Contractor shall not be entitled to recover anticipated loss of profits or any category of damages excluded pursuant to Section 109.11, "Compensation for Claim."

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 feet, 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 one (1) square yard;
 - a. 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;
 - b. Structures are measured according to the neat lines shown on the Plans or as provided by the Department;
 - c. 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. Timber and lumber (permanently incorporated in the Project) 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;
6. 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.
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. Materials that are measured by weight shall be measured and proportioned by weight using certified and accurate scales that are within tolerances established by state law;
 - a. The Contractor shall provide scales or use commercial scales;
 - b. Scales shall be sealed at least once every 12 months or each time the scales are relocated, or as directed by the Project Manager;
 - c. 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;

- d. Empty vehicles used to haul Material paid by weight shall be weighed at least twice daily, at a minimum once prior to initial Material delivery and once prior to final Material delivery. The Contractor shall ensure vehicles bear legible identification marks. On a daily basis the Contractor shall provide the Project Manager with a written list of delivery vehicles showing identification marks, number of axles, the distance between extreme axles and daily tare weights. The Contractor shall update this information before delivery of the Material and when the Contractor changes vehicles, combination vehicles, or axle length relationships;
- e. 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;
- f. 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:
 - i. Project number;
 - ii. Date;
 - iii. Ticket number;
 - iv. Truck / Trailer unit number;
 - v. Gross weight;
 - vi. Tare weight;
 - vii. Net weight;
 - viii. Material type;
 - ix. Certified weighmaster's name;
 - x. Signature of weighmaster; and
 - xi. Whether the driver was on or off the scale during weighing.

109.2 APPROVED EQUIPMENT RENTAL RATES

Equipment rental rates shall be paid as shown in the Blue Book in effect at Advertisement date.

The rates in the Rental Rate Blue Book reflect current ownership, overhead 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 Blue Book rates shall be used for the actual time the Equipment is in operation. The Department will add 15% only to the Equipment rental rates. The Department will apply Equipment rental rates pursuant to the Blue Book and 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 the use of the Blue Book rental rate for a comparable piece of Equipment shall be used as approved by the Project Manager. If no comparable piece of Equipment is identified in the Blue Book the Project Manager may negotiate a rental rate with the Contractor at a fair market rental rate;
3. 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;
4. The Contractor shall only be paid the operating rate for those hours the Equipment is actually in use. A standby rate for Equipment required to be at the Work site but not operating may be paid by the Department if agreed to in writing in advance by the Project Manager in which case the Department will pay for standby Equipment using standby-time rental rates at 50% of the Blue Book Equipment rental rate, without the cost of operating personnel.
5. 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;
6. 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 rate provided in the Blue Book.

109.3 SCOPE OF PAYMENT

The Contractor shall receive and accept compensation in accordance with the Bid for performing the Work in an Acceptable manner. The compensation associated with the Bid shall include the risks, losses, damages and expenses that, when considering the nature of the Work and having exercised Pre-Bid Due Diligence, should have been reasonably expected by the Contractor in prosecuting the Work.

The Department will pay for the approved actual quantities of Material incorporated into the Work unless otherwise provided in Method of Measurement.

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."

The Contractor shall not receive payment for corrective Work. 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 OVERRUN / UNDERRUN 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 Price for the Accepted quantity.

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 the following order of priority for payment:

1. Bid Item Unit Prices;
2. Negotiated unit prices;
3. Negotiated Lump sum; or
4. Force Account.

For Items of Work performed by the Contractor, the negotiated unit price or negotiated Lump sum price shall include all costs associated with the Work. If Subcontractors perform Work as Extra Work, the Department shall only compensate the Contractor an additional ten percent (10%) of the total actual cost of the subcontracted Work for indirect and administrative costs.

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 shall only compensate the Contractor an additional ten percent (10%) of the total cost of the subcontracted Work for indirect and administrative costs.

If the Contractor submits a timely notice of potential Claim in accordance with Section 105.19, “Notice of Potential Claim,” the Project Manager may, without admitting liability for the Claim, direct the Contractor to keep a complete and accurate account, in detail, of the cost of doing the Work on a Force Account basis. Failure to maintain records on a Force Account basis when so directed by the Project Manager shall waive any associated Claim by the Contractor.

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 either:

Option 1

The actual cost of the following, plus six percent (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.

Option 2

In lieu of supplying the above evidence and recovering actual costs:

1. The Contractor shall receive payment at a rate representing 30% of the labor costs for labor burden; and
2. The Contractor shall also receive payment for one percent (1%) of the total Force Account amount for the Contract Bonds.

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 as defined by the Blue Book), 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 other costs not specifically addressed in Section 109.6 "Force Account."

109.6.6 Documentation

The Contractor shall compare and reconcile records with the Project Manager daily, or as otherwise directed by the Project Manager, 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 furnishes 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. Equipment brand, year of manufacture, attachments, operating Specifications, dates of use, daily hours, total hours, current Blue Book rental rate, and rate of applicable attachment for each piece of Equipment;
3. Quantities of Materials and prices; and,
4. Transportation of Materials.

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 before the written notification at Bid Item Unit Price.

The total cost of return freight, handling and restocking for Materials associated with that eliminated Work will then be increased by 15%. If Materials cannot be returned, the Department will pay for said Materials at Contractor's actual cost and take ownership.

109.8 PROGRESS PAYMENTS

The Department will make Progress Payments at least once each month as the Work progresses. The Project Manager will prepare and post Progress Payments based on estimates of the value of the Work performed and Materials complete-in-place, and in accordance with Section 109.9, "Stockpile" and minus price reductions within five (5) Days of the estimate cut-off date.

The Department will include in the Progress Payments monies associated with accepted fully executed Change Orders, this shall be included within the next regularly scheduled Progress Payment or within 60 Days.

The Project Manager shall process a Progress Payment on a monthly basis regardless of the dollar amount, including zero dollar (\$0.00), owed the Contractor. The Department will not make a payment when the total value of the Work completed since the last Progress Payment is less than \$1,000.00 unless the Contractor requests such payment in writing and the Project Manager approves such payment.

109.8.1 Retainage

The Department will make Progress Payments to the Contractor in accordance with Section 109.8 "Progress Payments". The Department will pay 100% of the value of Work performed and Materials complete in place in accordance with Section 109.9, "Stockpile", until the sum of the Progress Payments made equals 95% of the Total Original Contract Amount as amended by Change Order. The Department will continue to make additional Progress Payments in the sum of zero dollars (\$0.00) after the Total Original Contract Amount as amended by Change Order equals 95% and until the Contractor completes the Work in an acceptable manner. The five percent (5%) retained when the Progress Payments equals 95% of the Total Original Contract Amount as amended by Change Order is the amount considered necessary to protect the interests of the public and the Department; those interests include ensuring that the Work is Acceptable, on schedule, in compliance with the Contract, and that the Work reaches Substantial Completion and final Acceptance. Subject to other deductions the amount retained shall be provided to the Contractor in accordance with Section 109.10 "Project Closure."

109.8.2 Non-Conformance

If the Contractor fails to comply with all material terms and conditions of the Contract the Department shall withhold an additional 25% as a Non-Conformance from each Progress Payment and subsequent Progress Payments in addition to Retainage until the Contractor fully complies with the Contract. Release of Non-Conformance withholdings shall be processed at the next scheduled Progress Payment after the resolution of the Non-Conformance.

Nothing in this section prevents the Department from withholding application and certification for payment because of the following: unsatisfactory job progress, defective construction not remedied, disputed Work, third party Claims filed or reasonable evidence that a Claim will be filed, failure of the Contractor to make timely or prompt payments for labor, Equipment, and Materials, damage to the Department, reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract, or for Retainage.

The Contractor is not entitled to late payment charges, including late payment charges pursuant to NMSA 1978, § 13-1-158, associated with any payment retained under this Section.

109.9 STOCKPILE

Unless otherwise specified in the Contract, it is the policy of the Department and the intent of this Contract to provide payment for Work for Items that have been Accepted and placed on the Project. However, upon adequate written justification provided from the Contractor seeking an exemption to this policy, the Project Manager may approve partial (stockpile) payment for the following Items not yet incorporated and Accepted into the Work and stored in a manner Accepted by the Project Manager.

1. Bid Items Pre-fabricated by a Supplier.

Unless otherwise specified in the Contract, the Project Manager shall not approve partial (stockpile) payment for the following Items or Materials not yet incorporated and Accepted into the Work.

1. Items Pre-fabricated by the Contractor or Subcontractor unless otherwise specified in the Contract;
2. Items or Materials associated with the typical section e.g. Aggregates, Cement, Asphalt Binder, Lime etc.;
3. Items associated with SWPPP;
4. Items associated with Signs; and,
5. Any Item or Material stored off the Project.

109.9.1 Stockpile Payment

After measurement, partial (stockpile) payments to the Contractor may be made for Items on hand not to exceed 50% of the Bid Item price under the following conditions:

1. The Items will be incorporated in the Work;
2. The Items are delivered to the Project or to a storage place approved by the Project Manager;
3. The delivered Items meet the requirements of the Contract;
4. The Items are purchased from a Supplier or Fabricator and are not produced by the Contractor or a Subcontractor unless otherwise specified in the Contract;
5. The Contractor submits paid invoices, certified by the Supplier or Fabricator, to the Project Manager; and
6. Unless otherwise specified in the Contract partial (stockpile) payments for Items on hand shall not exceed 50% the Bid Item price.

109.10 PROJECT CLOSURE

- | | |
|------------|---|
| Step I. | Contractor Notice of Projected Substantial Completion Date |
| Step II. | Department Determination of Substantial Completion |
| Step III. | Termination of Contract Time |
| Step IV. | Project Inspection and Development of Punch List |
| Step V. | Notice of Punch List Completion and Request of Final Inspection |
| Step VI. | Final Inspection |
| Step VII. | Contractor Submittal of Final Documentation |
| Step VIII. | Physical Completion and Release of Retainage and Final Payment |

109.10.1 Contractor Notice of Projected Substantial Completion Date

The Contractor shall provide written notification to the ADE-Construction of the projected Substantial Completion date. This notice shall be provided a minimum of 30 Days prior to the projected date unless otherwise directed by the Project Manager.

109.10.2 Department Determination of Substantial Completion

Prior to the projected Substantial Completion date, the ADE-Construction and the Project Manager shall conduct a completion conference with the Contractor to review the Project and determine conformance with the Contract. The Department and Contractor will address all outstanding Work needed for Substantial Completion. The Department and Contractor will agree on the schedule for completion of all Work necessary for project closure pursuant to Section 109.10 "Project Closure".

Within five (5) Days of the completion conference or as directed by the Project Manager the Contractor shall submit for approval by the Project Manager the Contractor's proposed updated schedule for project closure.

109.10.3 Termination of Contract Time

The Contractor shall provide to the ADE-Construction a written request to determine Substantial Completion. Within two (2) Days of receipt of the request for Substantial Completion the ADE-Construction will issue a determination of Substantial Completion, Contract Time or, if applicable, Liquidated Damages assessments will cease upon Substantial Completion.

109.10.4 Project Inspection and Development of Punch List

The Project Manager shall inspect the Project to verify that all Work is complete or develop Punch List items upon the determination of Substantial Completion. The Project Manager shall provide the Contractor written notice that all Work is complete or shall provide a Punch List. Contract Time shall resume if the Contractor fails to provide Acceptable Work associated with the Punch List within the agreed upon schedule or does not complete all items of Work by the date specified in the updated schedule. Resumed Contract Time shall continue until all Punch List Work is Accepted.

109.10.5 Notice of Punch List Completion and Request of Final Inspection

The Contractor shall provide written notification to the Project Manager that the Punch List is complete and request final inspection.

109.10.6 Final Inspection

The final inspection by the Project Manager and the ADE - Construction will be scheduled and conducted within five (5) Days of the Contractor written request for final inspection. If the Project Manager and the ADE - Construction are satisfied that the Work is complete and Acceptable, that inspection shall constitute the final inspection. The Project Manager shall provide written notification of this Acceptance to the Contractor within two (2) Days.

If the inspection reveals unacceptable or unsatisfactory Work, the Project Manager shall 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, written notification shall be provided to the Project Manager, the Project Manager shall make an additional inspection and notify the Contractor of the findings as soon as reasonably practicable.

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.

109.10.7 Contractor Submittal of Final Documentation

The Contractor shall submit all documents required by the Contract including the Final Payment Voucher, Certificate of Payment of Claims, Summary to Contractor, Pit Release Letter, Insurance Bonding Release, Affidavit of Wages Paid and Surety Release.

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.

The Department shall withhold final payment until the Contractor furnishes all documents required by the Contract.

109.10.8 Physical Completion and Release of Retainage and Final Payment

The Department shall not release retained amounts until Physical Completion and when the Contractor fully complies with all Contract requirements. Upon Acceptance of Punch List, all Work and receipt of all final documentation the ADE-Construction shall provide a written determination of Physical Completion to the Contractor. Within 60 Days of the written determination of the District Engineer or the designee (ADE-Construction) that the Project has reached Physical Completion, the Department may reduce Retainage if final payment has not been made.

The Project Manager shall prepare a proposed final payment statement (estimate). The proposed final payment statement (estimate) shall correct all prior Progress Payments and release Retainage. The Department shall withhold from the proposed final payment statement (estimate) any disputed amounts, Liquidated Damages and overpayments. Regardless of a disputed or pending Claim, the Contractor will have the right to sign an alternate final payment statement (estimate). With the Department's approval of the final payment under either the regular form or the alternate form, the Department will pay all remaining undisputed amounts due to the Contractor.

The Contractor shall approve and return the Department's final payment statement (estimate) or request an alternate final payment statement (estimate) within 30 Days of receipt. Upon receipt of final payment statement (estimate) from the Contractor or expiration of 30 Days, the Department shall Accept the Work, pay the balance due on the final payment statement (estimate) and close the Project.

A Claim is forever barred if the Claim is not timely and properly submitted pursuant to Section 105.19, "Notice of Potential Claim" and Section 105.20, "Administrative Remedy" within 30 Days of receipt of the Departments proposed final payment statement (estimate). If the Contractor has a disputed Claim and has fully complied with the Administrative Remedy provisions of Section 105.19 "Notice of Potential Claim" and Section 105.20 "Administrative Remedy", the alternate final payment statement (estimate) shall constitute a stipulation by the parties that the acceptance of such payment, the proffering or acceptance of the alternate final payment statement or the making of such refund does not constitute any bar, admission, or estoppel, or waiver of the Claim or any defense thereto, or have any effect as to the pending Claim between the Contractor and the Department.

The Contractor shall reimburse or refund the Department for any overpayment in response to a request for refund of overpayment within 30 Days of the Department's demand. Failure by the Contractor to comply may subject the Contractor to default and to rejection of the Contractor's Bids in accordance with Section 102.5, "Refusal or Rejection of Bids," until such time that Contractor complies with this Section.

109.11 COMPENSATION FOR CLAIMS

The Contractor is not entitled to payment for Work or that portion of Work that is the subject of a disputed Claim; the Department shall pay undisputed monies due for Accepted Work. The Contractor is not entitled to late payment charges, including late payment charges pursuant to NMSA 1978, § 13-1-158, associated with any Claim or disputed construction services and Materials. The Department will pay the Contractor late payment charges as authorized by NMSA 1978, § 13-1-158 for construction services and Materials not the subject of a disputed Claim or subject to Retainage or withheld Progress Payments and that have been certified by the Department to have been received and Accepted. The Department will pay the Contractor late payment charges on undisputed, qualified, delayed Progress Payments for certified, approved and Accepted Work in accordance with Section 109.8, "Progress Payments" that are not the subject of a disputed Claim.

The Contractor is barred from seeking a Claim, a remedy, compensation, time, cause of action, or any damages except as provided by Section 105.19, "Notice of Potential Claim," and Section 105.20 "Administrative Remedy," and this Section.

The Contractor shall not be entitled to any consequential, indirect, punitive, exemplary, special, or incidental damages and shall only be entitled to additional compensation and time as specifically provided by the following Sections of these Specifications: Section 104.2, "Significant Change in the Character of the Work"; Section 104.3, "Differing Site Condition"; Section 104.4, "Extra Work"; Section 107.10.3, "Cooperation with Owner of Railroad Right of Way"; Section 108.6, "Determination and Extension of Contract Time"; Section 108.10, "Termination of Contract; No Fault of Contractor"; Section 109, "Measurement and Payment"; and this Section.

Except as otherwise agreed to by the Contractor and the Department in a written Change Order, all Claims and causes of action arising out of the performance and administration of the Contract, including Claims for Delay, Claims for additional compensation and time, Contract adjustment, Claims seeking extension of Contract Time, Claims seeking Delay damages, pass-through Subcontractor Claims, causes of action for breach of Contract, promissory estoppel, equitable estoppel, waiver, detrimental reliance, bad faith breach of contract, breach of the covenant of good faith and fair dealing, or any other cause of action arising out of the performance of the Work or the Contract shall be governed by this Section. The compensation, time and damages provided for in this Section are exclusive, complete, and apply regardless of whether such Claims are to be resolved pursuant to the procedures set forth in Section 105.20, "Administrative Remedy," or any other legal or administrative procedure, whether or not authorized herein, including arbitration, mediation, or appeal.

Delay. The term "Delay" does not include time extensions granted by the Department by Change Order in accordance with Section 108.6, "Determination and Extension of Contract Time" that do not result in any additional compensation.

The Contractor's entitlement to compensation and time with regard to a Delay is defined, limited to, and provided as follows:

1. **Excusable Delay:** A Delay beyond the Contractor's control that negatively impacts the critical path of the Project and is not caused, in whole or in part, by the Contractor's fault or negligence and for which a time extension, but not additional compensation, may be granted;
2. **Compensable Delay:** An Excusable Delay that negatively impacts the critical path of the Project resulting from the neglect or default of the Department or from Differing Site Conditions. For such Delays, the Department may grant additional time and compensation. Examples of a Compensable Delay includes Delays attributable to design errors not readily discovered through Pre-Bid Due Diligence, failure by the Department to acquire Right of Way, and Department-initiated design changes;
3. **Noncompensable Delay:** An unforeseen and unanticipated Excusable Delay not caused by the fault of either the Contractor or the Department that negatively impacts the critical path of the Project. For such delays, the Contractor may receive

an extension of time but not additional compensation. Examples of a Noncompensable Delay includes Delays attributable to utility conflicts, widespread Materials shortages, extreme weather, war, acts of God, and labor strikes.

4. Concurrent Delay: A Delay for which the Contractor is not entitled to compensation that occurs when both the Contractor and the Department independently Delay work, or that occurs when the Contractor is responsible for an Excusable or Compensable Delay and also encounters a Differing Site Condition, which negatively impacts critical path activities during approximately the same time period or when separate Delays to the critical path occur at approximately the same time. The Contractor is not entitled to compensation due to or arising from a Concurrent Delay. The Contractor is not entitled to an extension of Contract Time for any period in which a Non-excusable Delay is concurrent with an Excusable Delay. When a Noncompensable Delay is concurrent with a Compensable Delay, the Contractor may be entitled to an extension of Contract Time but not entitled to compensation for the period the Noncompensable delay is concurrent with the Compensable Delay.
5. Inexcusable Delay or Nonexcusable Delay: a Delay for which the Contractor is not entitled to compensation or time that was caused by: factors within the Contractor's control; the fault or responsibility of the Contractor; factors that could or should have reasonably been foreseen by the Contractor; Delays caused by an event that the Contractor could have foreseen and prevented but failed to do so; or failure to reasonably mitigate a Delay. Examples of inexcusable or nonexcusable Delays include those attributable to reasonably expected seasonal inclement weather events, reasonable time periods necessary for reviews of shop drawings by the Department, for changes or additions to the Work that do not negatively impact the critical path of the Project, inefficient operation, inefficient or ineffective construction management, failure by the Contractor to properly perform Pre-Bid Due Diligence, failure by the Contractor to procure Materials in a timely manner, or failure by the Contractor to assign sufficient resources to the Project.
6. Non-critical Disruption: a disruption or interference with Contractor's performance, regardless of cause, that does not negatively impact the critical path of the Project and therefore does not meet the definition of a Delay and for which the Contractor receives neither compensation nor time.

Additional time for Delay. The Department may only extend Contract Time for an Excusable Delay, Compensable Delay, or a Non-compensable Delay. The Department may only grant an extension of Contract Time for an Excusable Delay using the Acceptable updated monthly or revised schedules current at the time the Delay occurred.

Compensation for Delay. The Department may only compensate the Contractor for a non-Concurrent, Compensable Delay as provided in this Section. In order to receive compensation for a Delay the Contractor shall document costs resulting from the Delay using actual cost records, shall measure expenses using generally accepted accounting principles, and shall comply with Section 108.3.2, "Schedule Format," and Section 105.20.1, "District Level." The compensation which the Contractor may recover for a Delay Claim is limited to:

1. Non-salaried labor expenses;
2. Material costs;
3. Equipment costs pursuant to Section 109.2 "Approved Equipment Rental Rates";
4. Costs of extended job site overhead, including bonds; or,
5. An additional ten percent (10%) of the total of items 1, 2, 3, and 4 to cover home office overhead, salaried labor expenses, and profit.

The Department reserves the right to use innovative bidding approaches, as specified in the Contract, as an alternate means of calculating Delay damages including requiring Bidders to bid a daily overhead rate (cost / Working Day) as a Bid Item Unit Price. If the Contract requires that the Contractor escrow its Bid documents, the escrow Bid Documents may be considered in resolving Claims.

If the source of the loss of productivity and Compensable Delay cannot be isolated and priced separately, the method by which the Department shall calculate the extent of an Excusable Delay caused by a production rate inefficiency shall be made in the following order of priority:

1. Measured Mile analysis by which the Department shall compare actual efficiency (production rates) in an impacted area to actual efficiency in a comparable non-impacted area;
2. Comparison of actual efficiency to actual efficiency on a comparable project; and,
3. Comparison of actual efficiency to planned efficiency taking into account the Contractor's Baseline Schedule and timely submitted Acceptable updated monthly or revised schedules.

In no event shall the Department make a payment based on application of the Eichleay formula, the Total Cost Method or other formula including original Contract period formula, fixed overhead formula, burden fluctuation method, and comparative absorption rates.

Non-Allowable Damages. Regardless of the basis or cause of the Claim, the Contractor may not recover and is not entitled to recover the following categories of damage:

1. Any compensation except as provided by Section 109.11 "Compensation for Claims" and for Delay;
2. Loss of anticipated profit, incentives or bonuses;
3. Labor inefficiencies;
4. Home office overhead regardless of whether it is characterized as absorbed, unabsorbed, or extended exceeding that provided in Section 109.11 "Compensation for Claims";
5. Home office overhead, extended home office overhead, or Delay damages calculated using the Eichleay formula or other formula including original Contract period formula, fixed overhead formula, burden fluctuation method, and comparative absorption rates;
6. Any indirect, special, incidental or consequential damages, including, but not limited to, lost or impaired bonding capacity, loss of Bidding and contracting opportunities, loss of credit standing, cost of financing, interest paid, lost Material discounts, economic loss, loss of reputation, loss of other Work, loss of use, loss of business opportunity, loss of product or output, income, loss of profit or revenue, cost of capital, financing, and for loss of management or employee productivity or of the services of such persons, other not Project direct costs, and business devastation, bankruptcy, or insolvency. The Department waives any entitlement to consequential damages from the Contractor other than liquidated damages as provided in the Contract;
7. Acceleration costs and expenses, except where the Department has expressly and specifically directed the Contractor in writing to accelerate the Work at the Department's expense;
8. Indirect costs or expenses;
9. Late payment charges, including late payment charges pursuant to NMSA 1978, § 13-1-158, related to any disputed Claim, or on any judgment or award made to the Contractor. This provision does not affect the Department's payment of late payment charges on undisputed, qualified, delayed Progress Payments for certified, approved and Accepted Work in accordance with Section 109.8, "Progress Payments" that are not the subject of a disputed Claim;
10. Prejudgment or post-judgment interest related to or arising from any disputed Claim or on any Award made to the Contractor; or,
11. Attorneys' fees and costs, Claim preparation expenses, and litigation or other costs related to or arising from any disputed Claim, or prosecution thereof.

DIVISION 200 – EARTHWORK

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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 and removal or control of all State-listed noxious weed species identified in the Contract. 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 six (6) inches above existing ground and will be at least four (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.

Remove or control all State-listed noxious weed species within the Right of Way Project limits as identified in the Contract in a manner that prevents their re-growth and spread. Herbicide use shall comply with all applicable Federal, State, County and Municipal regulations and ordinances." The current New Mexico Noxious Weed List is available at: <http://plants.usda.gov/java/noxious?rptType=State&statefips=35>

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—Reserved

201.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Clearing and Grubbing</i>	Lump Sum

201.5.1 Work Included in Payment

The Department will consider the following Work as included in the payment for Clearing and Grubbing and no separate payment will be made:

1. Obtaining disposal locations and in making the disposal;
2. When clearing and grubbing is not established as a pay item;
3. Herbicide applied for noxious weed control;
4. Delivery to storage site if required of salvageable timber.

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 and pavement investigation results (when available) in the Contract documents. Use the results for information only.

203.2.1 Material Classifications**203.2.1.1 Rock Excavation**

Rock excavation is material that meets one (1) 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.

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. Unsuitable material is that with an R-value less than the Contract R-value, or if Deleterious Material is present. Subexcavation shall consist of excavating unsuitable material below established Profile Grade or typical cross-section shown on the Plans, or as designated by the Project Manager. Voids created by subexcavation shall be backfilled with approved material meeting the R-value requirements shown in the Contract.

203.2.1.5 Unstable Subgrade Stabilization

Unstable Subgrade is defined as Subgrade that is soft, pumping, and/or displaces with applied loading when encountered in non-borrow sections such as cuts or existing grades, due to no fault or neglect of the Contractor.

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 six (6) inches 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 (1) 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 (1) 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 (3) blasting Projects, of similar complexity, successfully completed within the previous five (5) years.

The Blaster in Charge must be on site during blasting operations.

203.3.3.1.2.2 Blasting Plans

Submit a General Blasting Plan to the Project Manager for each cut that requires blasting, at least two (2) 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, subdrilling 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; storage and safe blasting practices in handling and use in accordance with 29 CFR part 1926.900 et seq;
3. Federal Department of Transportation (USDOT). Transportation and public safety, 49 CFR.

The fire marshal, sheriff, or other local officials, may have additional regulations for explosive Materials.

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 (5) 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 inches;
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 h 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 h 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 two (2) inch to three (3) inch, in accordance with the blasting test sections or the results achieved in similar geologic Materials. Do not exceed three (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 eight (8) inches, 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 five percent (5%) of the controlled blast holes are misaligned in any one (1) lift, reduce the height of the lifts until the eight (8) inch 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 inches from the bottom of each lift to allow for drill Equipment clearances, when the cut requires more than one (1) 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 inch sieve to stem the controlled blast holes, from the top charge to the hole collar.

203.3.3.1.7.4 Pre-Split Blasting

Perform pre-split blasting in accordance with Section 203.3.3.1.7.3, "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 three (3) times the blast hole depth, whichever is greater.

203.3.3.1.7.5 Cushion Blasting

Perform cushion blasting in accordance with item No. 3 of Section 203.3.3.1.7.3, "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.

203.3.3.1.7.6 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 six (6) inches, 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 inch 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 as 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 six (6) inches by plowing, scarifying, or stepping up. Compact this area to 95% of maximum density in accordance with Section 203.3.8, “Moisture and Density Control.” Place Material for Roadbed Embankment in horizontal layers not exceeding eight (8) inches thick and compact in accordance with Section 203.3.8, “Moisture and Density Control.”

The Department will allow rocks no larger than three (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 ten (10) ft;
2. No rock is placed in fill height less than eight (8) ft, measured at the edge of the Roadway Shoulder;
3. Place rocks inside a line six (6) inches from the slope stake, space a minimum of three (3) ft from edge to edge, and cover with approved Embankment Material.

Construct rock Embankments to a maximum of six (6) inches 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 Materials from the Subgrade unless an alternative treatment is agreed upon by the Project Manager.

203.3.7 Unstable Subgrade Stabilization

Areas that have been proof rolled and lack sufficient stability in the opinion of the Project Manager shall be treated as unstable Subgrade.

Prior to placement of the base material, the stabilized Subgrade shall be proof rolled with a roller having a minimum weight of 30 tons and shall exhibit no displacement when proof rolled.

The Contractor shall stabilize unstable Subgrade using acceptable chemical or mechanical methods meeting an equivalent R-value as approved by the State Pavement Design Engineer.

203.3.8 Moisture and Density Control

Maximum dry density of all soil types encountered or used will be determined in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified) and AASHTO T 224.

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 five percent (5%) less than the optimum level. 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 optimum moisture plus four percent (4%). 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 six (6) inches 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 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 in accordance with Material Testing Requirements.

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 ten (10) inches 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. Cross-sectional measurements for subexcavation shall be taken before backfill is placed.

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.

For borrow from commercial sources, use weight converted to cubic yards at minimum specified density.

203.4.4 Unstable Subgrade Stabilization

Unstable Subgrade stabilization shall be measured by the square yard.

203.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Rock Excavation</i>	Cubic Yard
<i>Unclassified Excavation</i>	Cubic Yard
<i>Borrow</i>	Cubic Yard
<i>Subexcavation</i>	Cubic Yard
<i>Unstable Subgrade Stabilization</i>	Square Yard
<i>Controlled Blasting</i>	Linear Foot

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 (1) 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.
 11. Suitable backfill Material for subexcavation.
 12. The removed Materials shall be hauled and disposed of at the site(s) designated in the Contract or as determined by the Project Manager.
 13. Proof rolling for Unstable Subgrade Stabilization shall be considered Incidental to the Contract and will not be measured or paid for separately.

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 or A-2-4as determined by AASHTO M 145, unless otherwise specified in the Contract. Do not use Recycled Asphalt Pavement (RAP) as select backfill Materials.

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 206.2.3:1
Sand Bedding**

Standard Sieve	Percent Passing
3/8 inch	100%
No. 4	95% - 100%
No. 16	50% - 85%
No. 30	25% - 60%
No. 50	5% - 30%
No.100	0% - 10%

206.3 CONSTRUCTION REQUIREMENTS

206.3.1 General

Remove unstable 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. Ensure the moisture content of the soil, at the time of compaction, is not greater than or five percent (5%) less than the optimum level. Compact the top six (6) inches of existing ground to at least 95% of maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (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 eight (8) inches deep (loose measurement), and compact to 95% of maximum density at optimum moisture to optimum moisture +/- three percent (3%) in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified) and AASHTO T 224. Test for field density and moisture content using nuclear methods in accordance with AASHTO T 310. Before placing

backfill Material against new masonry or concrete Structures, wait until the concrete has developed its specified design strength 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 if the deflections for pipe exceed the manufacturer's tolerances.

206.3.2 Pipe Culverts, Storm Drains, and Structural Plate Pipe

Remove rock and other unyielding foundation material a minimum of four (4) inches (maximum 12 inches) 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." Ensure that the trench width for pipes and Culverts conforms to the trench widths requirements in Section 570.3.2. 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

Excavate material to the elevations established by the Contract Plans. Do not remove material, except unstable material, below the final grade, if placing footings on excavated surfaces other than rock. Remove rock and other unyielding foundation material a maximum 12 inches below the bottom of the Structure. 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 Unstable Material Excavation below the bottom-of-structure elevation.

206.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Unstable Material Excavation</i>	Cubic Yard

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 unstable 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—Reserved**207.3 CONSTRUCTION REQUIREMENTS**

Maximum dry density of all soil types encountered or used will be determined in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified) and AASHTO T 224.

Ensure the top two (2) ft of the finished Subgrade contains material with the design R-value. For Subgrade material not meeting design R-value, perform subexcavation in accordance with section 203.3.6.

Compact the top six (6) inches of the Roadbed to 95% of maximum density.

Ensure the soil moisture content (at the time of compaction) is from optimum to optimum minus five percent (5%). 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 optimum moisture plus four percent (4%).

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 of the finished Subgrade is within 0.10 ft of the Plan Subgrade elevation. The Department will measure tolerances on the finished surface at right angles to the centerline.

207.4 METHOD OF MEASUREMENT—Reserved**207.5 BASIS OF PAYMENT**

Pay Item	Pay Unit
<i>Subgrade Preparation</i>	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—Reserved**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.

208.3.2 Compaction

Compact the top six (6) inches of the Roadbed to 95% of maximum density per AASHTO T180 Method D (TTCP Modified).

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 six (6) inches 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
<i>Linear Grading</i>	Mile

209.1 DESCRIPTION

This Work consists of restoring existing Roadbed to the specified grade and typical section.

209.2 MATERIALS—Reserved

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 six (6) inches of the Roadbed, after restoring the grade and typical section:

1. Scarify the surface;
2. Water, when required;
3. Compact to 95% of maximum density per AASHTO T180 Method D (TTCP Modified);
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
<i>Blading and Reshaping</i>	Mile

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 CBC's 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 two (2) inches. Provide select backfill Materials in accordance with AASHTO Soil Classifications A-1 or A-2-4 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 ten (10) feet 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".

Do not use Recycled Asphalt Pavement (RAP) as select backfill Materials.

210.3 CONSTRUCTION REQUIREMENTS**210.3.1 General**

Excavate material to the elevations established by the Contract Plans. Do not remove material, except unstable material, below the final grade, if placing footings on excavated surfaces other than rock. Remove rock and other unyielding foundation material a maximum 12 inches below the bottom of the Structure. 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. 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 203.3.5.1 Roadbed Embankments. Dispose of unstable excavated material outside of the Roadway Prism as directed by the Project Manager. Before placing backfill Material against new masonry or concrete Structures, wait until the concrete has developed its specified design strength as

determined in Section 510.3.5.1, "Concrete Strength." Prevent unbalanced loading while placing backfill Material.

210.3.2 Compaction

Make layers of uncompacted backfill no more than eight (8) inches thick. Before placing the next layer, compact to 95% of the maximum density near optimum moisture content for AASHTO Soil Classifications A-1-a Material and Roadway Embankment as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified). Use nuclear methods to determine field densities in accordance with AASHTO T 310.

210.3.3 Contractor Certification of Backfill

Unless otherwise specified in the Contract, provide Contractor Certification of Backfill. The Certification of Backfill will be required for all backfill placed within 50 feet of the Structure. Provide an independent New Mexico Professional Engineer's stamped letter of Certification to include:

1. Oversight of all backfill operations as covered under Section 210 were performed;
2. Compacted lift heights were performed and maintained as specified;
3. Proctor curves developed for material backfill were completed as specified and represent material placed and compacted and;
4. Field densities were performed on each lift height as specified based on Proctor curve for material supplied.

The independent New Mexico Professional Engineer providing the Letter of Certification to produce Proctor curves and field density tests utilized for the material backfill as covered. Attach to the letter of Certification copies of all daily logs verifying backfill placement lift heights, material properties, Proctor curves, field density tests, and testing frequency.

210.4 METHOD OF MEASUREMENT

The Department will measure Excavation and Backfill for Major Structures as excavation 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, in accordance with the limits shown in the Standard Drawings. 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.

Measure Contractor Certification of Backfill by the Lump Sum for the Certification Letter. The Certification Letter will cover all backfill specified on the Project to have Contractor Certification of Backfill.

210.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Excavation and Backfill for Major Structures</i>	Cubic Yard
<i>Unsuitable Material Excavation</i>	Cubic Yard

The Department will not pay for material excavated outside the area:

1. Bounded by vertical planes 18 inches from, and parallel to, the footings;
2. The neat lines for footings in rock; or
3. For material excavated below the established final elevation.

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

210.5.1 Work Included in Payment

Excavation and Backfill for Major Structures includes the following:

1. Compaction to 95% of maximum density as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified) for 50 ft approach to Bridge abutments;
2. Any temporary shoring of excavations required for construction phasing;
3. Contractor Certification of backfill; and
4. Dewatering of excavations for Structure backfill.

213.1 DESCRIPTION

This Work consists of obliterating old Road.

213.2 MATERIALS—Reserved**213.3 CONSTRUCTION REQUIREMENTS**

After the old Road is no longer needed for traffic, remove and stockpile existing surfacing Materials to Subgrade 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 old Road.

213.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Obliterating Old Road</i>	Mile

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SECTION 302: PROCESSING, PLACING, AND COMPACTING EXISTING PAVEMENT

302.1 DESCRIPTION

This Work consists of processing, placing, and compacting existing pavements.

302.2 MATERIALS

The following gradation requirements apply:

Table 302.2:1
Gradation Requirements

Sieve size (inch)	% passing
2	95–100
1 1/2	90–100

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."

302.4 METHOD OF MEASUREMENT—Reserved

302.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Processing, Placing, and Compacting Existing Pavement</i>	Square Yard

SECTION 303: BASE COURSE

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 (1) or more of the following:

1. Crushed stone;
2. Crushed or screened gravel;
3. Caliche;
4. Sand;
5. Recycled Asphalt Pavement (RAP) not to exceed 50%; recycled concrete pavement (RC) not to exceed 75%; and the combined RAP and RC not to exceed 75% by weight.
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 Department from the Roadway. Unless the Contract specifies otherwise, combine the aggregate Materials, including processed glass aggregate (if used), in proportions that produce a homogeneous composite blend in accordance with Table 303.2.1:1, "Type I Base Course Gradation Band."

**Table 303.2.1:1
Type I Base Course Gradation Band**

Sieve size	% passing
1.0 inch	100
¾ inch	80--100
No. 4	30-60
No. 10	20-45
No. 200	3.0-10.0

Table 303.2.1:2
Type II Base Course Gradation Band

Sieve size	% passing
1.0 inch	100
¾ inch	85-95
No. 4	40-70
No. 10	30-55
No. 200	6.0-15.0

Ensure that at least 50% of the Materials retained on or above the No. 4 sieve have at least two (2) Fractured Faces when evaluated in accordance with AASHTO T-335, "Determining the Percentage of Fracture in Coarse Aggregate". Provide Base Course from a material source with a maximum AI of 35 when calculated in accordance with Section 901, "QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)," a maximum LL of 25, and a maximum PI of 6. Determine the AI for the untreated natural aggregate source.

303.3 CONSTRUCTION REQUIREMENTS

303.3.1 Preparation of Subgrade

Clear the Subgrade of loose and Deleterious Material. Ensure that the top six (6) inches of the Roadbed meets the density requirements of Section 207, "Subgrade Preparation." Proof-roll the Subgrade with Equipment described in the Contractor's Quality Control Plan and 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 six (6) inches (compacted) lifts, unless specified otherwise. Do not place on frozen Subgrade. Compact Base Course to at least 96% of maximum density as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified). The Department will take field density tests and gradation samples at random locations. The Department will use nuclear testing methods to determine in-place densities in accordance with AASHTO T 310 and TTCP procedures.

303.3.3 Surface Tolerance

The Department will allow a surface tolerance of ½ inch within ten (10) feet. 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.

303.3.4 Plan Base Course and Sub-base 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 ½ inch, the Project Manager may:

1. Accept and approve the payment for the measured quantity only; or
2. Allow Contractor to add material and reprocess to correct the deficiency, to meet specification required in section 303.2.2.

303.3.5 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."

303.3.6 Removing and Processing Base Course

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

303.3.7 Sampling and Testing

Sample and test the Base Course in accordance with Section 901, Quality Control/Quality Assurance (QC/QA), and the Department's "Minimum Testing Requirements for Base Course". Department personnel may test locations other than the random locations generated for statistical analysis. These tests will not be used for pay factor determination, but may be used to determine Acceptance or rejection of localized material.

303.3.7.1 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. Aggregate quality
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.

Provide copies of TTCP wallet cards or certifications for personnel who are responsible for sampling and testing the Base Course. Update the list as required if personnel substitutions are made. 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.

303.3.8 Acceptance

The Department will accept Base Course Materials based on samples taken in accordance with the Departments Minimum Testing Requirements after placement but before compaction. Acceptance will be in accordance with Section 303.3 Construction Requirements. If necessary, re-work the Base Course until all requirements are met.

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 two percent (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* as determined in Section 303.3.8, "Acceptance."

Pay Item

Base Course

Base Course _____inch Depth

Remove, Process and Place Base Course

Section 303: Base Course

Pay Unit

Cubic Yard or Ton

Square Yard

Square Yard or Ton

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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 509 or 510, "Portland Cement Concrete Mix Designs"

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 \pm 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 306.2.2.1:1
Hydrated Lime Gradation Requirements

Sieve size	% passing
No. 30	97.0 – 100.0
No. 200	75.0 – 97.0

306.2.2.2 Quicklime

Provide quicklime in accordance with AASHTO M 216. When dry sieved in a mechanical shaker for 10 min, \pm 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 306.2.2.2:1
Quicklime Gradation Requirements

Sieve size	% passing
3/4 inch	95 – 100
No. 100	0 – 25

306.2.2.3 Lime-Slurry

Provide 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. Lime-slurry shall be a mixture of quicklime and water. 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 306.2.2.3:1
Lime-Slurry "Solids Content" Gradation Requirements

Sieve size	% passing
No. 4	99 – 100
No. 30	96 – 99

3. Grade. Provide lime-slurry with a minimum "dry solids content," of 35%.

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 inch sieve.

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

Proof-roll the material with Equipment, approved by the Project Manager, to expose and correct the soft areas.

Where unstable Subgrade is encountered in cuts or existing grades, due to no fault or neglect of the Contractor, sub-excavation and borrow will be paid for and measured as per Section 203, "Excavation, Borrow, and Embankment." Engineered designs will be measured and paid for on an item by item basis or as specified in the Contract. Conduct operations in such a way 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 so that 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 the Plans. When processing the Portland cement-treated Subgrade, ensure that cement dust is not a hazard to the public or workers. Perform mixing, placing, compacting, and finishing on the same 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 six (6) inches between 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 five percent (5%) over optimum within the entire treated depth.

306.3.2.2 Finishing Operations

Compact to 95% maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified), 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 roll the surface to finish the completed Work and prevent hairline cracking. Finish within four (4) h of adding the Portland cement.

Allow the cement-treated Subgrade to cure for at least seven (7) Days. Maintain a moist, not saturated, condition during the entire curing period, to prevent drying. If permitted by local jurisdiction, the Contractor may use an alternate curing procedure by applying a CSS-1 or SS-1 emulsified asphalt to the surface so that the surface is fully covered and sealed, as approved by the Project Manager.

306.3.3 Lime Treated Subgrade

Use a distributor that will apply a uniform application and automatically adjust the spread rate for variable travel speeds. Apply hydrated lime or quicklime dry, within $\pm 0.5\%$ of the specified percentage, by weight shown on the approved mix design, 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 quicklime is equivalent to 1.3 tons hydrated lime).

Apply lime-slurry, at the specified percentage of dry solids content onto the prepared scarified Subgrade, with a distributor having a pump and a spray bar. Continuously circulate the slurry 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 that is left exposed on the ground to the open air for more than ten (10) hours and shows excessive moisture loss.

306.3.3.1 Initial Mixing

Process the hydrated lime, quicklime, or lime-slurry so as not to present a hazard to the public 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 two (2) inch, that, when compacted, will meet the required depth and width shown in the Plans. Overlap at least six (6) inches 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 three percent (3%) to five percent (5%) above optimum in accordance with AASHTO T 180 (Modified Proctor), Method D (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 three percent (3%), or more than five percent (5%) above optimum as determined by AASHTO T 180 (Modified Proctor), Method D (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 the requirements of Table 306.3.3.3:1, "Lime-Treated Subgrade Gradation Requirements" before final compaction.

**Table 306.3.3.3:1
Lime-Treated Subgrade Gradation Requirements**

Sieve size	% passing
One (1) inch	100.0
No. 4	60.0 – 100.0

306.3.3.4 Finishing Operations

Compact immediately after final mixing is complete to 95% of the maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (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, Sub-base, 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:

One (1) ton of quicklime equals 1.3 ton of hydrated lime.

306.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Cement-Treated Subgrade</i>	Square Yard
<i>Portland Cement</i>	Ton
<i>Lime Treated Subgrade</i>	Square Yard
<i>Hydrated Lime, per Section 402</i>	Ton

DIVISION 400 – SURFACE TREATMENTS AND PAVEMENTS

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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 Mean Roughness Index (MRI) measurement for the established categories provided within this Section.

Unless otherwise specified in the Contract, category one (1) Table 401.5.1.1:1, "MRI Based Profile Pay Adjustment Schedule for Category I HMA/WMA Projects," will be applicable to all Hot Mix Asphalt (HMA)/Warm Mix Asphalt (WMA) Projects. Unless otherwise specified in the Contract, Table 401.5.1.2:1, "MRI Based Profile Pay Adjustment Schedule for Category I PCCP Projects" will be applicable to all Portland Cement Concrete Pavement (PCCP) Projects.

This specification applies to all construction Projects, with one (1) opportunity for pavement smoothness. An example of one (1) opportunity for pavement smoothness is a single lift of paving operations for HMA/WMA or PCCP.

401.2 MATERIALS—Reserved

401.3 CONSTRUCTION REQUIREMENTS

401.3.1 Profile Measurements

Collect raw profile data utilizing profiler settings used in certification by TTCP "Certification of Intertila Profilers." Export all raw profile data to create files conforming to the University of Michigan Transportation Research Institute's Engineering Research Division (ERD) format using an upper wavelength cutoff filter of 300 ft for HMA/WMA. For PCCP data collection use a Butterworth Band-Pass filter short cutoff wavelength of seven (7.0) ft and a long cutoff wavelength of 300 ft, and the current calibration documentation to the accompanying Department representative, within one (1) hour after the data has been collected, on either a CD or Universal Serial Bus (USB) memory storage device. Provide additional data files or text files upon request. If the Contractor does not submit the profile measurements files within this time period, the Department may alter the Pay Adjustments resulting from Table 401.5.1.1:1, "MRI Based Profile Pay Adjustment Schedule for Category I HMA/WMA Projects", Table 401.5.1.1:2 "MRI Based Pay Adjustment Schedule for Category II HMA/WMA Projects", Table 401.5.1.2:1, "MRI Based Profile Pay Adjustment Schedule for Category I PCCP Projects", or Table 401.5.1.2:2, "MRI Based Profile Pay Adjustment Schedule for Category II PCCP Projects" by applying an additional five percent (5%) price deduction of the total price reduction for the Profiled area in question.

401.3.1.1 Profile Measurement Device

Provide, operate, and maintain a profile measurement device that uses Equipment and computer programs in accordance with AASHTO M 328 "Inertial Profiler", 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"*. Profile measurement devices used for Acceptance testing on NMDOT Projects shall 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.

Verify calibration of the profile measurement device. Verify both horizontal and vertical calibration before each use. Perform verifications in the presence of the Department's representative as determined by the Project Manager and in accordance with the manufacturer's approved procedures and maintain copies of the verification documentation

and manufacturer's procedures with the machine and provide the calibration documentation and verification documentation to the Project Manager. 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. The TTCP Administrator will provide a temporary TTCP certification valid until the next scheduled certification.

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. The Department State Materials Engineer, through the TTCP, will investigate any concerns submitted in writing as to the competence of a certified individual and implement corrective action if necessary in accordance with the TTCP Board of Directors established procedures.

401.3.1.4 Profile Measurement Operations

The Department will consider profile testing as part of the paving operation. Include the proposed frequency and schedule for profile testing with the paving plan submittal at the pre-paving conference. Allow the Department's Representative to witness the collection of raw data by riding in the vehicle while collecting the data.

Obtain the Project Manager's written approval and sweep the Roadway surface before beginning profile operations.

Final surface is the surface immediately behind the paving operation prior to any surface modification.

Measure the longitudinal smoothness of the final surface of HMA, WMA, OGFC, and PCCP using a Department certified profile measurement device. Operate the profile measurement device in accordance with AASHTO R 57 "Operating Inertial Profiling Systems" and manufacturer's recommendations. Using dual-sensors, with single point lasers or bar lasers one (1.0) inch or less, measure the profile traces for each wheel path. Locate outside trace three (3) feet from and parallel to the approximate location of the pavement edge line. Ensure the centerline distance between sensors is 70.0 inches \pm one (1.0) inch. At transverse joints, commence profile traces at the joint location. Operate the device on the driving surface of the Roadway at the manufacturer's recommended speed without interfering with traffic or its own operation.

On HMA/WMA Projects, perform profile measurements and corrective actions on the final surface of HMA/WMA. On PCCP Projects, perform profile measurements and corrective actions on the finished surface after tining or grooving.

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. Net total linear feet of each lane,

6. Filter settings, and
7. Operator's signature.

401.3.1.5 ProVal Profile Data Analysis by the Department

The Department will use the FHWA's current version of "ProVal" software to determine the MRI for each 0.1 mile section of each lane, reported to the nearest 0.1 inch per mile using the average of the two wheel paths' IRI's, using Ride Quality Analysis. Using the ProVal software, the Department will not use any further filter settings. Do not use the 250 mm filter in "ProVal". Data obtained through analysis by the Department will be used for evaluations of all "Must Grind Work", "Corrective Work", and "Pay Adjustments."

401.3.2 Straightedge Measurements (Category III)

Test the final surface of HMA, WMA, or PCCP with an approved ten (10) foot straightedge at both right angles and parallel to the centerline, advancing the straightedge in five (5) foot increments. In lieu of a physical ten (10) foot straightedge measurement and at the direction of the Project Manager a profile measurement device that complies with Section 401.3.1.1 "Profile Measurement Device" can be used for the ten (10) foot straightedge measurement. Correct surface deviations greater than 1/8 inch within ten (10) ft, as directed by the Project Manager.

401.3.3 Evaluation for Must Grind Work and Corrective Work

Evaluate the pavement in 0.1-mile sections for determining needed Must Grind Work, Corrective Work and Pay Adjustments.

401.3.4 Diamond Grinding

Diamond grinding equipment uses diamond tipped saw blades, composed of industrial diamonds and metallurgical powder, that are gang mounted on a cutting head ranging in width from 36 inches to 48 inches. The diamond grinding equipment shall use water to cool the cutting head. The slurry or residue resulting from the grinding operation shall be continuously removed from the pavement with a wet vacuum process. The slurry or residue shall not be allowed to flow across lanes occupied by traffic or to flow into gutters or other drainage facilities. Diamond grinding equipment shall be self-propelled, self-contained and without external attachments acting as cutting / grinding devices.

Diamond grinding operations shall not dislodge aggregate or binder creating rock pockets or deviations on pavement surface.

401.3.5 Must Grind Work

Identify potential must grind locations using "Ride Quality Analysis" under the "Analysis Type" with the "Continuous" feature of the latest version of the FHWA's "ProVAL" software. Use a MRI threshold (inch/mi) of 105.00 and a segment length of 25.00 feet. Identify must grind locations for each lane using the "MRI" Ride Quality Index feature of ProVAL. Any locations with a MRI of 105.00 to 125.00 will be evaluated by the Project Manager and the Contractor, to determine if diamond grinding is required, final determination will be made by the Project Manager. All locations with an MRI above 125.00 must be included in the corrective action plan.

Develop and submit an appropriate written corrective action plan, including methods and procedures utilized to diamond grind and achieve the specified MRI values proposed by the Contractor, to the Project Manager for review and written approval. Do not begin must grind Work until the Project Manager approves the methods and procedures in writing. Failure to submit and obtain approval of the corrective action plan will result in the contractor correcting all locations identified by ProVAL regardless of the smoothness value for the 0.1 mile section. The Project Manager's approval does not relieve the Contractor of the responsibility to comply with the Specifications.

Correct all must grind locations on the Project identified by the approved written corrective action plan then measure and evaluate Roadway profiles for smoothness Pay Adjustment. Use diamond grinding to bring the reported average measured smoothness value to an acceptable level.

Do not reduce planned pavement thickness by more than 0.3 inches without written approval of the Project Manager.

Grind must grind areas across the lane width to produce a smooth transition to the surrounding pavement. If the must grind area is not the full width of the lane, only half of the lane containing the roughness shall be ground and smoothly feathered into the surrounding pavement.

For HMA/WMA, if the Contract does not require an OGFC, or OGFC will not be placed before Project suspension, apply a fog seal to the ground areas as approved by the Project Manager. Fog seal and all operations necessary to apply it is included in the Bid Item Unit Price for HMA/WMA, the Department will make no separate payment.

401.3.6 Corrective Work

Develop and submit an appropriate written Corrective Work Plan, including methods and procedures, utilized to diamond grind and achieve the specified MRI values proposed by the Contractor, to the Project Manager for review and written approval if the measured smoothness value falls within the "Corrective Work Required" (CWR) value of the applicable pay adjustment table and category as indicated in the Contract. If approved, complete elected corrective Work, including necessary traffic control, at no additional cost to the Department. After completion of the approved corrective Work, re-profile the corrected area to verify compliance with specification requirements.

Limit corrective Work to diamond grinding, overlaying, or removing and replacing rejected 0.1-mile sections. 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. Surface Diamond Grinding. Use diamond grinding to bring the measured smoothness value to an acceptable level in accordance with the applicable table(s) and category(ies) as indicated in the Contract.

Do not reduce planned pavement thickness by more than 0.3 inches without written approval of the Project Manager.

Grind corrective Work areas to produce a smooth transition to the surrounding pavement. If the corrective Work areas are not the full width of the lane, only half of the lane containing the corrective Work area shall be ground and smoothly feathered into the surrounding pavement.

For HMA/WMA, if the Contract does not require an OGFC, or OGFC will not be placed before Project suspension, apply a fog seal to the ground areas as approved by the Project Manager. Fog seal and all operations necessary to apply will be incidental to the Bid Item Unit Price for HMA/WMA; the Department will make no separate payment.

For PCCP, perform additional diamond grinding as necessary in the following situations:

- 1.1. The transverse direction, so the lateral diamond 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 diamond grinding begins and ends at lines perpendicular to the pavement centerline. Maintain diamond grinding locations as neat rectangular areas of uniform appearance. If timing is eliminated by

diamond grinding, machine groove the hardened concrete in the same pattern as adjacent tining at no additional cost to the Department.

2. Overlaying. If the Contractor uses an additional lift of HMA/WMA to correct rough pavement, the HMA/WMA 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 as specified in Section 401.3.6 "Corrective Work".

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 the type of approved HMA, WMA or PCCP as originally specified in the Project Contract 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 Pay Adjustment purposes.

401.3.7 OGFC Placement and Profile Measurement

Ensure HMA/WMA profile measurements and corrective Work has been completed before placing OGFC. Pay Adjustment will be based on the MRI of the HMA/WMA unless the measured MRI of the OGFC is greater than the measured MRI of the HMA/WMA on the same 0.1 mile section, then the Department will base the Pay Adjustment for the HMA/WMA section on the OGFC's measured MRI.

401.4 METHOD OF MEASUREMENT

The Department will determine smoothness Pay Adjustments on the calculated square yards of the surface area of the travel lane bound by the plan typical section travel lanes and 0.1-mile lane length.

401.5 BASIS OF PAYMENT

Surface smoothness testing and corrective Work to bring the final surface within specification smoothness in accordance with the applicable table(s) and category(ies) as indicated in the Contract is Incidental to the Bid Item Unit Price for HMA, WMA or PCCP; the Department will make no separate payment. All traffic control required to determine and correct pavement smoothness is Incidental to the HMA, WMA or PCCP item.

All adjustments of manhole and utility valves for the facilitation of pavement smoothness shall be performed after paving of the finish grade. This Work shall be paid in accordance with Section 662 "Manholes" and 663 "Utility Items."

401.5.1 Pay Adjustments

The Department will calculate a Pay Adjustment for each 0.1 mile section of travel lane. The Pay Adjustments will apply to the total accepted area of each 0.1 mile section of HMA, WMA or PCCP constructed for the plan typical section travel lane width and Roadway length.

The Department will not include Shoulder and turnout areas for payment purposes.

If the Pay Adjustment for a 0.1 mile section is not equal to CWR but less than 0.00, the Contractor shall accept the designated Pay Adjustment.

401.5.1.1 Pay Adjustment for Category I and Category II HMA/WMA Projects

The Department will base Pay Adjustments on the final MRI for each 0.1 mile section in accordance with Table 401.5.1.1:1, "MRI Based Profile Pay Adjustment Schedule for Category I HMA/WMA Projects" and Table 401.5.1.1:2, "MRI Based Profile Pay Adjustment Schedule for Category II HMA/WMA Projects", after the Contractor performs and measures corrective Work.

Table 401.5.1.1:1
MRI Based Profile Pay Adjustment Schedule
for Category I HMA/WMA Projects

Pay Adjustment (\$ per square Yard)			
MRI (Mean Roughness Index) inch/0.1mi			Category I
<52.1			0.00
52.1	to	53.0	-0.14
53.1	to	54.0	-0.28
54.1	to	55.0	-0.42
55.1	to	56.0	-0.56
56.1	to	57.0	-0.70
57.1	to	58.0	-0.84
58.1	to	59.0	-0.98
59.1	to	60.0	-1.12
>60.0			Corrective Work Required

Table 401.5.1.1:2
MRI Based Profile Pay Adjustment Schedule
for Category II HMA/WMA Projects

Pay Adjustment (\$ per square Yard)			
MRI (Mean Roughness Index) inch/0.1mi			Category II
<62.1			0.00
62.1	to	63.0	-0.12
63.1	to	64.0	-0.24
64.1	to	65.0	-0.36
65.1	to	66.0	-0.48
66.1	to	67.0	-0.60
67.1	to	68.0	-0.72
68.1	to	69.0	-0.84
69.1	to	70.0	-0.96
70.1	to	71.0	-1.08
71.1	to	72.0	-1.20
72.1	to	73.0	-1.32
73.1	to	74.0	-1.44
>74.0			Corrective Work Required

401.5.1.2 Pay Adjustment for PCC Pavement

The Department will base Pay Adjustments on the final average MRI for each 0.1 mile section in accordance with Table 401.5.1.2:1, "MRI Based Profile Pay Adjustment Schedule for Category I PCCP Projects" and Table 401.5.1.2:2, "MRI Based Profile Pay Adjustment Schedule for Category II PCCP Projects," after the Contractor performs and measures corrective Work.

Table 401.5.1.2:1
MRI Based Profile Pay Adjustment Schedule
for Category I PCCP Projects

Pay Adjustment (\$ per square Yard)			
MRI (Mean Roughness Index) inch/0.1mi			Category I
<59.3			0.00
59.3	to	60.2	-0.14
60.3	to	61.2	-0.28
61.3	to	62.3	-0.42
62.4	to	63.3	-0.56
63.4	to	64.3	-0.70
64.4	to	65.4	-0.84
65.5	to	66.4	-0.98
66.5	to	67.5	-1.12
>67.5			Corrective Work Required

Table 401.5.1.2:2
MRI Based Profile Pay Adjustment Schedule
for Category II PCCP Projects

Pay Adjustment (\$ per square Yard)			
MRI (Mean Roughness Index) inch/0.1mi			Category II
<65.0			0.00
65.0	to	66.0	-0.12
66.1	to	67.0	-0.24
67.1	to	68.0	-0.36
68.1	to	69.0	-0.48
69.1	to	70.0	-0.60
70.1	to	71.0	-0.72
71.1	to	72.0	-0.84
72.1	to	73.0	-0.96
73.1	to	74.0	-1.08
74.1	to	75.0	-1.20
75.1	to	76.0	-1.32
76.1	to	77.0	-1.44

Table 401.5.1.2:2
MRI Based Profile Pay Adjustment Schedule
for Category II PCCP Projects

77.1	to	78.0	-1.56
78.1	to	79.0	-1.68
79.1	to	80.0	-1.80
>80.0			Corrective Work Required

SECTION 402: ASPHALT MATERIALS, HYDRATED LIME, AND ANHYDRITE BASED MATERIAL

402.1 DESCRIPTION

This Work consists of providing, mixing, and applying asphalt Materials, hydrated lime, or anhydrite based material.

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 Certified Test Reports (CTRs). Sample and test performance-graded asphalt binders in accordance with the Department's *Standard Practice for Certifying Suppliers of Performance-Graded Asphalt Binders* and in accordance with Section 402.2.5 Performance-Graded Asphalt Binder (PGAB) of the Standard Specifications. The Department will assume no obligation to accept the CTRs and may additionally test the certified Materials. The Department may test asphalt Materials at the manufacture shipping or Project storage 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* and in accordance with Section 402.2.5 Performance-Graded Asphalt Binder (PGAB) of the Standard Specifications.

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 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 (PGAB)

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.

402.2.5.1 Sampling

The Contractor shall perform all Quality Assurance sampling using AASHTO T 40, Standard Method of Test for Sampling Bituminous Materials under the direct supervision of TTCP certified sampling personnel, and witnessed by the Project Manager or his designee. The samples will be taken either from the discharge side of the storage tank or from the delivery trucks. The samples will be taken after a sufficient amount, a minimum of one (1) gallon, of PGAB is run out to clear any residual PGAB or other asphalt material and/or solvent that may have built up in the sampling valve. All approved sample containers shall be identified using Department Form MT-85.

The minimum sampling frequency for PGAB shall be one (1) sample during the test strip operation and every 5000 tons of HMA or WMA thereafter. One (1) sample of PGAB shall be taken representing OGFC operations. A minimum of two (2) samples shall be taken per Project representing asphalt binder from HMA or WMA, and a minimum of one (1) sample representing asphalt binder for OGFC. A sample shall consist of (3) separate 1-quart sub-samples. All samples shall be maintained in a secure, dry location at the Project office or at a pre-agreed upon location that is satisfactory to the Contractor and Project Manager.

402.2.5.2 Testing

One (1) sub-sample shall be tested by NMDOT Chemistry Unit when the test strip is performed. Another randomly selected sub-sample shall be tested by the NMDOT Chemistry Unit during the course of the Project. If the results of any of the sub-samples designate failing material, the second sub-sample shall be submitted to and tested by the NMDOT Chemistry Unit. If the second sub-sample does not meet Specifications in accordance with AASHTO M 320, Table 402.2.5.2.1 "Pay Adjustment Factor Based on PGAB Test Results" will be implemented by the Project Manager. The Pay Adjustment Factor will represent the total asphalt binder used for 5000 Tons of HMA or the tonnage of HMA used for the test strip. If there are multiple failures for each binder test on the same sample, the Project Manager will base the adjustment on the lowest pay factor of all the tests. The Price Adjustment will be executed with a Change Order (Field Sheet).

TABLE 402.2.5.2.1
Pay Adjustment Factor¹
Based on Binder Test Results

Binder Property	Measured Value	Pay Factor Applied
DSR on Original Binder G*/sinδ (kPa) Min. 1.00 kPa	<1.00 – 0.98	0.98
	<0.98 – 0.96	0.95
	<0.96 – 0.94	0.92
	<0.94 – 0.90	0.85
	<0.90	0.75 or Removal ²
DSR on RTFO Aged Material G*/sinδ (kPa) Min. 2.20 kPa	<2.20 – 2.15	0.98
	<2.15 – 2.09	0.95
	<2.09 – 2.02	0.92
	<2.02 – 2.00	0.85
	<2.00	0.75 or Removal ²
DSR on PAV Aged Material G* sinδ (kPa) Max. 5000 kPa	>5000 – 5100	0.98
	>5100 – 5250	0.95
	>5250 – 5400	0.92
	>5400 – 5600	0.85
	>5600	0.75 or Removal ²
BBR Slope value (m) of PAV Aged Binder Min. 0.300	<0.300 – 0.298	0.98
	<0.298 – 0.293	0.95

TABLE 402.2.5.2.1
Pay Adjustment Factor¹
Based on Binder Test Results

	<0.293 – 0.290	0.92
	<0.290 – 0.285	0.85
	<0.285	0.75 or Removal ²
BBR Stiffness of PAV Aged Binder S (MPa) Max. 300 MPa	>300 – 306 >306 – 315 >315 – 324 >324 – 330 >330	0.98 0.95 0.92 0.85 0.75 or Removal ²
% Elastic Recovery on RTFO Aged Material ³ Min 65%	<65 – 60 <60	0.95 0.75 or Removal ²

¹Price Reduction will be applied to contractor's invoice price of asphalt binder.

²The Assistant District Engineer-Construction will determine if the non-compliant HMA material will be removed. Removal and replacement will be at no additional cost to the department. If the non-compliant material is accepted, a price reduction factor of 0.75 will apply.

³Elastic-Recovery is only applicable to PG+ and PGR+ Binders.

402.2.5.3 Appeal Procedure (Asphalt Materials, Hydrated Lime, and Anhydrite Base Materials - Only)

If desired, the Contractor at no expense to the Department may submit the third sub-sample (referee) to a mutually agreed upon Independent Laboratory. The Independent Laboratory shall be currently accredited to perform such testing by the AASHTO Accreditation Program (AAP).

If the Contractor desires to appeal the price adjustment for a particular PGAB grade production lot (5000 Tons of HMA or WMA), the Contractor shall submit a written request to the Project Manager, with a copy to the QC Engineer, within ten (10) Calendar Days of the reported test results. The request must describe in full the grounds of circumstances for the appeal. The appeal request will be reviewed by the Project Manager and Assistant District Engineer-Construction and either accepted or denied. If the appeal is denied, a letter from the Project Manager stating the grounds for denial will be sent to the Contractor and the price adjustment will be executed with a Change Order (Field Sheet).

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 Binder."

Table 402.2.6:1
OGFC Polymer-Modified Asphalt Binders

Properties	Requirements	
	PG 70-28+	PG 70-28R+
Terminal-Blended Tire Rubber Content, % minimum	-----	5.0
Styrene-Butadiene-Styrene (SBS) Polymer Content by Weight of Total Formulation, % minimum	-----	2.0
Solubility in Trichloroethylene, % minimum (Note 1), ASTM D 2042	97.5	97.5

Table 402.2.6:1
OGFC Polymer-Modified Asphalt Binders

Elastic Recovery @ 77°F, % minimum, AASHTO T 301	65	65
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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

Test	HFE-60	HFE-90	HFE-150	HFE-300
Viscosity, Saybolt Furol at 122 °F, Seconds	50+	50+	50+	50+
Sieve Test, Retained on No. 20 Sieve, %	0.10-	0.10-	0.10-	0.10-
Settlement, 5 Days, %	5-	5-	5-	5-
Storage Stability Test, 1 Day, %	1-	1-	1-	1-
Demulsibility, 1.2 fl oz 0.10 N, CaCl, %	30+	30+	—	—
Residue from Distillation Test to 500 °F	65+	65+	65+	65+
Oil Distillate by Volume of Emulsion, %	1-	3-	7-	7-
Coating Test, 3 minutes	Grades, stones coated thoroughly			
Tests on Residue from Distillation Test				
Penetration at 77 °F, 3.5 oz., 5 sec, 0.1 mm	60–90	90–150	150–300	300+
Float Test at 140 °F, Seconds	1,200+	1,200+	1,200+	1,200+

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

Test	HFE-60P	HFE-100P	HFE-150P	HFE-300P
Viscosity, Saybolt Furol at 122 °F, Seconds	50+	50+	50+	50+
Sieve Test, Retained on No. 20 Sieve, %	0.10-	0.10-	0.10-	0.10-
Storage Stability Test, 1 Day, %	1-	1-	1-	1-
Demulsibility, 1.2 fl oz 0.10 N, CaCl, %	30+	30+	—	—
Residue from Distillation Test to 400 °F	65+	65+	65+	65+
Oil Distillate by Volume of Emulsion, %	1-	3-	7-	7-
Tests on Residue from Distillation Test				

Table 402.2.7.2:1
Polymer-Modified High-Float Emulsions Requirements

Test	HFE-60P	HFE-100P	HFE-150P	HFE-300P
Penetration at 77 °F, 3.5 oz., 5 s, 0.1 mm	60–90	90–150	150–300	300+
Ductility 77 °F, 2 inch/min	40+	40+	40+	—
Elastic Recovery, %	55+ ^a	58+ ^a	25+ ^b	25+ ^b
Float Test @ 140 °F, Seconds	1,200+	1,200+	1,200+	1,200+

^aTest in accordance with AASHTO T 301 at a test temperature of 50 °F.

^bTest in accordance with AASHTO T 301 at a test temperature of 39.2 °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

Test	HFRS-2P
Viscosity, Saybolt Furol at 122 °F, Seconds	100–400
Sieve Test, Retained on No. 20 Sieve, %	0.10
Demulsibility, 1.2 fl oz 0.02 N, CaCl, %	40+
Residue from Distillation Test to 450 °F	65+
Oil Distillate by Volume of Emulsion, %	3.0-
Tests on Residue from Distillation	
Penetration at 77 °F, 3.5 oz., 5 s, 0.1 mm	90–150
Ductility 39.2 °F, 2 inch/min	20+
Elastic Recovery, % ^a	58+
Float Test at 140 °F, Seconds	1,200+

^aTest 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

Test	AE-P
Viscosity Saybolt Furol at 122 °F, Seconds	15–150
Settlement 24 h, %	1-
Residue from Distillation Test, %	65+
Oil Distillate by volume of Emulsion, %	25-
Tests on Residue from Distillation	
Solubility in Trichloroethylene, %	97.5+

402.2.7.5 Penetrating Emulsified Prime (PE-P)

Provide PE-P designated penetrating emulsified prime in accordance with Table 402.2.7.5:1, "Penetrating Emulsified Prime."

Table 402.2.7.5:1
Penetrating Emulsified Prime

Test	PE-P
Viscosity, Saybolt Furol at 122 °F, Seconds	75-
Sieve Test, Retained on 0.35 in Sieve, %	0.1-
Residue from Distillation Test, %	38+
Oil Distillate by volume of Emulsion, %	0-4

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 three percent (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 ¼-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

Chemical Compound	Percent by Weight
SiO ₂	6.7 to 10.7
Al ₂ O ₃	1.0 to 3.0
Fe ₂ O ₃	1.0 to 1.4
MgO	0.2 to 1.2
CaO	44.5 to 54.5
SO ₃	32.3 to 42.3

Table 402.2.10:2
Anhydrite Based Material Physical Properties

Property	Range
LOI, %	0.37 to 1.37
Passing #200 Sieve, %	98.8 to 100.0
Passing #325 Sieve, %	98.0 to 100.0
Specific Gravity	2.970 to 3.030

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 *Virgin Asphalt Material*, per lot, based on the following equation:

$$Q = T \times X \quad (1)$$

Where,

Q is the quantity of *Virgin Asphalt Material* (in tons)
 T is the quantity of placed and accepted asphalt pavement (in tons)
 X is the average percent virgin asphalt content in the asphalt pavement (per lot)

402.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Virgin Asphalt Material</i>	Ton
<i>Hydrated Lime</i>	Ton
<i>Anhydrite Based Material</i>	Ton

SECTION 403: OPEN-GRADED FRICTION COURSE (NON-QLA)

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 403.2.2:1
OGFC Gradation Requirements**

Sieve size	% passing
1/2 inch	100
3/8 inch	90 – 100
No. 4	25 – 55
No. 10	0 – 12
No. 40	0 – 8
No. 200	0 – 4

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 (2) 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 AI of 20 or less when calculated in accordance with Section 901, "QUALITY CONTROL/QUALITY ASSURANCE (QC/QA).";
4. The Department will allow the combination of Materials from two (2) or more sources to produce coarse aggregate only when each source independently meets the requirements of item three (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 $\pm 0.3\%$.

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 one percent (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 ten (10) foot straightedge to ensure the surface is free of irregularities larger than 1/8 inch. 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 inch.

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 (1) test per 250 tons of Material produced for the first 2000 tons of production, and test at least 500 tons of Material produced thereafter.

403.3.6.1.1 Suspension of Operations

If one (1) or more properties listed in Subsection 403.6.3, Department Quality Assurance Testing, fail to meet the specification requirements for a period of one (1) 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 403.3.7:1
Acceptance Limits and Factors

Characteristic	Specification limits
Asphalt Content	$\pm 0.3\%$ ^a
Hydrated Lime or Anhydrite based Material Content (If Required by the Mix Design)	$\pm 0.2\%$ ^a
1/2 inch	Gradation Band
3/8 inch	Gradation Band
No. 4	Gradation Band
No. 10	Gradation Band
No. 40	Gradation Band
No. 200	Gradation Band

^aPercent 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

The accepted quantities of the OGFC will be paid for at the contract unit price per square 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:

Pay Item	Pay Unit
<i>Open-Graded Friction Course</i>	Square Yard or Ton

403.5.1 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 403-A: WARM MIX ASPHALT – OPEN GRADED FRICTION COURSE (NON-QLA)

Warm mix asphalt (WMA) is a generic term used to describe the reduction in production, paving, and compaction temperatures achieved through the use of one (1) of the NMDOT approved WMA technologies.

Some modification to HMA plants may be necessary to accommodate the WMA technologies as noted in Section 424.3 Construction Requirements.

403-A.1 DESCRIPTION

This Work consists of constructing a warm-mix asphalt open-graded friction course (WMA-OGFC) on a prepared surface with a warm-mix additive or technologies, approved by the New Mexico Department of Transportation, and included the most current Approved Products List (APL).

Warm-Mix Asphalt shall be produced in a mixing plant and stored, hauled, placed and compacted in accordance with the requirements of this Section and as shown on the Plans. A technical representative of the Warm Mix Additive Supplier, including contact information, shall be provided in writing to the District prior to mix design process. The representative is expected to ensure that the Warm-mix additive is handled properly. This representative does not have the authority to allow any deviation from the Department Specifications and Project requirements.

403-A.2 MATERIALS

403-A.2.1 General

Provide WMA-OGFC composed of aggregate, asphalt binder, and hydrated lime or anhydrite based material.

WMA may be produced by one (1) or a combination of several technologies which may include WMA plant foaming processes and Equipment, mineral additives or chemicals that allow the reduction of the production temperatures.

403-A.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-A.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 403-A.2.2:1
OGFC Gradation Requirements**

Sieve size	% passing
1/2 inch	100
3/8 inch	90 – 100
No. 4	25 – 55
No. 10	0 – 12
No. 40	0 – 8
No. 200	0 – 4

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 (2) 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 AI of 20 or less when calculated in accordance with Section 901, "QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)";
4. The Department will allow the combination of Materials from two (2) or more sources to produce coarse aggregate only when each source independently meets the requirements of item three (3), above.

403-A.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-A.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-A.2.5 Mix Design

A Department approved Private Testing Lab will develop the WMA -OGFC mix design in accordance with ASTM D 7064, "Standard Practice for Open Graded Friction Course (OGFC) Mix Design", as modified by the New Mexico Department of Transportation State Asphalt Engineer. The mix design shall be signed by a professional Engineer licensed by the NM Board of Registration for Professional Engineers and Land Surveyors. The JMF gradation will be within the master range for the specified type of WMA-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. The Mix Design shall identify the minimum and maximum mixing and placement temperatures of the mix. Add a minimum of one percent (1%) hydrated lime or anhydrite based material, include it in the gradation for establishing the mix design.

403-A.2.6 Warm Mix Additive or Technology

Only Warm Mix additives or technologies approved by the Product Evaluation Program and currently listed on the Approved Products List can be used on Department Projects. To be placed on the Approved Products list, the WMA additive Supplier shall verify that the binder with the additive meets the PG grade of the specified binder. The potential additive Supplier shall demonstrate this to the Department by evaluating the Asphalt Binder and WMA additive for compliance with the rheological properties for low and high temperatures for the specified PG grade in accordance with AASHTO M320, Table 1 and Section 402.2.6, Polymer-Modified Asphalt Binder. The type and dosage of Warm Mix Additives shall comply with the requirements of the Warm Mix additive Supplier. The type and/or dosage of the WMA additives shall be provided to the Project Manager two (2) weeks prior to the commencement of pavement operations. Warm Mix additive dosage rates shall not deviate from those designated by the Warm Mix Additive Supplier. If a terminal blend Warm Mix additive is used, the dosage rate shall be shown on the Materials Certificate of Compliance.

After the Warm Mix Additive is introduced, the PG grade of the binder shall comply with the PG grade as specified in the Contract.

For foamed asphalt systems, water used as directed by the foamed asphalt system manufacturer shall be considered to be the Warm Mix additive. Only foam systems on the Department's Approved Products List shall be used.

403-A.3 CONSTRUCTION REQUIREMENTS

403-A.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 $\pm 0.3\%$.

403-A.3.2 Preparation of Roadbed

Before placing WMA-OGFC, clean Deleterious Materials from the existing surface.

403-A.3.3 Temperature and Weather Limitations

Do not place WMA-OGFC on wet surfaces or when the Project Manager determines that the weather conditions prevent proper handling and finishing. Place WMA- OGFC when the Chill Factor is at least 55 °F. If the air temperature is 90 °F or warmer, do not consider the Chill Factor.

403-A.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. Some modification to HMA plants may be necessary to accommodate the WMA technologies as noted in Section 424.3 “Construction Requirements”;
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 mixing and placement temperature for the mixture do not exceed or fall below the temperatures established in the approved mix design, and
6. Indicate which warm mix technologies are to be incorporated into the mix design.

The Mix Design will specify whether to add hydrated lime or anhydrite based material and how much to use.

403-A.3.5 Placement and Finishing

Place the WMA-OGFC with a paving machine in accordance with Section 424.3.4.3, “Pavers.” The Project Manager may require an external reference of at least 40 ft to improve the ride ability. 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 ten (10) foot straightedge to ensure the surface is free of irregularities larger than 1/8 inch. Immediately remove low and defective areas, replace them with new, hot OGFC, and compact the corrected Work to conform to the surrounding area.

403-A.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 inch.

403-A.3.6 Sampling and Testing

403-A.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 (1) 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-A.3.6.1.1 Suspension of Operations

If one (1) or more properties listed in Subsection 403-A.3.6.2, Department Quality Assurance Testing, fail to meet the specification requirements for a period of one (1) 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-A.3.6.2 Department Quality Assurance

403-A.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-A.3.6.2.1:1 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 403-A.3.6.2.1:1
Acceptance Limits and Factors**

Characteristic	Specification limits
Asphalt Content	$\pm 0.3\%^a$
Hydrated Lime or Anhydrite based	$\pm 0.2\%^a$

Table 403-A.3.6.2.1:1
Acceptance Limits and Factors

Characteristic	Specification limits
Material Content (If Required by the Mix Design)	
1/2 inch	Gradation Band
3/8 inch	Gradation Band
No. 4	Gradation Band
No. 10	Gradation Band
No. 40	Gradation Band
No. 200	Gradation Band
^a Percent difference from TV of approved JMF.	

403-A.4 METHOD OF MEASUREMENT

403-A.4.1 WMA-OGFC

WMA-OGFC will be measured by the square yard or ton. The average width of the WMA-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-A.5 BASIS OF PAYMENT

The accepted quantities of the WMA-OGFC will be paid for at the Contract unit price per square 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:

Pay Item	Pay Unit
<i>Open-Graded Friction Course</i>	Square Yard or Ton

403-A.5.1 Price Adjustments

A price reduction in accordance with the Department's Price Reduction Guidelines will be applied if the WMA-OGFC, bituminous material, or hydrated lime are not produced, mixed, or placed in accordance with the Contract requirements.

404.1.0 DESCRIPTION

Rubberized Open Graded Friction Course (ROGFC) shall consist of furnishing all Materials, mixing at a plant, hauling and placing a mixture of open graded aggregate Materials, and asphaltic cement binder to form a permeable pavement Surface Course.

Section 403 Open Graded Friction Course (NON-QLA) shall be complied with except as modified herein:

404.2.0 MATERIALS**404.2.1 General**

Terminal blended asphalt rubber binder shall consist of a uniform homogeneous mixture of tire rubber obtained from recycled tires, and compatible PG 70-28⁺ asphalt binder. All binder components shall be thoroughly blended and reacted prior to use.

404.2.2 Asphalt Cement

The PG 70-28⁺ asphalt cement for the asphalt rubber binder shall comply with the requirements of Section 402 "Asphalt Materials, Hydrated Lime, and Anhydrite Based Materials" for PG 70-28R⁺.

404.2.3 Tire Rubber Modifier

Tire rubber modifier (TRM) shall be produced from the recycling of automobile and/or truck tires. The specific gravity of the TRM shall be 1.15 +/- 0.05. The fiber content shall be less than 0.5% by weight for all other applications. The TRM shall contain no metal particles. Mineral contaminates shall be less than 0.25% by weight.

The metal content shall be determined by thoroughly stirring a 50 gram sample of the TRM with a magnet.

Determine the mineral contaminate by *Saline Float Separation Method*:

- Stir a 50 gram sample of TRM into a one (1) liter glass beaker filled with a saline solution (1 part table salt into 3 parts distilled water) and allow the sample to stand undisturbed for 30 minutes. The mineral contaminate is that material which does not float to the top of the solution.

404.2.4 Asphalt Rubber Binder Formulation Design

The asphalt rubber binder shall contain a minimum of ten percent (10%) TRM and a minimum of two percent (2%) styrene-butadiene-styrene (SBS) polymer by weight of total formulation that shall comply with the requirements of Table A. The design for the asphalt rubber binder formulation shall be performed by the asphalt rubber Supplier.

The terminal-blended asphalt rubber binder shall conform to the requirements of AASHTO M320, as well as the requirements in Table A. If the solubility of the terminal-blended asphalt rubber binder is less than 97.5%, the base asphalt binder shall be tested. The solubility of the base asphalt binder shall be greater than 99%.

The Contractor shall provide the Project Manager with a copy of the terminal-blended asphalt rubber binder formulation design at least 15 Calendar Days prior to use. The design shall include:

- a. Source;
- b. Grade;
- c. Type;

- d. Proportion expressed as a percentage of total weight of the formulation for each component material;
- e. Physical properties of the asphalt rubber binder in accordance with Table 404.2.4:1; and
- f. Recommended mixing and compaction temperatures for intended use.

Table 404.2.4:1

Test Properties	Specification		
	Minimum	Maximum	
Whole Ground Tire Rubber Content, %	10.0		
COC Flash Point, °C (°F)	230 (446)		AASHTO T48
Elastic Recovery, 10 °C (50 °F), %, 5cm/min, hold 5 minutes and cut, % recovery after 1 hour	65		AASHTO T301
Solubility in Trichloroethylene, %	98.0		AASHTO T44
Original DSR, $G^*/\sin\delta$ @ 70 °C, 10 rad/sec,KPa	1.00		AASHTO T315
RTFO Aging, $G^*/\sin\delta$ @ 70 °C, 10 rad/sec,KPa	2.20		AASHTO T240
PAV Aging, $G^*/\sin\delta$ @ 25 °C, 10 rad/sec,KPa		5000	AASHTO T315
Creep stiffness, S, MPa		300	AASHTO T313
M-Value @60s, °C	0.300		AASHTO T313

404.2.5 Mix Design

A Department approved Private Testing Lab will develop the Rubberized OGFC mix design in accordance with ASTM D 7064, "Standard Practice for Open Graded Friction Course (OGFC) Mix Design", as modified by the New Mexico Department of Transportation State Asphalt Engineer. The mix design shall be reviewed and signed by a professional Engineer licensed by the New Mexico Board of Registration for Professional Engineers and Land Surveyors. 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 either hydrated lime or anhydrite based material as an anti-strip, at a minimum of one (1) percent, by weight. The mix design shall indicate the amount used and it shall be included in the aggregate gradation for establishing the mix design. The Mix Design shall identify the minimum and maximum mixing and placement temperatures of the mix.

Mix aggregate with asphalt at three (3) asphalt contents in 0.5% increments. Three (3) specimens should be compacted to optimum and three (3) specimens each at both 0.5% above and 0.5% below the estimated optimum asphalt content. Estimate the optimum asphalt content as follows:

For <3 % aggregate absorption, use estimated optimum AC = 6.5%;

For >3 % aggregate absorption use estimated optimum AC = 7.0%.

Determine the maximum specific gravity (G_{mm}) of the loose mix in accordance with AASHTO T 209 using a companion sample mixed with the middle increment of AC content.

Perform the drain down test in accordance with AASHTO T305. If the sample has a drain down in excess of 0.3 %, make the necessary adjustments in the AC content or aggregate gradation and repeat the test.

Evaluate the stripping potential in accordance with the Static Immersion Test described below. If less than 95% of the binder is retained, repeat the test using an appropriate

adjustment to the type of anti-strip agent used and/or the amount of anti-stripping agent. Retention greater than 95% of the binder is required in order for the ROGFC mix to be approved for use on this Project.

The Mix Design shall provide the terminal-blended asphalt rubber binder formulation design, including:

- a. Source;
- b. Grade;
- c. Type;
- d. Proportion expressed as a percentage of total weight of the formulation for each component material;
- e. Physical properties of the asphalt rubber binder in accordance with Table 402.2.6.1; and
- f. Recommended mixing and compaction temperatures for intended use.

404.2.6 Static Immersion Test Procedure

404.2.6.1 Scope

This method describes coating and static immersion procedures for determining the retention of a bituminous film on an aggregate surface in the presence of water.

404.2.6.2 Significance and Use

The purpose of the test is to evaluate the effectiveness of an anti-strip additive in the asphalt coating of aggregate used for Open Graded Friction Course (OGFC).

This test evaluates the effectiveness of the anti-strip additive with specific asphalt and a specific aggregate. Different asphalts and aggregates will give variable response to this test with the same additive.

This procedure is to be used as a go/no-go test at the ninety-five percent (95%) level. No attempt shall be made to evaluate the retention of a film below 95%.

If both hydrated lime and anhydrite based material provide retention of 95% or greater, the Contractor may choose which anti-strip material will be used.

This test is a static immersion test and should not be confused with the immersion-compression test.

404.2.6.3 Apparatus

1. Containers for mixing such as stainless steel bowls or seamless tin cans.
2. Hot Plate or Oven for bringing the asphalt and aggregate to suitable mixing temperatures.
3. Oven or Water Bath capable of maintaining a constant temperature of 140 °F for 24 hours.
4. Pyrex Beakers or other suitable glass containers, 600 ml capacity.
5. Spatula for mixing.

404.2.6.4 Sample Preparation

Select a representative sample of the aggregate passing the 3/8" sieve and retained on the No. 4 sieve. Dry and weigh the aggregate, then add sufficient water (2 to 4%) to obtain proper coating of the aggregate with the proposed anti-strip material. When aggregate is thoroughly moistened, weigh in one percent (1%) anti-strip, by weight of dry aggregate and thoroughly mix to coat all aggregate surfaces with the anti-strip material. Air or oven dry as time permits.

Place 100 +/- 1 grams of the anti-strip treated minus 3/8 inch plus #4 material into a clean mixing container and heat in the oven or on the hot plate to proper mixing temperature.

Add sufficient heated PG 70-28R⁺ to completely cover all aggregate surfaces. Mix asphalt and aggregate with heated spatula until aggregate is thoroughly coated.

Place mixed material into a Pyrex beaker and allow cooling for at least two (2) hours.

404.2.6.5 PROCEDURE

Cover mixed material in the beaker with about 2 1/2 inches of distilled water at room temperature.

Place the beaker in an oven or water bath at 140 °F for 24 hours.

Remove the beaker from the oven or water bath and without disturbing or agitating the coated aggregate; remove any film on the surface of the water.

Place the beaker in an area with good light and position it to eliminate glare from the surface of the water. By observation through the water from above estimate the percentage of the total visible area of the aggregate which remains coated as greater than, or less than 95%.

Report the estimated coated area as "greater than 95%" or "less than 95%".

404.3 CONSTRUCTION REQUIREMENTS

404.3.1 Placement and Finishing

Place the ROGFC 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 ride ability. Immediately following the ROGFC 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 (ROGFC) shall be smooth and in accordance with Section 401.3.1.4, "Profile Measurement Operations." Use a ten (10) foot straightedge to ensure the surface is free of irregularities larger than 1/8 inch. Immediately remove low and defective areas, replace them with new, hot ROGFC, and compact the corrected Work to conform to the surrounding area.

Note: All requirements for OGFC "Section 401 Pavement Smoothness Measurement" shall apply to ROGFC.

404.4.0 METHOD OF MEASUREMENT

ROGFC will be measured by the square yard or ton. The average width of the ROGFC 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.

404.5.0 BASIS OF PAYMENT

The accepted quantities of the ROGFC will be paid for at the Contract unit price per 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 Materials, binders, modifiers, asphalt cement, hydrated lime, and anhydrite based material if required.

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:

Pay Item

Rubberized Open Graded Friction Course Complete

Pay Unit

Ton

404.5.1 Price Adjustments

A price reduction in accordance with the Department's Price Reduction Guidelines will be applied if the ROGFC, bituminous material, hydrated lime, or anhydrite based material are not produced, mixed, or placed in accordance with the Contract requirements.

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 two (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 (2) 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 405.2.3:1

Acceptance Testing Tolerances

Description	Structural coefficient
Base Course	0.11
Hot-mix asphalt (HMA)	0.44
Cold-mixed asphalt pavement ^a	0.15

^aThe 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 two (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, "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" and Section 702, "Construction Control Devices."

405.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Detour Pavement Construction</i>	Square Yard

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 HMA/WMA, 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.

SECTION 407: TACK COAT

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 (1) 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

Pay Item

Asphalt Material for Tack Coat

Section 407: Tack Coat

Pay Unit

Ton

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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 (1) 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 408.2.2:1
Blotter Material**

Sieve size	% passing
3/8 inch	100
No. 4	80 – 100
No. 16	45 – 80
No. 50	10 – 30
No. 100	2 – 10

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 h 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

Pay Item	Pay Unit
<i>Prime Coat Material</i>	Ton

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 (1) 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 one (1) inch 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 inch to provide a minimum sealant reservoir of 1/2 inch wide and to a depth of from 3/4 inch to one (1) inch, unless

otherwise directed by the Project Manager. Center routers over the cracks during routing operations.

Clean cracks with an average clear opening 1/2 inch or greater with high-velocity compressed air to a depth of from 3/4 inch to one (1) inch, 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 inch to 1/4 inch 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.

Follow special preparation or placement requirements indicated by the manufacturer.

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—Reserved

411.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Hot-Poured Crack Sealing</i>	Pound

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/WMA 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 Roadway's binder properties. The existing Roadway'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 Roadway 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/WMA

Provide the HMA Material and mix design in accordance with Section 423, "Hot-Mix Asphalt (QLA & Non-QLA)" or WMA Material and mix design in accordance with Section 424, "Warm Mix Asphalt (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. Submit a Quality Control Plan in accordance with the most recent Department's Contractor Quality Control Guidelines for the Project Manager's approval. 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/WMA.

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 or WMA. 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 or WMA 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 four (4) inches 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 or WMA 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."

412.3.3.4 Project Verification Testing

Place new HMA Materials in accordance with Section 423.3.6.4, "Independent Assurance Testing" or WMA Materials in accordance with Section 424.3.6.4, "Independent Assurance Testing."

412.3.4 Department Quality Assurance

412.3.4.1 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. New WMA Materials shall meet the requirements of Section 424.3.6, "Sampling and Testing," with the exception that the Department will base Acceptance on random test samples taken from the WMA windrow before the Material goes through the paver.

412.3.4.2 Department Quality Assurance Testing for HMA or WMA Compaction

The Department will test in accordance with Section 423.3.6, or 424.3.6, "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 three percent (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 or WMA at no additional cost to the Department; or
2. Accept the HMA or WMA 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.

412.3.4.3 Department Quality Assurance Testing for HMA/WMA Smoothness

If the Contract requires two (2) or more layers of new HMA/WMA Material, place in accordance with Section 401, "Pavement Smoothness Measurement." For the purposes of this section, Hot Recycled insitu material is not defined as HMA.

412.4 METHOD OF MEASUREMENT

The Department will measure HMA in accordance with Section 423.4, "Method of Measurement" or WMA in accordance with Section 424.3, "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" or WMA Material in accordance with Section 424.5, "Basis of Payment."

Pay Item	Pay Unit
<i>Hot In-place Recycling of Asphalt Pavement</i>	Square Yard
<i>Rejuvenating Agent</i>	Gallon

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 or WMA 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 Roadway binder properties. Extract, recover, and combine the existing Roadway'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 Roadway 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 — (QLA & Non-QLA)" Or WMA Material in accordance with Section 424, "Warm Mix Asphalt (QLA & non-QLA)."

Provide a HMA mix design in accordance with subsection 423.2, "Materials" or a WMA mix design in accordance with subsection 424.2, "Materials". The State Materials Bureau must approve the HMA or WMA 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. Submit a Quality Control Plan in accordance with the most recent Department's Contractor Quality Control Guidelines for the Project Manager's approval. 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 one (1) inch.

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 one (1) inch. The unit shall loosen the in-place asphalt pavement to a minimum depth of one (1) inch 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 or WMA.

Coordinate the repaver speed with the production of the HMA or WMA plant to achieve a continuous operation.

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 one (1) inch, in accordance with the Plans. Heat the existing pavement surface with continuously moving heaters to scarify the pavement to at least a one (1) inch 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 four (4) inches 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 inch 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 or WMA on top of the recycled paving material using a four-section vibratory screed. Perform this in one (1) 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 four (4) inches 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 asphalt mixture.

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 or WMA 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 inches 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" or WMA Materials in accordance with Section 424.3/6.1, Contractor Quality Control," except take random test samples from the HMA or WMA 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."

413.3.3.4 Project Verification Testing

New HMA Material is subject to Independent Assurance Testing in accordance with Section 423.3.6.4, "Independent Assurance Testing. New WMA Material is subject to Independent Assurance Testing in accordance with Section 424.3.6.4. "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," and new WMA Materials shall meet the requirements of Section 424.3.6.2.1, "Acceptance," with the exception that the Department will base Acceptance on random test samples taken from the HMA or WMA 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" Or Section 424.3.6.2.1, "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 or WMA 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 or WMA 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/WMA Smoothness

If the Contract requires two (2) or more lifts of new HMA/WMA Material, place in accordance with Section 401, "Pavement Smoothness Measurement." For the purposes of this section, Hot Recycled Insitu material is not defined as HMA.

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."

Pay Item	Pay Unit
<i>Single-Machine Hot In-Place Surface Repaving</i>	Square Yard
<i>HMA or WMA Sampling and Testing by the Contractor</i>	Lump Sum
<i>Rejuvenating Agent</i>	Gallon

414.1 DESCRIPTION

This Work consists of cold milling pavement surfaces and removing, hauling, and disposing of cold-milled Materials.

414.2 MATERIALS—Reserved**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 inch 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 inch, as directed by the Project Manager.

Minimize gouges, grooves, and ridges to create a uniform surface without deviations greater than 1/2 inch when measured with a ten (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 48 hours 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 inch, if by the square yard-inch.

414.5 BASIS OF PAYMENT

Pay Item*Cold Milling (Asphalt)**Cold Milling (Concrete)**Patching of Milled Surface***Pay Unit**

Square Yard-Inch or Square Yard

Square Yard-Inch or Square Yard

Ton

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) or Warm Mix Asphalt (WMA) 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 or WMA.

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 (1) 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 415.2.1:1
Cold Recycled Pavement Gradation Requirements**

Sieve size	% passing
1 1/4 inch ^a	100
One (1) inch	90–100

^aAllow 1 1/2 inch 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

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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 or WMA inlay. Provide HMA or WMA in accordance with a Department-recognized HMA/WMA mixture type, with a nominal size of at least 3/4 inch or greater, and Section 423, "Hot-Mix Asphalt — (QLA & Non-QLA) Or Section 424, "Warm Mix Asphalt." 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 (QLA & Non-QLA)" or Section 424, "Warm Mix Asphalt (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 (1) 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 two percent (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 (2) 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 \pm ten percent (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 (1) 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 a pneumatic roller that weighs at least 30 ton for the breakdown roller. 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 or WMA Inlay

Provide and use Equipment in accordance with Section 423, "Hot-Mix Asphalt (QLA & Non-QLA)," Section 424, "Warm Mix Asphalt (QLA & Non-QLA)" Section 407, "Tack Coat," and Section 414, "Cold Milling."

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 four (4) inches and the specified width, or as directed by the Project Manager. Begin placing the HMA or WMA overlay of the in-situ cold recycled layer within one (1) week 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 one (1) inch 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 (1) 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 inch when measured with a ten (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 $\pm 0.2\%$ 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 (2) 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 one percent (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.

The State will 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 one percent (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 or WMA Inlay

Ensure that Option B Work has a minimum depth of three (3) inches, 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."

415.3.3 Contractor Quality Control

415.3.3.1 Contractor Quality Control for Materials

Place new HMA Materials in accordance with Section 423.3.6.1, "Contractor Quality Control" or WMA in accordance with Section 424.3.6.1, "Contractor Quality Control" except take random test samples from the HMA windrow before the Material goes through the paver.

415.3.3.2 Contractor Quality Control for Compaction

See Section 423.3.6.1.2, Contractor Quality Control for Compaction.

415.3.3.4 Project Verification Testing

Place new HMA Material in accordance with Section 423.3.6.4, "Independent Assurance Testing" or WMA Material in accordance with Section 424.3.6.4, "Independent Assurance Testing."

415.3.4 Department Quality Assurance

415.3.4.1 Department Quality Assurance for HMA/WMA

New HMA Materials shall meet the requirements of Section 423.3.6.2.1, "Acceptance" and new WMA Materials shall meet the requirements of Section 424.3.6.2.1, "Acceptance," with the exception that the Department will base Acceptance on random test samples taken from the HMA or WMA before the Material goes through the paver.

415.3.4.2 Department Quality Assurance Testing for HMA or WMA Compaction

Meet the requirements of Section 423.3.6.2.1, "Acceptance" Or Section 424.3.6.2.1, "Acceptance," as appropriate. 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 or WMA 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 three (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.

415.4 METHOD OF MEASUREMENT—Reserved

415.5 BASIS OF PAYMENT

All Process Control and Quality Control Testing required shall be Incidental to Pavement Surface Restoration.

Pay Item	Pay Unit
<i>Pavement Surface Restoration</i>	Square Yard

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 one percent (1%) to two percent (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 (1) or more courses of HMA or WMA pavement on a prepared base in accordance with the Plans or as directed by the Project Manager. All Projects with less than 5,000 tons of HMA or WMA shall be paid as Minor Paving. Projects with less than 15,000 tons may be designated as Minor Paving in the Plans.

Examples of minor paving locations may include the following:

1. Bridge approaches;
2. Intersection improvements;
3. Auxiliary lanes; and
4. Turnouts.

416.2 MATERIALS

Use HMA or WMA of the type and gradation shown in the Contract for minor paving. HMA and WMA are a mixture of asphalt binder, aggregate, blending sand, mineral filler, hydrated lime, or anhydrite based material, WMA additive or process, as appropriate. Use Materials for minor paving in accordance with Section 423.2, "Materials" or 424.2, "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" or in accordance with the appropriate 424 Sections. No referee testing will be required for Minor Paving. Referee Testing may be used if both parties agree in writing prior to commencing placement operations for Minor Paving.

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 in accordance with AASHTO T 310, Standard Method of Test for In-Place Density and Moisture Content of Soil-Aggregate by Nuclear Methods (Shallow Depth). Contractor shall provide cores from three (3) locations designated by the Project Manager for correlation with the Nuclear Densometer.

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 all density tests per Project, taken at a minimum of ten (10) density tests per 5,000 tons, and will accept air voids and asphalt content based on a minimum of three (3) tests per 5,000 tons.

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 416.3.1.2.1:1
Price Adjustments for Density**

Percent density	Pay factor (%)
> 97.99	Reject
97.0 – 97.99	90
96.0 – 96.99	95
– 95.99	100
93.0 –	100
92.0 – 92.99	95
91.0 – 91.99	90
90.0 – 90.99	80
< 90.00	Reject

**Table 416.3.1.2.1:2
Price Adjustment for Air Voids**

Percent deviation from TV	Pay factor (%)
< 1.3	100
1.31 – 1.69	90
1.7 – 1.99	75
≥ 2.0	Reject

**Table 416.3.1.2.1:3
Price Adjustment for Asphalt Content**

Percent deviation from TV	Pay factor (%)
< 0.29	100
0.30 – 0.49	90
≥ 0.5	Reject

**Table 416.3.1.2.1.1:4
Price Adjustment for Thickness**

Deficiency from plan minimum thickness	Pay factor (%)
None (Plan Minimum or Thicker)	100
<1/4 inch	100
1/4 inch–1/2 inch	90
1/2 inch–3/4 inch	75
3/4 inch–one (1) inch	50
>one (1) inch	Corrective action

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**

HMA Type	Lift Thickness (Inches)	
	Minimum	Maximum
SP-III	2.5	3.5
SP-IV	1.5	3.0

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—Reserved

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.”

Pay Item	Pay Unit
<i>Minor Pavement</i>	Square Yard

417.1 DESCRIPTION

This Work consists of constructing one (1) 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, or as designated in the Plans.

417.2 MATERIALS

The asphalt paving consists of coarse and fine aggregates, asphalt binder, mineral filler, and hydrated lime or anhydrite based material.

417.2.1 Aggregate

Use aggregate that meets the requirements in Table 417.2.1:1, "Aggregate Gradation Requirements."

Table 417.2.1:1
Aggregate Gradation Requirements

Sieve size	% passing
3/4 inch	100
No. 4	40 – 70
No. 200	< 10

Coarse aggregate shall have an AI of 30 or less in accordance with Section 901, "QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)." 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 four percent (4%) or less, except for ditch paving, which shall have a design air voids of three percent (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 35% 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)" or Section 424, "Warm-Mix Asphalt (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." No referee testing will be required for Miscellaneous Paving. Referee Testing may be used if both parties agree in writing prior to commencing placement operations for Miscellaneous Paving.

417.3.2 Haul Equipment

Use haul Equipment in accordance with Section 423.3.4.2, "Haul Equipment."

417.3.3 Placement Operations

Unless otherwise specified in the Contract, prepare the surface by compacting the top six (6) inches of soil to 95% of maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (TTTCP Modified). 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 guardrail pads and bicycle/pedestrian paths and trails.

Evaluate density with nuclear methods and calibrate with the test area produced at the beginning of paving. For the test area, place the HMA at the proper compaction temperature and thickness (as shown on the Plans). Run three (3) 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 yd², or per guardrail pad. Take three (3) nuclear density readings at random locations within the first test area, and use the average of the three (3) tests or determination of the maximum density to be used for Acceptance and pay factor. The Department will determine the pay factor for each lot in accordance with Table 417.3.5:1, "Price Adjustments for Density":

Table 417.3.5:1
Price Adjustments for Density

Density, percent of test area	Pay factor (%)
≥ 98	100
95.0 – 97.9	95
92.0 – 94.9	80
< 92.0	Reject

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—Reserved

417.5 BASIS OF PAYMENT

The Department will adjust payment for miscellaneous paving in accordance with Section 417.3.5, "Acceptance."

Pay Item

Miscellaneous Paving

Asphalt Curb

Pay Unit

Square Yard

Linear foot

423.1 DESCRIPTION

This Work consists of constructing one (1) 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. Unless otherwise prohibited in the Contract, the Department will allow Recycled Asphalt Pavement (RAP) in HMA mixtures as long as the resulting mixture conforms to all specification requirements.

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

Ensure the aggregate gradation of the HMA mixture meets 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 determines 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 (2) or more sources to produce aggregate only when each individual aggregate source meets all applicable quality requirements.

423.2.2.1 Gradation and Quality Requirements

**Table 423.2.2.1:1
HMA Aggregate Gradation Control Points**

Sieve size	% passing per HMA type					
	SP-II		SP-III		SP-IV	
	Min	Max	Min	Max	Min	Max
two (2) inch	—	—	—	—	—	—
1 1/2 inch	100	—	—	—	—	—
One (1) inch	90	100	100	—	—	—
3/4 inch	—	90	90	100	100	—
1/2 inch	—	—	—	90	90	100
3/8 inch	—	—	—	—	—	90
No. 8	19	45	23	49	28	58
No. 200	1.0	7.0	2.0	8.0	2.0	10.0

423.2.2.1.1 Aggregate Quality

For each Material source, ensure the HMA coarse aggregate has an AI of 25 or less when calculated in accordance with Section 901, "QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)."

Regulate the crushing of aggregate stockpiles so that the minimum Fractured Faces content of the plus No. 4 Material complies with the requirements of Table 423.2.2.1.2:1, "Fractured Faces, Sand Equivalent, and Fine Aggregate Angularity," and evaluation by NMDOT

Method FF-1, “*Fractured Face Determination for Coarse Aggregate*.” Ensure the plus 3/8 inch material contains no more than 20% flat, elongated particles with a dimensional ratio of 3:1 or greater as determined by ASTM D 4791 (TTCP Modified). Ensure the combined material, excluding RAP, passing the No. 40 sieve is non-plastic. Ensure that 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, complies with the requirements of Table 423.2.2.1.2:1, “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.

Table 423.2.2.1.2:1
Minimum Fractured Faces, Sand Equivalent, and Fine Aggregate Angularity for Virgin Aggregates

Design Traffic, ESALs ^a x 10 ⁶	Fractured Faces ^b	Sand Equivalent (%)	Fine Aggregate Angularity
< 3.0	75.0 / —	45.0	40.0
≥ 3.0 – < 10.0	85.0 / 80.0	45.0	45.0
≥ 10.0 – < 30.0	95.0 / 90.0	45.0	45.0
≥ 30.0	99.0 / 95.0	50.0	45.0

^aESALs are based on a 20-year design life for all scenarios.

^bUnder “Fractured Faces”, 85.0 / 80.0 denotes that 85.0% of the coarse aggregate has at least 1 Fractured Face and 80.0% has at least two (2) Fractured Faces.

Ensure RAP provided from sources outside the Project has at least 75% Fractured Faces (one (1) Fractured Face); however, Sand Equivalent and Fine Aggregate Angularity do not apply.

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 (2) 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 mix design 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. The Contractor may use RAP produced from outside sources provided evidence of ownership is supplied and the following is met: 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 of 75% Fractured Faces content (one (1) face).

The Contractor may use a maximum of 15% RAP (by weight) in the production of HMA mixtures without changing the asphalt binder. For quantities greater than 15% to 25% RAP, either lower the asphalt binder's high and low temperature grades by one (1) grade (e.g. lower a PG 76-22 to a PG 70-28) or extract, recover, and combine the RAP's asphalt binder with a virgin asphalt binder per AASHTO M 323, Appendix A, ensuring the resultant binder meets the entire AASHTO M 320 required Project PG asphalt binder properties indicated on the approved mix design. For quantities greater than 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. For Projects of entirely new construction, limit the RAP to 15% in the top mat or extract, recover and combine the RAP's asphalt binder with a virgin asphalt binder per AASHTO M323, Appendix A. Ensure the resultant binder meets the entire AASHTO M320 required Project PG asphalt binder properties indicated on the approved mix design.

Process RAP so that 100% passes a 1-1/2-inch sieve. For HMA mixtures containing greater than 15% RAP, maintain adequate stockpile management (i.e. sufficient quantities and shaping of the stockpiles) and fractionation (divide the RAP into a minimum of two (2) stockpiles), so they are uniform throughout the stockpiles. Address in the Quality Control Plan how RAP will be controlled, such as which screen will be used to split into two (2) stockpiles, or by what method the RAP will be controlled to keep the resultant mix within acceptable limits. 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 asphalt binder in the RAP or asphalt binder due to asphalt binder grade adjustment. As RAP is produced and prepared for inclusion in the HMA, perform Process Control testing in accordance with Section 901, "Quality Control/Quality Assurance," Table 901.7.3, Minimum Process Control Guidelines for Aggregates and Base Course.

If problems with HMA consistency or compliance with Project Specifications occur, additional efforts taken to achieve acceptable levels of consistency and compliance with Contract Specifications, at the Contractor's discretion (at no additional cost to the Department), include, but are not limited to:

- Reduce the top size of the RAP from 1-1/2" to 1";
- Fractionate the aggregates on a second screen, such as the 3/8" or 1/4" Screen so that the RAP is maintained in three (3) stockpiles, one being Rap larger than 1-1/2" to 2", Coarse RAP and the third being Fine RAP;
- Ensure that the RAP used in the HMA mix design is representative of the RAP available on the Project;
- Cover the RAP pile(s) so that ambient moisture is not absorbed; and
- Process and maintain the stockpiles so that the RAP material is equally and uniformly distributed throughout the entire stockpile(s) and is withdrawn such that uniform, non-segregated RAP is delivered to the hoppers.

423.2.8 Mix Design

Provide a mix design developed by a Department-approved testing Laboratory, reviewed and signed by a professional Engineer licensed by the New Mexico Board of Registration for Professional Engineers and Land Surveyors. 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 prior to the Project Pre-Paving Conference. Submit at least five (5) 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 Asphalt Engineer. 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 Project Manager and State Asphalt Engineer for review and concurrence by the State Asphalt Engineer. 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 one percent (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 shall 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. AASHTO TP 77 may be used in lieu of AASHTO T 84/T 85. The mix design shall be in accordance with Table 423.2.8:1, "HMA Superpave Design Requirements for Aggregates with Less Than three percent (3.0%) Absorption," or Table 423.2.8:2, "HMA Superpave Design Requirements for Aggregates with three percent (3.0%) or Greater Absorption."

Test the HMA with at least one percent (1.0%) hydrated lime or anhydrite based material in accordance with AASHTO T 283, as modified below:

- Use six (6) inch by 3.75 inch specimens for all prisms;
- Compact all test specimens in accordance with AASHTO T 312 to an air content of seven percent (7%) +/- 0.5%;
- On the AASHTO T283 Section 11.3 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 a minimum of one percent (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 one (1), as determined by AASHTO T283 Section 11.3. 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, 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

(a) 20-year design ESALs	N initial	N design (b)	N max	Percent Voids in the Mineral Aggregate (VMA) per nominal aggregate size maximum			Voids Filled with Asphalt (VFA) Range, % (c)	Dust to Binder Ratio Range
				One (1) inch (SP-II)	3/4 inch (SP-III)	1/2 inch (SP-IV)		
< 0.3	<91.5			12.5	13.5	14.5	72.0–80.0	0.6 to 1.4
0.3–<3.0	<90.5	96.0	< 98.0	14.0	15.0	16.0	68.0–78.0	
≥3.0	<89.0						68.0–75.0	

^aIn Millions

^bDesign Air Void Content of four percent (4%)

^cFor one (1) inch nominal maximum size mixtures, the specified lower limit of the VFA shall be 70% for the design traffic level <0.3 million ESALs.

Table 423.2.8:2
HMA Superpave Design Requirements for Aggregates with 3.0% or Greater Absorption

(a) 20-year design ESALs	N _{initial}	N _{design} (b)	N _{max}	Percent Aggregate	Voids in the	Mineral	Voids Filled with Asphalt (VFA) Range, % (c)	Dust to Binder Ratio Range
				maximum (SP-II)	aggregate size (SP-III)	nominal (SP-IV)		
				One (1) inch				
<0.3	<91.5						70.0–80.0	
0.3–<3.0		96.5	< 98.0	12.0–14.0	13.0–15.0	14.0–16.0	65.0–78.0	0.6 to 1.4
≥3.0	<89.0						65.0–78.0	

^aIn Millions

^bDesign Air Void Content of 3.5%

^cFor one (1) inch nominal maximum size mixtures, the specified lower limit of the VFA will be 70% for the design traffic level <0.3 million ESALs.

When Department Reviewed Commercial Mix Designs are used on the Project, submit a copy of proposed commercial mix design to the State Materials Bureau with Project information to verify the proposed commercial mix design is appropriate to use and meets all the requirements for the specific Project. If the proposed commercial mix design meets all the requirements for the specific Project; the State Materials Bureau may re-issue the proposed commercial mix design for that specific Project.

The State Materials Bureau may allow the Contractor to use a mix design for one (1) year from the date of review by the State Materials Bureau. The Contractor may use or re-submit the design before the expiration of the one (1) year time frame. Do not use a Mix Design beyond one (1) year after the State Materials Bureau's review date. Submit acceptable evidence to the State Materials Bureau verifying that the component Materials have not changed. Submit a new mix design if changing the source of Materials. Obtain concurrence from the State Materials Bureau before using the new Materials.

423.2.9 Job Mix Formula

The Job Mix Formula (JMF) must be in accordance with all aggregate gradation requirements and result in a mix that meets all specified mix design requirements. The Department will refer to the result of the Laboratory mix design developed in accordance with Section 423.2.8, "Mix Design," as JMF1.

Prepare the aggregate gradation of the calibration samples 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 including a set for the Referee Lab. Provide a minimum of five (5) sets of calibration samples. Do not combine the elements of the calibration samples prepared for the Referee Lab, and provide them, with the Project Number, Contractor and Project Manager clearly identified to the Project Manager who will forward them to the State Asphalt Engineer. All Quality Control, Quality Assurance and Independent Assurance ovens must be calibrated by this procedure prior to start of production of a JMF. New calibration samples may be required for new JMF's, as determined by the District Lab Supervisor or the State Asphalt Engineer. The Project

Manager will suspend paving operations until calibration of the ovens has been completed. No additional time or compensation will be granted for completion of this requirement.

423.2.9.1 Job Mix Formula Adjustment

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 complies with the Specifications will be required prior to being reviewed by the Project Manager and concurred by the State Materials Bureau. Review and concurrence of a JMF adjustment can only be made after:

- The Quality Control Plan (including checks on specific gravity) has been submitted and concurred by the Project Manager and the District Lab Supervisor for use on the Project;
- Confirmation by the Project Manager that the Quality Control Plan is being followed;
- Concurrence of the proposed changes from Project Manager and District Lab Supervisor,
- Submittal by the Testing Laboratory responsible for the original mix design to the Project Manager with a copy to the State Asphalt Engineer.

If the JMF is adjusted after the Shakedown Period, terminate the previous lot when the adjusted JMF has been reviewed and concurred with by the Project Manager, Assistant District Engineer for Construction and the State Materials Bureau. Terminated lot will be added to the previous lot for evaluation by QLA. Begin a new lot for the QLA with the adjusted JMF. During the Shakedown Period, make JMF adjustments in accordance with Section 423.3.5.7, Test Strip and Shakedown Period.

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 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 into the transport vehicle to be greater or less than the target mixing temperature specified in the mix design by more than ten percent (10%) F, not to exceed 350° F, unless written concurrence by the oil Supplier and design lab are provided to the Project Manager. HMA delivered to the Project with mix temperatures outside the acceptable range shall, at the sole discretion of the Project Manager, be removed and replaced at no cost to the Department.

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 while adding to the aggregate. Use an enclosed conveyor belt to prevent blowing or loss of hydrated lime or anhydrite based material if necessary. During production, if necessary to counteract loss, increase the percentage 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 $\pm 3.0\%$, 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's approval for 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 foundation system to support the silo in accordance with the silo manufacturer's recommendations. Control the hydrated lime or anhydrite based material content such that at a minimum the amount added is equal to the Target Value on the Job Mix Formula.

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 $1.5\% \pm 0.5\%$, 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, record the average amount of added moisture to verify specification compliance. Supply the recorded moisture information to the Project Manager upon request.

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 ensure 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 with burner fuel.

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 recording thermometer with a range of from 100 °F to 400 °F. Equip the discharge chute of the drier with an approved recording 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."

423.3.4.1.9.3 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 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 (1) 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 release agents derived from petroleum derivatives, including but not limited to diesel fuel that contaminate or alter the characteristics of the mix.

Be prepared to cover and insulate hauling beds. Equip each truck with a waterproof and windproof cover of suitable material and sufficient size to protect the mix from the weather. Securely fasten covers when necessary to maintain temperature. Ensure that covers do not allow water to enter the bed, paver or mix material transfer device during mix unloading. Use insulated truck beds when necessary to maintain temperature.

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. All rollers must be capable of reversing direction without shoving or tearing the mixture.

423.3.5 Placement Operations

For cold milled surfaces, prepare the surface in accordance with Section 414, Cold Milling. Clean the existing surfaces and apply a tack coat in accordance with Section 407, "Tack Coat."

When placing HMA on Base Course, Proof Roll the Base Course with a 27 ton roller or other approved Equipment and correct any soft areas, as directed by the Project Manager. Correct deficient areas at the Contractor's expense. Place the HMA on the approved surface, then spread, and strike off to the specified grade and elevation. Spread and compact the HMA in layers in accordance with the Plans.

For new construction and reconstruction, prepare the Subgrade or Base Course as follows:

1. Clean of loose or Deleterious Materials;
2. Free of frozen material;
3. Meet the moisture and density requirements; and
4. Place prime coat, as required in the Plans unless otherwise approved by the Project Manager, in accordance with Section 408, Prime Coat.

Unless otherwise specified in the Plans, for construction on NMDOT Projects using State approved HMA designs utilizing greater than 25% RAP the use of a Materials Transfer Vehicle is required.

Materials Transfer Vehicle (MTV): Use a MTV with storage and remixing capabilities on all mainline construction when placing HMA State approved designs. The MTV will independently remix and deliver mixture from the hauling Equipment to the paving Equipment.

Furnish an MTV with the following capabilities:

1. An unloading system to receive mixtures from the hauling Equipment.
2. A minimum storage capacity of 13 tons with a remixing system in the MTV storage bin.
3. A discharge conveyor to deliver the mixture to the paver hopper.
4. The MTV system cannot exceed maximum legal loading on Structures.

Pick-up machines, hopper inserts and material transfer devices are not considered MTVs.

In the event the MTV malfunctions during paving operations, the Contractor can finish the Day without the MTV. Do not resume further mainline mix placement until the MTV is operational.

Consistently overloading the HMA mix into the paving machine is not acceptable. 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 grade and the transverse slope 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 ;
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. Place HMA when the Chill Factor is at least 40 °F and rising. If the air temperature is 60 °F or warmer, do not consider the Chill Factor.

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 Not Used

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 six (6) inches relative to the longitudinal joints of the underlying course.

Unless otherwise specified, taper transverse and longitudinal joints as follows:

1. At least a three (3) ft taper for transverse joints, with a taper slope no steeper than 24:1.
2. At least a one (1) ft taper or a notched taper, for longitudinal joints, with a taper slope no steeper than 6:1 or a notched taper with a one (1) inch vertical edge at the top of the taper connected to a 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.
5. Avoid placing longitudinal joints in the wheel paths, unless approved by the Project Manager.

Completely bond joints. Smooth the surface of each course at the joints. The Department will not allow deviations greater than 3/16 inch when tested with a ten (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 seven (7) Days.

423.3.5.5 Surface Tolerances

Smooth the surface of each completed course and prevent deviations larger than 1/8 inch using a ten (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

Provide pavement at the depth specified in the Contract. Monitor depths by calculating continuous production yields using the formula found in the MT-1, as maintained by the State Construction Bureau. Calculate the required yield and the corresponding yields for 0.25 inch increase (upper limit) and decrease (lower limit). The Project Manager may adjust the required yield to fit field conditions. If adjusted, the new target yield will be communicated to the Contractor in writing. Control production to keep yield within the upper and lower limits. Correct deficiencies at no cost to the State. Correct deficient depths during placement. Address Plan Surfacing Depths in the Quality Control Plan.

423.3.5.7 Test Strip & Shakedown Period

Construct a maximum 1,000 ton test strip for each HMA mix design with a minimum of three (3) Contractor and three (3) agency samples to evaluate the JMF, process control, and placement operations. Construct test strip on Shoulder, low volume segments of the pavement, or area approved by the Project Manager. Correct and modify non-complying placement operations and produce necessary process control adjustments. Develop a revised JMF if necessary based on the results of the test strip. Production and placement operations prior to approval of the revised JMF and placement operations are at the Contractor's risk. For purposes of payment, the test strip will be evaluated in conformance with Section 416, Minor Paving. If accepted, the test strip will have a pay factor of 1.0. If rejected, said material shall be handled in accordance with Section 423.3.6.1.3 Adherence to Specifications and Rejection of Non-specification Material. Remove unaccepted test strip material placed within the Roadway Prism at no cost to the Department. If the Contractor disagrees with removing and replacing unacceptable material placed in test strips outside the Roadway Prism, the Assistant District Engineer for Construction, based on engineering judgment, will decide if the material can remain in place with a maximum pay factor of 50%, or shall be removed and replaced at no cost to the Department. If the test strip is rejected, construct a subsequent test strip. Do not proceed to full production until an accepted test strip is produced. After the test strip is placed, continue to evaluate the mix properties and the JMF during the placement of the first two (2) sublots in the first lot. Changes may be made to either the JMF or the mix proportions and/or properties with the concurrence of the Assistant District Engineer for Construction. For changes made prior to the completion of the first two (2) sublots, the adjustments will be applied to the entire lot for purposes of payment.

The Project Manager may waive test strip requirements for the Project, if requested by the Contractor based on prior experience with the JMF.

For QLA Projects, the Shakedown Period is defined as the first two (2) sublots produced in the first lot.

For Non-QLA Projects, the Shakedown Period is defined as the test strip. As the test strip is placed, evaluate the mix properties and the JMF. Changes may be made to either the JMF or the mix proportions and/or properties with the concurrence of the Project Manager, State Materials Bureau and the Assistant District Engineer for Construction.

423.3.6 Sampling and Testing

Sample and test the aggregate production and HMA mixture in accordance with Section 901, Quality Control /Quality Assurance (QC/QA), and the Department's "Minimum Testing Requirements." Department personnel may test locations other than the random locations generated for statistical analysis. These tests will not be used for pay factor determination, but may be used to determine Acceptance or rejection of localized material.

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. Ensure the Plan conforms to Section 901.2, "Contractor Quality Control." Submit the Plan a minimum of two (2) weeks prior to commencement of crushing operations and at a minimum comply with "Contractor Quality Control Plan Guidelines". No HMA operations are allowed until the Plan has been approved by the Project

The Plan shall 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. Sampling and Testing;
 - 1.3. Aggregate production;
 - 1.3.1. Gradation,
 - 1.3.2. Minus 200 wash,
 - 1.3.3. Plasticity index,
 - 1.3.4. Sand equivalent,
 - 1.3.5. Fine aggregate angularity,
 - 1.3.6. Flat and elongated particles count, and
 - 1.3.7. Fractured Face count.
 - 1.4. RAP (if used);
 - 1.5. Quality of components;
 - 1.6. Stockpile management;
 - 1.7. Proportioning;
 - 1.7.1. Gradation,
 - 1.7.2. Minus 200 wash,
 - 1.7.3. Plasticity index,
 - 1.7.4. Sand equivalent,
 - 1.7.5. Fine aggregate angularity,
 - 1.7.6. Flat and elongated particles count, and
 - 1.7.7. Fractured Face count.
 - 1.8. Mixing, including addition of hydrated lime or anhydrite based material, and/or asphalt additive, if required;
 - 1.9. Transporting;
 - 1.10. Placing and finishing;
 - 1.11. Joints;
 - 1.12. Compaction;
 - 1.13. Smoothness;
 - 1.14. Plan Surfacing Depths;
 - 1.15. Shakedown period;
 - 1.16. Corrective Action Processes; and
 - 1.17. Proposed lot size and subplot size in accordance with Section 423.3.6.3 QLA.

For the properties listed in 1.3 above, specifically address the requirements of Table 423.2.2.1.2:1 in the Plan. Define planned corrective action if the requirements are not met.

- 1.3.1 and 1.3.2 are for informational purposes during aggregate production.
- 1.3.3 through 1.3.7, if three (3) consecutive tests fail, address what will change in production. Failure to adjust will result in ceasing operations until a corrective action plan is approved by the Project Manager.

For the properties listed in 1.7 above, specifically address the requirements of Table 423.2.2.1.2:1 in the Plan. Define planned corrective action if the requirements are not met.

- 1.7.1 and 1.7.2 are to be evaluated against the Job Mix Formula.
 - For properties listed in 1.7.3 through 1.7.4, if any three (3) consecutive tests fail, the Contractor is to cease operations until a corrective plan is approved by the Project Manager and implemented.
 - For properties listed in 1.7.5 through 1.7.7, any test failing by more than 5 percentage points, or if three (3) consecutive tests fail by an average of 0 to 5 percentage points, cease operations until a corrective plan is approved by the Project Manager and implemented.
2. Employ sampling and 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.

On Projects designated as QLA Projects, sample and test HMA in accordance with Section 901, "Quality Control/Quality Assurance (QC/QA)."

- 2.1. The Contractor is responsible for inspection performed at the crushing operations, hot mix plant and at the Contractor's field Laboratory; using the Laboratory test results and other Quality Control practices to ensure the quality of aggregate sources and other mix components. Adjust and control mix proportioning to meet the mix design. Be responsible for periodically inspecting all Equipment used in proportioning and mixing to ensure its proper operating condition and to ensure that proportioning and mixing is in conformance with the mix design and other requirements.
 - 2.2. Be responsible for inspection, sampling, and testing performed at the paving site, ensuring that the delivered Materials meet Contract requirements and for periodically inspecting all Equipment used in transporting, placing, finishing, and compacting to ensure its proper operating condition. Ensure that placing, finishing, joint construction, compaction, and thickness, when required, are as specified.
3. Define and document the coordination of activities between the Contractor's management and all Contractor testing personnel including the frequency of each type of test, the criteria used by the Contractor's management and technicians to recognize deficiencies and reject or correct unacceptable Materials, and a description of proposed corrective actions.
 4. In the Plan, describe, in detail, the proposed process control sampling and testing programs. Include the method by which random sampling locations are to be determined. Develop sample locations for process control tests so that the center of the sample is at least 12 inches from a joint or edge of the pavement layer.

423.3.6.1.1 Contractor Quality Control of Aggregate

Obtain samples in accordance with Section 901.2.4 Sampling.

Take representative samples as required, either at the stockpile or after the aggregate material is combined but before the addition of hydrated lime or anhydrite based material and

mixing with asphalt binder. Test these samples for conformance with the approved Job Mix Formula and: (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 Project Manager may sample and test the aggregate at any time during production or stockpiling, or may request to split samples with the Contractor. If testing indicates corrections are necessary, make corrections in conformance with the Plan. The Department will base evaluation of RAP aggregate in accordance with Section 423.2.7, "Reclaimed Asphalt Pavement."

423.3.6.1.2 Contractor Quality Control for Compaction

Monitor the compaction process by determining the density of the HMA with a portable densometer in accordance with the Plan. Establish calibration of the portable 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 with the portable densometer. Correlate these test results. Conduct Quality Control testing in accordance with Section 901, "Quality Control/Quality Assurance (QC/QA)," and provide test results to the Project Manager. 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 Non-specification Material

Produce Material in compliance with all specification requirements. Evaluate test results for specification compliance and treatment of Material that does not meet Specifications in accordance with Section 423 in its entirety. All Material that is rejected shall, at the sole discretion of the Department, 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. Sample and test the mixture and pavement on a statistically random basis in accordance with Table 901.7:6, "Minimum Acceptance Guidelines." The Project Manager may reject material that appears to be defective based on visual inspection.

**Table 423.3.6.2.1:1
Acceptance Testing Tolerances^a**

Characteristic	Specification limit, percentage points from TV
Air Voids, %	± 1.4
Pavement Density % ^c	± 2.5
Hydrated Lime or Anhydrite Based Material % ^e	Minimum of JMF Target Value
Voids in the Mineral Aggregate (VMA), % ^{a,d}	± 1.6
Asphalt Content % ^{a,b}	± 0.50

Table 423.3.6.2.1:1
Acceptance Testing Tolerances^a

^a All gradation, Asphalt Content, VMA, and VFA values shall be determined using the AASHTO T 308 testing results.

^b HMA will not be rejected based on Asphalt Content Determined by AASHTO T 308

^c Density payment will be adjusted in accordance with Section 901.5

^d 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.

^e If Hydrated Lime or Anhydrite Based Material is below Design TV cease hot mix production, investigate and correct.

423.3.6.2.1.1 Non-QLA

The Department will evaluate (QA) test results from Projects with Bid quantities less than 15,000 tons for specification compliance in accordance with the following procedures: 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 901.5, Quality Level Analysis. 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 15,000 tons. Remove and replace rejected Material with specification Material at no additional cost to the Department.

423.3.6.2.1.1.1 Acceptance of Pavement Density

The target density for Acceptance of HMA will be 94.5% of the theoretical maximum density as determined from AASHTO T 209. For determination of maximum specific gravity, obtain and test a minimum of two (2) samples and ensure the Department obtains and tests a minimum of one (1) sample for each Day that the HMA is placed. Each individual density test value obtained must be from 92.0% to 97.0% of the theoretical maximum density.

To be prepared for dispute resolution, the Contractor is to provide one (1) additional core for each core tested by the Department for Acceptance of density. The additional core is to be from the same lot as the initial core and shall be generated from the random sample plan. If the Contractor believes the Department's cut pavement samples have been damaged they may invoke Section 423.3.7 Dispute Resolution. The Referee Lab results will replace the initial core in determining pay factor. The Assistant District Engineer for Construction will make the final decision on accepting or rejecting material, based on the Referee Laboratory's result(s) by:

1. Accepting the section or subplot if the density falls between 92.0% - 97.0%;
2. Determining that a portion, based on visual determination, or all of the Material in that section or subplot shall be removed or replaced at no additional cost to the Department;
3. Determining that a portion, based on visual determination, of the Material in that section or subplot will 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 pay factor in accordance with Section 901.5, Quality Level Analysis. Use a minimum of ten (10) cores to determine the pay factor, unless otherwise directed by the Assistant District Engineer for Construction. 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. If a composite pay factor of more than 1.00 is calculated, the composite pay factor will be a 1.00 for the purposes of payment.

For Projects consisting of single lift overlays or mill and inlay with a single lift of two and a half inches or less, the Project Manager may grant an exception to the mean density target requirement of at least 94.5% of the theoretical maximum density if the Contractor can demonstrate that a minimum of 92.0% cannot be reasonably obtained because of the existing conditions of the Pavement Structure or Subgrade Materials. The Contractor demonstrates this by providing density results obtained during paving operations witnessed by a State Inspector at the location in question. If the Project Manager grants this exemption, construct a Roadway test strip and develop an 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, establish a new target value for density and establish a new Acceptance lot only for the portion of the Project addressed herein (except for the Roadway test strip) before paving begins or continues. Density shall not fall below 91%. If a lot does not meet either of the revised density requirements, the Project Manager will, with the concurrence of the Assistant District Engineer for Construction, do the following:

1. Accept and pay for the lot of HMA at 50% of the Bid Item Unit Price; or
2. Reject the in-place material and require the Contractor to remove and replace.

423.3.6.3 QLA

On Projects with Bid quantities of 15,000 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". Acceptance lots shall be between 15,000 tons and 30,000 tons, as determined at the pre-paving conference. Table 423.3.6.2.1:2 indicates properties that will be tracked for purposes of Quality Assurance. For all QLA Projects, if a composite pay factor of more than 1.00 is calculated, the composite pay factor will be a 1.00 for the purposes of payment.

423.3.6.3.1 Acceptance of Pavement Density

The target density for Acceptance of HMA will be 94.50% of the theoretical maximum density as determined from AASHTO T 209. For determination of maximum specific gravity, obtain and test a minimum of two (2) samples and ensure the Department obtains and tests a minimum of one (1) sample for each Day that the HMA is placed, in accordance with the random sampling plan. Each individual density test value obtained must be from 92.0% to 97.0% of the theoretical maximum density.

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 pay factor in accordance with Section 901.5, Quality Level Analysis. Use a minimum of ten (10) cores to determine the pay factor, unless otherwise directed by the Assistant District Engineer for Construction. To be prepared for dispute resolution, the Contractor is to provide one (1) additional core for each core tested by the Department for Acceptance of density. The additional core is to be from the same lot as the initial core and shall be generated from the random sample plan. If the Contractor or Department believes the Department's cut pavement samples have been damaged they may invoke Section 423.3.7 Dispute Resolution. The Referee Lab results will replace the initial core in determining pay factor. 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. If a composite pay factor of more than 1.00 is calculated, the composite pay factor will be a 1.00 for the purposes of payment.

For Projects consisting of single lift overlays or mill and inlay with a single lift of two and a half inches or less, the Project Manager may grant an exception to the mean density target requirement of at least 94.5% of the theoretical maximum density if the Contractor can demonstrate that a minimum of 92.0% cannot be reasonably obtained because of the existing conditions of the Pavement Structure or Subgrade Materials. The Contractor demonstrates this by providing non-destructive density results obtained during paving operations witnessed by a State Inspector at the location in question. If the Project Manager grants this exemption, construct a Roadway test strip and develop an 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, establish a new target value for density and establish a new Acceptance lot only for the portion of the Project addressed herein (except for the Roadway test strip) before paving begins or continues. Lot density shall not fall below 91%. If a lot does not meet either of the revised density requirements, the Project Manager will, with the concurrence of the Assistant District Engineer for Construction do the following:

1. Accept and pay for the lot of HMA at 50% of the Bid Item Unit Price; or
2. Reject the in-place material and require the Contractor to remove and replace at no cost to the Department.

423.3.6.4 Independent Assurance Testing

The Department will perform Independent Assurance sampling and testing in accordance with Section 901.3, "Independent Assurance Testing."

423.3.7 Dispute Resolution

For any test incorporated into the pay factor, if a dispute exists the Project Manager and Contractor will investigate to determine why and make corrections if possible. If the discrepancy cannot be resolved, then either party may invoke a referee lab. The State Asphalt Engineer will maintain a list of labs that are willing and capable of performing referee testing. All referee labs shall be AASHTO Materials Reference Laboratory (AMRL) certified for the test(s) to be performed. Neither the Department's Project staff, nor the Contractor will know who is performing the referee testing. The State Asphalt Engineer will select a Laboratory, without disclosing the name of the lab to Department Project Personnel or Contractor personnel, from the following, not in priority order:

1. A District Laboratory not from the District in which the Project resides; or
2. A private Laboratory currently listed on the State Material's Bureau's list of approved private labs not involved in the subject Project in any manner, such as mix design submittal, preliminary testing for design, etc. Only laboratories that are in the routine business of providing testing and designs will be considered. Contractor owned laboratories will not be allowed.

When a referee lab is used, the referee lab's test results will be used in determining the pay factor. The referee lab must be invoked in writing within ten (10) Calendar Days of receiving the test results from the other party. If not invoked within ten (10) Calendar Days, the test results are deemed accepted. The results will be used to determine pay factors. The Department's prior test results or the Contractor's prior test results for the test in question will be discarded. If the composite pay factor decreases from applying the referee lab's results, the Contractor shall pay for the testing performed by the referee lab. If the composite pay factor increases from applying the referee lab's results, the Department will pay for the testing performed by the referee lab. If the composite pay factor remains unchanged, the cost shall be split with each party responsible for 50% of the total cost.

For all testing incorporated into the pay factor, each party shall generate an additional sample from the Department's Acceptance Samples and the Contractor's Quality Control Samples used in pay factor analysis. Failure to provide the referee samples prior to testing the initial sample will result in the Project Manager suspending the Project at no cost to the Department. Additional time will not be added to the Contract for Project suspension caused by failure to comply with Dispute Resolution Process. Work shall not resume until the Contractor provides the delayed sample(s) and satisfies the Project Manager, in writing, that future samples will be provided in compliance with this requirement. The extra sample(s) is (are) to be retained by the Department. The Department will retain the samples at the Project location inside a locked cargo container, provided by the Contractor at no cost to the State. The State will provide the lock for the cargo container. Once the pay factor is determined dispose of the unused samples at no cost to the Department. In no case will the unused samples be disposed of prior to the ten (10) Calendar Day period in which the Dispute Resolution process may be invoked.

For Pavement Density, the Contractor shall provide an additional core only for each core provided to the Department for Acceptance. The additional core will be stored and retained in the provided container. Should the Contractor invoke the Dispute Resolution Process for Density, the second core will be provided to the Referee Lab. The density pay factor for the material in question will be based solely on the Referee Lab result, not including Department or Contractor results.

Failure to comply with the requirements contained herein will result in the pay factor being calculated in accordance with the applicable Sections of 423, Superpave (QLA and Non-QLA), and 901, Quality Control/Quality Assurance (QC/QA). No test results will be replaced by referee results.

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

Pay Item	Pay Unit
<i>HMA Complete</i>	Ton or Square Yard
<i>HMA</i>	Ton or Square Yard

The Department will pay for accepted quantities at the Bid Item Unit Price, adjusted in accordance with Section 423.5.1, "Price Adjustments." Providing and transporting all cores, samples and storage containers shall be Incidental to the Pay Items above.

423.5.1 Price Adjustments

423.5.1.1 Projects with Bid Quantities of 15,000 Tons or Greater

The Department will pay for accepted quantities of *HMA* or *HMA Complete* at the Bid Item Unit Price, adjusted in accordance with Section 901.5, "Quality Level Analysis." The *HMA* will be evaluated 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 423.5.1.1:1, "Weighting Factors," to calculate each lot's composite pay factor. The pay factor for the entire Project will be calculated by applying weighted averages, based on tonnage contained within each lot, to each lot's composite pay factor. If the composite pay factor for a lot is greater than 1.0, the pay factor will be set at 1.0.

**Table 423.5.1.1:1
Weighting Factors**

Characteristic	"f" Factor (%)
Mat Density	35
Air voids	35
Voids in the mineral aggregate (VMA)	20
Asphalt Content*	10

*If the individual pay factor for asphalt content is less than 0.75, it will be set at 0.75 for the purpose of calculating payment.

423.5.1.2 Projects with Bid Quantities Less than 15,000 Tons

The Department will pay for accepted quantities of *HMA* or *HMA Complete* 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." If the mean of the test results for any of the listed properties is outside of the testing tolerances as listed in Section 423: Hot Mix Asphalt – Superpave (QLA & Non-QLA)

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. In no case will the pay factor be greater than 1.00.

423.5.1.2.1 Price Adjustment for Pavement Density (Bid Quantities Less than 15,000 Tons)

The Department will also adjust the Bid Item Unit Price for the HMA or *HMA Complete* Pay Item, based on the Roadway density, in accordance with Section 901, Quality Control/Quality Assurance (QC/QA), specifically Section 901.5, Quality Level Analysis, steps one (1) through nine (9). If the density pay factor for a lot is greater than 1.0, the density pay factor will be set at 1.0 for purposes of payment. The Department will apply the price adjustments to the HMA Bid Item unit price for each lot.

SECTION 424: WARM MIX ASPHALT

Warm Mix Asphalt (WMA) is a generic term used to describe the reduction in production, paving and compaction temperatures achieved through the use of one (1) of the approved WMA technologies.

Some modification to WMA plants may be necessary to accommodate the WMA technologies as noted in Section 424.3 Construction Requirements.

424.1 DESCRIPTION

This Work consists of constructing one (1) or more courses of Warm-Mix Asphalt (WMA) pavement courses on a prepared base produced with a warm-mix additive or technologies, approved by the New Mexico Department of Transportation, and included the most current Approved Products List (APL).

Warm-Mix Asphalt shall be produced in a mixing plant and stored, hauled, placed and compacted in accordance with the requirements of this Section and as shown on the Plans. A technical representative of the Warm Mix Additive Supplier, including contact information, shall be designated in writing via the mix design submittal process. The representative is expected to ensure that the Warm-mix additive is handled properly. This representative does not have the authority to allow any deviation from the Department Specifications and Project requirements.

424.2 MATERIALS

424.2.1 General

WMA may be produced by one (1) or a combination of several technologies which may include WMA plant foaming processes and Equipment, mineral additives or chemicals that allow the reduction of the production temperatures.

WMA is a mixture of asphalt binder, Warm Mix Additive (or technologies), aggregate, blending sand, mineral filler, and hydrated lime or anhydrite based material. Unless otherwise prohibited in the Contract, the Department will allow Recycled Asphalt Pavement (RAP) in WMA mixes as long as the resulting mixture conforms to all specification requirements.

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.

424.2.2 Aggregate

Ensure the aggregate gradation of the WMA mixture meets the requirements of Table 424.2.2.1:1, "WMA 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 determines there are Deleterious Materials present in the aggregate stockpiles before aggregate gradation testing. The Contract will specify the type of WMA the Contractor is to use. The Department will allow the Contractor to combine Materials from two (2) or more sources to produce aggregate only when each individual aggregate source meets all applicable quality requirements.

424.2.2.1 Gradation and Quality Requirements

Table 424.2.2.1:1
WMA Aggregate Gradation Control Points

Sieve size	% passing per WMA type					
	SP-II		SP-III		SP-IV	
	Min	Max	Min	Max	Min	Max
Two (2) inch	—	—	—	—	—	—
1 1/2 inch	100	—	—	—	—	—
One (1) inch	90	100	100	—	—	—
¾ inch	—	90	90	100	100	—
½ inch	—	—	—	90	90	100
3/8 inch	—	—	—	—	—	90
No. 8	19	45	23	49	28	58
No. 200	1.0	7.0	2.0	8.0	2.0	10.0

424.2.2.1.1 Aggregate Quality

For each Material source, ensure the WMA coarse aggregate has an AI of 25 or less when calculated in accordance with Section 901, "QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)."

Regulate the crushing of aggregate stockpiles so that the minimum Fractured Faces content of the plus No. 4 Material complies with the requirements of Table 424.2.2.1.2:1, "Fractured Faces, Sand Equivalent, and Fine Aggregate Angularity," and evaluation by NMDOT Method FF-1, "*Fractured Face Determination for Coarse Aggregate*." Ensure the plus 3/8 inch material contains a maximum of 20% flat, elongated particles with a dimensional ratio of 3:1 or greater as determined by ASTM D 4791 (TTCP Modified). Ensure the combined material, excluding RAP; passing the No. 40 sieve is non-plastic. Ensure that 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, complies with the requirements of Table 424.2.2.1.2:1, "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.

424.2.2.1.2 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.

Table 424.2.2.1.2:1
Minimum Fractured Faces, Sand Equivalent, and Fine Aggregate Angularity for Virgin Aggregates

Design Traffic, ESALs ^a x 10 ⁶	Fractured Faces ^b	Sand Equivalent (%)	Fine Aggregate Angularity
< 3.0	75.0 / —	45.0	40.0
≥ 3.0 – < 10.0	85.0 / 80.0	45.0	45.0
≥ 10.0 – < 30.0	95.0 / 90.0	45.0	45.0
≥ 30.0	99.0 / 95.0	50.0	45.0

^aESALs are based on a 20-year design life for all scenarios.

^bUnder "Fractured Faces", 85.0 / 80.0 denotes that 85.0% of the coarse aggregate has at least 1 Fractured Face and 80.0% has at least two (2) Fractured Faces.

Ensure RAP provided from sources outside the Project has at least 75% Fractured Faces (one (1) Fractured Face); however, Sand Equivalent and Fine Aggregate Angularity do not apply.

424.2.2.2 Production

When producing aggregates for WMA, 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 (2) stockpiles of fine and coarse aggregates. Regulate crushing operations to produce Material within the specified gradation band.

424.2.2.3 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.

424.2.2.4 Combining

When combining crushed Materials from different stockpiles, including RAP (if in the mixture) ensure the product is in accordance with the mix design gradation requirements. Use controlled feeders from each stockpile to combine crushed Material.

424.2.3 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.

424.2.3.1 Warm Mix Additive or Technology

Only Warm Mix Additives or Technologies approved by the Product Evaluation Program and currently listed on the Approved Products List can be used on Department Projects. To be placed on the Approved Products List, the WMA additive Supplier shall verify that the binder with the additive meets the PG grade of the specified binder. The potential additive Supplier shall demonstrate this to the Department by evaluating the Asphalt Binder and WMA additive for compliance with the rheological properties for low and high temperatures for the specified PG grade in accordance with AASHTO M320, Table 1 and Section 402.2.5, Performance Graded Asphalt Binder. The type and dosage of Warm Mix Additives shall comply with the requirements of the Warm Mix Additive Supplier. The type and/or dosage of the WMA additives shall be provided to the Project Manager two (2) weeks prior to the commencement of paving operations. Warm Mix Additive dosage rates shall not deviate from those designated by the Warm Mix Additive Supplier. If a terminal blend Warm Mix Additive is used, the dosage rate shall be shown on the Materials Certificate of Compliance.

After the Warm Mix Additive is introduced, the PG grade of the binder shall comply with the PG grade as specified in the Contract.

For foamed asphalt systems, water used as directed by the foamed asphalt system manufacturer shall be considered to be the Warm Mix Additive. Only foam systems on the Department's Approved Product List shall be used.

424.2.4 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."

424.2.5 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.

424.2.6 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 WMA.

424.2.7 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. The Contractor may use RAP produced from outside sources provided evidence of ownership is supplied and the following is met: 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 of 75% Fractured Faces content (one (1) face).

The Contractor may use a maximum of 15% RAP (by weight) in the production of WMA mixtures without changing the asphalt binder. For quantities greater than 15% to 25% RAP, either lower the asphalt binder's high and low temperature grades by one (1) grade (e.g. lower a PG 76-22 to a PG 70-28), or extract, recover, and combine the RAP's asphalt binder with a virgin asphalt binder per AASHTO M 323, Appendix A, ensuring the resultant binder meets the entire AASHTO M 320 required Project PG asphalt binder properties indicated on the approved mix design.. For quantities greater than 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 WMA mixtures. For Projects of entirely new construction, limit the RAP to 15% in the top mat or extract, recover and combine the RAP's asphalt binder with a virgin asphalt binder per AASHTO M323, Appendix A. Ensure the resultant binder meets the entire AASHTO M320 required Project PG asphalt binder properties indicated on the approved mix design.

Process RAP so that 100% passes a 1-1/2-inch sieve. For WMA mixtures containing greater than 15% RAP, maintain adequate stockpile management (i.e. sufficient quantities and shaping of the stockpiles) and fractionation (divide the RAP into a minimum of two (2) stockpiles), so they are uniform throughout the stockpiles. Address in the Quality Control Plan how RAP will be controlled, such as which screen will be used to split into two (2) stockpiles, or by what method the RAP will be controlled to keep the resultant mix within acceptable limits. 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 WMA mixtures, the Department will make no additional payment for the asphalt binder in the RAP or asphalt binder due to asphalt binder grade adjustment. As RAP is

produced and prepared for inclusion in the WMA, perform Process Control testing in accordance with Section 901, "Quality Control/Quality Assurance," Table 901.7:3, Minimum Process Control Guidelines for Aggregates and Base Course.

If problems with WMA consistency or compliance with Project Specifications occur, additional efforts taken to achieve acceptable levels of consistency and compliance with Contract Specifications, at the Contractor's discretion (at no additional cost to the Department), include, but are not limited to:

- Reduce the top size of the RAP from 1-1/2" to 1";
- Fractionate the aggregates on a second screen, such as the 3/8" or 1/4" Screen so that the RAP is maintained in two (2) stockpiles, one being Coarse RAP and the second being Fine RAP;
- Ensure that the RAP used in the WMA mix design is representative of the RAP available on the Project;
- Cover the RAP pile(s) so that ambient moisture is not absorbed; and
- Process and maintain the stockpiles so that the RAP material is equally and uniformly distributed throughout the entire stockpile(s) and is withdrawn such that uniform, non-segregated RAP is delivered to the hoppers.

424.2.8 Mix Design

Provide a mix design developed by a Department-approved testing Laboratory, reviewed and signed by a Professional Engineer licensed by the New Mexico Board of Registration for Professional Engineers and Land Surveyors. 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 prior to the Project Pre-Paving Conference. Submit at least five (5) 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 Asphalt Engineer. 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 Project Manager and State Asphalt Engineer for review and concurrence by the State Asphalt Engineer. 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 424.2.8.1, "Mix Design Adjustment."

Create the JMF gradation in accordance with Table 424.2.2.1:1, "WMA 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 shall 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. AASHTO TP 77 may be used in lieu of AASHTO T 84/T 85. The mix design shall be in accordance with Table 424.2.8:1, "WMA Superpave Design Requirements for Aggregates with Less Than 3.0% Absorption," or Table 424.2.8:2, "WMA Superpave Design Requirements for Aggregates with 3.0% or Greater Absorption."

Test the WMA with at least 1.0% hydrated lime or anhydrite based material in accordance with AASHTO T 283, as modified below:

- Use six (6) inch by 3.75 inch specimens for all prisms;

- Compact all test specimens in accordance with AASHTO T 312 to an air content of seven percent (7%) +/- 0.5%;
- On the AASHTO T283 Section 11.3 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 a minimum of one percent (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, as determined by AASHTO T283 Section 11.3. 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, perform the required changes at no additional cost to the Department.

Table 424.2.8:1
WMA Superpave Design Requirements for Aggregates with Less Than 3.0% Absorption

(a) 20-year design ESALs	N initial	N design (b)	N max	Percent Voids in the Mineral Aggregate (VMA) per nominal aggregate size maximum			Voids Filled with Asphalt (VFA) Range, % (c)	Dust to Binder Ratio Range
				1 inch (SP-II)	3/4 inch (SP-III)	1/2 inch (SP-IV)		
< 0.3	<91.5			12.5	13.5	14.5	72.0–80.0	0.6
0.3– <3.0	<90.5	96.0	< 98.0	–	–	–	68.0–78.0	to 1.4
≥3.0	<89.0			14.0	15.0	16.0	68.0–75.0	

^aIn Millions

^bDesign Air Void Content of four percent (4%)

^cFor one (1) inch nominal maximum size mixtures, the specified lower limit of the VFA shall be 70% for the design traffic level <0.3 million ESALs.

Table 424.2.8:2
WMA Superpave Design Requirements for Aggregates with 3.0% or Greater Absorption

(a) 20-year design ESALs	N initial	N design (b)	N max	Percent Voids in the		Mineral nominal	Voids Filled with Asphalt (VFA) Range, % (c)	Dust to Binder Ratio Range
				Aggregate maximum (SP-II)	(VMA) per aggregate size (SP-III)	(SP-IV)		
<0.3	<91.5						70.0–80.0	
0.3–<3.0		96.5	< 98.0	12.0–14.0	13.0–15.0	14.0–16.0	65.0–78.0	0.6 to 1.4
≥3.0	<89.0						65.0–78.0	

^aIn Millions

^bDesign Air Void Content of 3.5%

^cFor one (1) inch nominal maximum size mixtures, the specified lower limit of the VFA will be 70% for the design traffic level <0.3 million ESALs.

When Department Reviewed Commercial Mix Designs are used on the Project, submit a copy of proposed commercial mix design to the State Materials Material Bureau with Project information to verify the proposed commercial mix design is appropriate to use and meets all the required Specifications for the Project. If the proposed commercial mix design meets all the requirements for the specific Project, the State Materials Bureau may re-issue the proposed commercial mix design for that specific Project.

The State Materials Bureau may allow the Contractor to use a mix design for one (1) year from the date of review by the State Materials Bureau. The Contractor may use or re-submit the design before the expiration of the one (1) year time frame. Do not use a Mix Design beyond one (1) year after the State Materials Bureau's review date. Submit acceptable evidence to the State Materials Bureau verifying that the component Materials have not changed. Submit a new mix design if changing the source of Materials. Obtain concurrence from the State Materials Bureau before using the new Materials. Provide documentation confirming that the WMA additive blended with the asphalt binder results in asphalt cement that meets the specified PG Grade Asphalt Binder.

The WMA Additive Supplier and the Asphalt Binder Supplier will recommend mixing, compaction and maximum allowable temperatures to be used for the development of the mix design. The WMA mix design signed and submitted by a Department Approved Testing Laboratory will be reviewed by the State Asphalt Engineer in accordance with Department procedures, and if found to comply with all requirements, sent to the Project Manager for final Acceptance for use by the Department.

424.2.9 Job Mix Formula

The Job Mix Formula (JMF) must be in accordance with all aggregate gradation requirements and result in a mix that meets all specified mix design requirements. The Department will refer to the result of the Laboratory mix design developed in accordance with Section 424.2.8, "Mix Design," as JMF1.

Prepare the aggregate gradation of the calibration samples 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 including a set for the Referee Lab. Provide a minimum of five (5) sets of calibration samples. Do not combine the elements of the calibration samples prepared for the Referee Lab, and provide them, with the Project Number, Contractor and Project Manager clearly identified, to the Project Manager who will forward them to the State Asphalt Engineer. All Quality Control, Quality Assurance and Independent Assurance ovens must be calibrated by this procedure prior to start of production of a JMF. New calibration samples may be required for new JMF's, as determined by the District Lab Supervisor or the State Asphalt Engineer. The Project Manager will suspend paving operations until calibration of the ovens has been completed. No additional time or compensation will be granted for completion of this requirement.

424.2.9.1 Job Mix Formula Adjustment

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 complies with the Specifications will be required prior to being reviewed by the Project Manager and concurred by the State Materials Bureau. Review and concurrence of a JMF adjustment can only be made after:

- The Quality Control Plan (including checks on specific gravity) has been submitted and concurred by the Project Manager and the District Lab Supervisor for use on the Project;
- Confirmation by the Project Manager that the Quality Control Plan is being followed;
- Concurrence of the proposed changes from Project Manager and District Lab Supervisor,
- Submittal by the Testing Laboratory responsible for the original mix design to the Project Manager with a copy to the State Asphalt Engineer.

If the JMF is adjusted after the Shakedown Period, terminate the previous lot when the adjusted JMF has been reviewed and concurred with by the Project Manager and the State Materials Bureau. Terminated lot will be added to the previous lot for evaluation by QLA. Begin a new lot for the QLA with the adjusted JMF. During the Shakedown Period, make JMF adjustments in accordance with Section 424.3.5.7, Test Strip and Shakedown Period.

424.3 CONSTRUCTION REQUIREMENTS

424.3.1 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 uncoated aggregate exists, take corrective action. Ensure that the moisture content of the WMA at discharge from the mixer does not exceed 0.5%.

424.3.2 Mix Temperature Requirements

Do not allow the temperature of the WMA discharged from the mixer into the transport vehicle to be greater than 275 degrees F or less than 215 degrees F unless written recommendations by the asphalt cement Supplier, the Warm Mix Additive Supplier and the Mix Design Laboratory are provided to the Project Manager. WMA delivered to the Project with mix temperatures outside the acceptable range shall, at the sole discretion of the Project Manager, be removed and replaced at no cost to the Department.

424.3.3 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 while adding to the aggregate. Use an enclosed conveyor belt to prevent blowing or loss of hydrated lime or anhydrite based material if necessary. During production, if necessary to counteract loss, increase the percentage 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 $\pm 3.0\%$, 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's approval for 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 foundation system to support the silo in accordance with the silo manufacturer's recommendations. Control the hydrated lime or anhydrite based material content such that at a minimum the amount added is equal to the Target Value on the Job Mix Formula.

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 $1.5\% \pm 0.5\%$, 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, record the average amount of added moisture to verify specification compliance. Supply the recorded moisture information to the Project Manager upon request.

424.3.4 Equipment

Use Equipment and WMA technologies capable of producing an asphalt mixture that meets specification requirements and is workable at the minimum placement and compaction temperatures desired, regardless of storage or haul distance considerations.

424.3.4.1 Mixing Plants

Modify the asphalt mixing plant as required by the manufacturer to introduce the WMA technology.

424.3.4.1.1 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.

424.3.4.1.2 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 ensure proper and continuous circulation during the operating period. Allow measuring and sampling of asphalt binder from the delivery truck upon arrival.

424.3.4.1.3 Feeder for Drier

Equip the plant with an accurate feeding mechanism to deliver the aggregate into the drier and maintain uniform production and temperature.

424.3.4.1.4 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 with burner fuel.

424.3.4.1.5 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.

424.3.4.1.6 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.

424.3.4.1.7 Thermometers

Equip the asphalt feed line, near the charging valve at the mixer unit, with an approved recording thermometer with a range of from 100 °F to 400 °F. Equip the discharge chute of the drier with an approved recording 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.

424.3.4.1.8 Truck Scales

Weigh the WMA on approved scales (provided by the Contractor) or public scales in accordance with Section 109.1, "Measurement of Quantity."

424.3.4.1.9 Requirements for Batching Plants

424.3.4.1.9.1 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."

424.3.4.1.9.3 Mixer

Provide a batch mixer with a capacity of at least 2,000 lb, capable of producing a uniform mixture within specified tolerances.

424.3.4.1.9.4 Control of Mixing Time

Equip the mixer with an accurate timing device that signals the end of the mixing time.

424.3.4.1.10 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 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 (1) 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.

424.3.4.2 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 release agents derived from petroleum derivatives, including but not limited to diesel fuel, that contaminate or alter the characteristics of the mix.

Be prepared to cover and insulate hauling beds. Equip each truck with a waterproof and windproof cover of suitable material and sufficient size to protect the mix from the weather. Securely fasten covers when necessary to maintain temperature. Ensure that covers do not allow water to enter the bed, paver or mix material transfer device during mix unloading. Use insulated truck beds when necessary to maintain temperature.

424.3.4.3 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 WMA in accordance with the Plans.

424.3.4.4 Compaction Equipment

Provide a sufficient number, weight, and type of rollers to obtain the required compaction and specified pavement density while the WMA is in a workable condition. All rollers must be capable of reversing direction without shoving or tearing the mixture.

424.3.5 Placement Operations

For cold milled surfaces, prepare the surface in accordance with Section 414, Cold Milling. Clean the existing surfaces and apply a tack coat in accordance with Section 407, "Tack Coat."

When placing WMA on Base Course, Proof Roll the Base Course with a 27 ton roller or other approved Equipment and correct any soft areas, as directed by the Project Manager. Correct deficient areas at the Contractor's expense. Place the WMA on the approved surface, then spread, and strike off to the specified grade and elevation. Spread and compact the WMA in layers in accordance with the Plans.

For new construction and reconstruction, prepare the Subgrade or Base Course as follows:

- 1) Clean of loose or Deleterious Materials;
- 2) Free of frozen material; and
- 3) Meet the moisture and density requirements.
- 4) Place prime coat, as required in the Plans unless otherwise approved by the Project Manager, in accordance with Section 408, Prime Coat.

Unless otherwise specified in the Plans, for construction on NMDOT Projects using State approved WMA designs utilizing greater than 25% RAP the use of a Materials Transfer Vehicle is required.

Materials Transfer Vehicle (MTV): Use a MTV with storage and remixing capabilities on all mainline construction when placing WMA State approved designs. The MTV will independently remix and deliver mixture from the hauling Equipment to the paving Equipment. Furnish an MTV with the following capabilities:

1. An unloading system to receive mixtures from the hauling Equipment.
2. A minimum storage capacity of 13 tons with a remixing system in the MTV storage bin.
3. A discharge conveyor to deliver the mixture to the paver hopper.
4. The MTV system cannot exceed maximum legal loading on Structures.

Pick-up machines, hopper inserts and material transfer devices are not considered MTVs.

In the event the MTV malfunctions during paving operations, the Contractor can finish the Day without the MTV. Do not resume further mainline mix placement until the MTV is operational.

Consistently overloading the WMA mix into the paving machine is not acceptable. 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 grade and the transverse slope 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 WMA according to the following:

1. Without segregation or tearing;
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 WMA by other methods to achieve the required compacted thickness.

424.3.5.1 Weather Limitations

Do not place WMA on wet or frozen surfaces or if weather conditions prevent proper handling, finishing, and compacting. Place WMA when the Chill Factor is at least 35 °F and rising. If the air temperature is 55 °F or warmer, do not consider the Chill Factor.

424.3.5.2 Compaction

Compact the WMA thoroughly and uniformly immediately after placement. Operate rollers at speeds slow enough to minimize displacement of the WMA, 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 WMA 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 WMA 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 WMA, and compact to match the surrounding area, at no additional cost to the Department. Immediately correct areas that have excessive or deficient asphalt binder.

424.3.5.3 Not Used

424.3.5.4 Joints

Place the WMA as continuously as possible. Do not pass rollers over the unprotected end of a freshly laid mixture. When placing open-graded friction course over WMA, stagger longitudinal joints at least six (6) inches relative to the longitudinal joints of the underlying course. Unless otherwise specified, taper transverse and longitudinal joints as follows:

1. At least a three (3) ft taper for transverse joints, with a taper slope no steeper than 24:1.
2. At least a one (1) ft taper or a notched taper, for longitudinal joints, with a taper slope no steeper than 6:1 or a notched taper with a one (1) inch vertical edge at the top of the taper connected to a 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.
5. Avoid placing longitudinal joints in the wheel paths, unless approved by the Project Manager.

Completely bond joints. Smooth the surface of each course at the joints. The Department will not allow deviations greater than 3/16 inch when tested with a ten (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 seven (7) Days.

424.3.5.5 Surface Tolerances

Smooth the surface of each completed course and prevent deviations larger than 1/8 inch using a ten (10) ft straightedge in any direction. Immediately correct deviations exceeding this tolerance. Provide a final WMA surfacing course that conforms to Section 401, "Pavement Smoothness Measurement."

424.3.5.6 Plan Surfacing Depths

Provide pavement at the depth specified in the Contract. Monitor depths by calculating continuous production yields using the formula found in the MT-1, as maintained by the State Construction Bureau. Calculate the required yield and the corresponding yields for 0.25 inch increase (upper limit) and decrease (lower limit). The Project Manager may adjust the required yield to fit field conditions. If adjusted, the new target yield will be communicated to the Contractor in writing. Control production to keep yield within the upper and lower limits. Correct deficiencies at no cost to the Department. Correct deficient depths during placement. Address Plan Surfacing Depths in the Quality Control Plan.

424.3.5.7 Test Strip & Shakedown Period

Construct a maximum 1,000 ton test strip for each WMA mix design with a minimum of three (3) Contractor and three (3) agency samples to evaluate the JMF, process control, and placement operations. Construct test strip on Shoulder, low volume segments of the pavement, or area approved by the Project Manager. Correct and modify non-complying placement operations and produce necessary process control adjustments. Develop a revised JMF if necessary based on the results of the test strip. Production and placement operations prior to approval of the revised JMF and placement operations are at the Contractor's risk. For purposes of payment, the test strip will be evaluated in conformance with Section 416, Minor Paving. If accepted, the test strip will have a pay factor of 1.0. If rejected, said material shall be handled in accordance with Section 424.3.6.1.3 Adherence to Specifications and Rejection of Non-specification Material. Remove unaccepted test strip material placed within the Roadway Prism at no cost to the Department. If the Contractor disagrees with removing and replacing unacceptable material placed in test strips outside the Roadway Prism, the Assistant District Engineer for Construction, based on engineering judgment, will decide if the material can remain in place with a maximum pay factor of 50%, or shall be removed and replaced at no cost to the Department. If the test strip is rejected, construct a subsequent test strip. Do not proceed to full production until an accepted test strip is produced. After the test strip is placed, continue to evaluate the mix properties and the JMF during the placement of the first two (2) sublots in the first lot. Changes may be made to either the JMF or the mix proportions and/or properties with the concurrence of the Assistant District Engineer for Construction. For changes made prior to the completion of the first two (2) sublots, the adjustments will be applied to the entire lot for purposes of payment.

The Project Manager may waive test strip requirements for the Project, if requested by the Contractor based on prior experience with the JMF.

For QLA Projects, the Shakedown Period is defined as the first two (2) sublots produced in the first lot.

For Non-QLA Projects, the Shakedown Period is defined as the test strip. As the test strip is placed, evaluate the mix properties and the JMF. Changes may be made to either the JMF or the mix proportions and/or properties with the concurrence of the Project Manager, Assistant District Engineer for Construction and the State Asphalt Engineer.

424.3.6 Sampling and Testing

Sample and test the aggregate production and WMA mixture in accordance with Section 901, Quality Control /Quality Assurance (QC/QA), and the Department's "Minimum Testing Requirements." Department personnel may test locations other than the random locations generated for statistical analysis. These tests will not be used for pay factor determination, but may be used to determine Acceptance or rejection of localized material.

424.3.6.1 Contractor Quality Control

Administer a Quality Control Plan, referred to hereafter as "the Plan," to provide a product in accordance with the Contract. Ensure the Plan conforms to Section 901.2, "Contractor Quality Control." Submit the Plan a minimum of two (2) weeks prior to commencement of crushing operations and at a minimum comply with "Contractor Quality Control Plan Guidelines". No WMA operations are allowed until the Quality Control Plan has been approved by the Project Manager and the District Lab Supervisor. Address changes in the Job Mix Formula in conformance with Section 424.2.9.1, Job Mix Formula Adjustments.

The Plan shall 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. Sampling and Testing;
 - 1.3. Aggregate production;
 - 1.3.1. Gradation,
 - 1.3.2. Minus 200 wash,
 - 1.3.3. Plasticity index,
 - 1.3.4. Sand equivalent,
 - 1.3.5. Fine aggregate angularity,
 - 1.3.6. Flat and elongated particles count, and
 - 1.3.7. Fractured Face count.
 - 1.4. RAP (if used)
 - 1.5. Quality of components;
 - 1.6. Stockpile management;
 - 1.7. Proportioning;
 - 1.7.1. Gradation,
 - 1.7.2. Minus 200 wash,
 - 1.7.3. Plasticity index,
 - 1.7.4. Sand equivalent,
 - 1.7.5. Fine aggregate angularity,
 - 1.7.6. Flat and elongated particles count, and
 - 1.7.7. Fractured Face count.
 - 1.8. Mixing, including addition of hydrated lime or anhydrite based material, and/or asphalt additive, if required;
 - 1.9. Transporting;
 - 1.10. Placing and finishing;
 - 1.11. Joints;
 - 1.12. Compaction;
 - 1.13. Smoothness;
 - 1.14. Plan Surfacing Depths;
 - 1.15. Shakedown period;

1.16. Corrective Action Processes; and

1.17. Proposed lot size and subplot size in accordance with Section 424.3.6.3 QLA.

For the properties listed in 1.3 above, specifically address the requirements of Table 424.2.2.1.2:1 in the Plan. Define planned corrective action if the requirements are not met.

- 1.3.1 and 1.3.2 are for informational purposes during aggregate production.
- 1.3.3 through 1.3.7, if three (3) consecutive tests fail, address what will change in production. Failure to adjust will result in ceasing operations until a corrective action plan is approved by the Project Manager.

For the properties listed in 1.7 above, specifically address the requirements of Table 424.2.2.1.2:1 in the Plan. Define planned corrective action if the requirements are not met.

- 1.7.1 and 1.7.2 are to be evaluated against the Job Mix Formula.
- For properties listed in 1.7.3 through 1.7.4, if any three (3) consecutive tests fail, the Contractor is to cease operations until a corrective plan is approved by the Project Manager and implemented.
- For properties listed in 1.7.5 through 1.7.7, any test failing by more than 5 percentage points, or if three (3) consecutive tests fail by an average of 0 to 5 percentage points, cease operations until a corrective plan is approved by the Project Manager and implemented.

2. Employ sampling and 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.

On Projects designated as QLA Projects, sample and test WMA in accordance with Section 901, "Quality Control/Quality Assurance (QC/QA)."

- 2.1. The Contractor is responsible for inspection performed at the crushing operations, hot mix plant and at the Contractor's field Laboratory; using the Laboratory test results and other Quality Control practices to ensure the quality of aggregate sources and other mix components. Adjust and control mix proportioning to meet the mix design. Be responsible for periodically inspecting all Equipment used in proportioning and mixing to ensure its proper operating condition and to ensure that proportioning and mixing is in conformance with the mix design and other requirements.
- 2.2. Be responsible for inspection, sampling, and testing performed at the paving site, ensuring that the delivered Materials meet Contract requirements and for periodically inspecting all Equipment used in transporting, placing, finishing, and compacting to ensure its proper operating condition. Ensure that placing, finishing, joint construction, compaction, and thickness, when required, are as specified.

3. Define and document the coordination of activities between the Contractor's management and all Contractor testing personnel including the frequency of each type of test, the criteria used by the Contractor's management and technicians to

recognize deficiencies and reject or correct unacceptable Materials, and a description of proposed corrective actions.

4. In the Plan, describe, in detail, the proposed process control sampling and testing programs. Include the method by which random sampling locations are to be determined. Develop sample locations for process control tests so that the center of the sample is at least 12 inches from a joint or edge of the pavement layer.

If the WMA additive Supplier indicates that the additive makes mix properties time dependent; the plan must include how all of the required testing will be completed in the designated time frame. This plan will include how the Contractor will comply with the required testing within the Supplier specified time frames. It will also include how the Department will be supported, if necessary, to complete their tests within the time frame required if the testing cannot be performed at established Department facilities. This plan must be reviewed and approved by the Department's Project Manager and by the District Laboratory Supervisor prior to the placement of any WMA on the Project. If the Job Mix Formula changes, it shall be addressed in conformance with Section 424.2.9.1, Job Mix Formula Adjustments.

424.3.6.1.1 Contractor Quality Control of Aggregate

Obtain samples in accordance with Section 901.2.4 Sampling. Take representative samples as required, either at the stockpile or after the aggregate material is combined but before the addition of hydrated lime or anhydrite based material and mixing with asphalt binder. Test these samples for conformance with the approved Job Mix Formula and: (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 Project Manager may sample and test the aggregate at any time during production or stockpiling, or may request to split samples with the Contractor. If testing indicates corrections are necessary, make corrections in conformance with the Plan. The Department will base evaluation of RAP aggregate in accordance with Section 424.2.7, "Reclaimed Asphalt Pavement."

424.3.6.1.2 Contractor Quality Control for Compaction

Monitor the compaction process by determining the density of the WMA with a portable densometer in accordance with the approved Quality Control Plan. Establish calibration of the portable 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 with the portable densometer. Correlate these test results. Conduct Quality Control testing in accordance with Section 901, "Quality Control/Quality Assurance (QC/QA)," and provide test results to the Project Manager. 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 WMA.

424.3.6.1.3 Adherence to Specifications and Rejection of Non-specification Material

Produce Material in compliance with all specification requirements. Evaluate test results for specification compliance and treatment of Material that does not meet Specifications in accordance with Section 424 in its entirety. All Material that is rejected shall, at the sole discretion of the Department, be removed and replaced with specification Material at the Contractor's expense.

424.3.6.2 Department Quality Assurance

424.3.6.2.1 Acceptance

The Department will evaluate Materials for Acceptance in accordance with this section. Sample and test the mixture and pavement on a statistically random basis in accordance with Table 901.7:6, "Minimum Acceptance Guidelines." The Project Manager may reject material that appears to be defective based on visual inspection.

Table 424.3.6.2.1:1
Acceptance Testing Tolerances^a

Characteristic	Specification limit, percentage points from TV
Air Voids, %	± 1.4
Pavement Density % ^c	± 2.5
Hydrated Lime or Anhydrite Based Material % ^f	Minimum of JMF Target Value
Voids in the Mineral Aggregate (VMA), % ^{a,d}	± 1.6
Asphalt Content % ^{a,b}	± 0.50

^a All gradation, Asphalt Content, VMA, and VFA values shall be determined using the AASHTO T 308 testing results.

^b WMA will not be rejected based on Asphalt Content Determined by AASHTO T 308

^c Density payment will be adjusted in accordance with Section 901.5

^d 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.

^e If Hydrated Lime or Anhydrite Based Material is below Design TV cease hot mix production, investigate and correct.

424.3.6.2.1.1 Non-QLA

The Department will evaluate (QA) test results from Projects with Bid quantities less than 15,000 tons for specification compliance in accordance with the following procedures: If the mean of the test results for each property is within the Acceptance Tolerances as listed in Table 424.3.6.2.1:1, "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 901.5, Quality Level Analysis. If the mean of the test results for any of the listed properties is outside of the tolerances as listed in Table 424.3.6.2.1:1, "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 15,000 tons. Remove and replace rejected Material with specification Material at no additional cost to the Department.

424.3.6.2.1.1.1 Acceptance of Pavement Density

The target density for Acceptance of WMA will be 94.5% of the theoretical maximum density as determined from AASHTO T 209. For determination of maximum specific gravity, obtain and test a minimum of two (2) samples and ensure the Department obtains and tests a minimum of one (1) sample for each Day that the WMA is placed. Each individual density test value obtained must be from 92.0% to 97.0% of the theoretical maximum density.

To be prepared for dispute resolution, the Contractor is to provide one (1) additional core for each core tested by the Department for Acceptance of density. The additional core is to be from the same lot as the initial core and shall be generated from the random sample plan. If the Contractor believes the Department's cut pavement samples have been damaged they

may invoke Section 424.3.7 Dispute Resolution. The Referee Lab results will replace the initial core in determining pay factor. The Assistant District Engineer for Construction will make the final decision on accepting or rejecting material, based on the Referee Laboratory's result(s) by:

1. Accepting the section or subplot if the density test falls between 92.0% - 97.0% ;
2. Determining that a portion, based on visual determination, or all of the Material in that section or subplot shall be removed or replaced at no additional cost to the Department;
3. Determining that a portion, based on visual determination, of the Material in that section or subplot will 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 WMA. Determine the pay factor in accordance with Section 901.5, Quality Level Analysis. Use a minimum of ten (10) cores to determine the pay factor, unless otherwise directed by the Assistant District Engineer for Construction. 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. If a composite pay factor of more than 1.00 is calculated, the composite pay factor will be a 1.00 for the purposes of payment.

For Projects consisting of single lift overlays or mill and inlay with a single lift of two and a half inches or less, the Project Manager may grant an exception to the mean density target requirement of at least 94.5% of the theoretical maximum density if the Contractor can demonstrate that a minimum of 92.0% cannot be reasonably obtained because of the existing conditions of the Pavement Structure or Subgrade Materials. The Contractor demonstrates this by providing density results obtained during paving operations witnessed by a State Inspector at the location in question. If the Project Manager grants this exemption, construct a Roadway test strip and develop a WMA compaction process to get the highest possible density based on an approved roller's density gain per pass, in accordance with Section 424.3.4.4, Compaction Equipment. The Project Manager will approve the process, establish a new target value for density and establish a new Acceptance lot only for the portion of the Project addressed herein (except for the Roadway test strip) before paving begins or continues. Density shall not fall below 91%. If a lot does not meet either of the revised density requirements, the Project Manager will, with the concurrence of the Assistant District Engineer for Construction, do the following:

1. Accept and pay for the lot of WMA at 50% of the Bid Item Unit Price; or
2. Reject the in-place material and require the Contractor to remove and replace.

424.3.6.3 QLA

On Projects with Bid quantities of 15,000 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 424.3.6.2.1:1, "Acceptance Testing Tolerances". Acceptance lots shall be between 15,000 tons and 30,000 tons, as determined at the pre-paving conference. Table 424.3.6.2.1:2 indicates properties that will be tracked for purposes of Quality Assurance. For all QLA Projects, if a composite pay factor of more than 1.00 is calculated, the composite pay factor will be a 1.00 for the purposes of payment.

424.3.6.3.1 Acceptance of Pavement Density

The target density for Acceptance of WMA will be 94.5% of the theoretical maximum density as determined from AASHTO T 209. For determination of maximum specific gravity, obtain and test a minimum of two (2) samples and ensure the Department obtains and tests a minimum of one (1) sample for each Day that the WMA is placed, in accordance with the random sampling plan. Each individual density test value obtained must be from 92.0% to 97.0% of the theoretical maximum density.

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

WMA. Determine the pay factor in accordance with Section 901.5, Quality Level Analysis. Use a minimum of ten (10) cores to determine the pay factor, unless otherwise directed by the Assistant District Engineer for Construction. To be prepared for dispute resolution, the Contractor is to provide one (1) additional core for each core tested by the Department for Acceptance of density. The additional core is to be from the same lot as the initial core and shall be generated from the random sample plan. If the Contractor or Department believes the Department's cut pavement samples have been damaged they may invoke Section 424.3.7 Dispute Resolution. The Referee Lab results will replace the initial core in determining pay factor. 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. If a composite pay factor of more than 1.00 is calculated, the composite pay factor will be a 1.00 for the purposes of payment.

For Projects consisting of single lift overlays or mill and inlay with a single lift of two and a half inches or less, the Project Manager may grant an exception to the mean density target requirement of at least 94.5% of the theoretical maximum density if the Contractor can demonstrate that a minimum of 92.0% cannot be reasonably obtained because of the existing conditions of the Pavement Structure or Subgrade Materials. The Contractor demonstrates this by providing non-destructive density results obtained during paving operations witnessed by a State Inspector at the location in question. If the Project Manager grants this exemption, construct a Roadway test strip and develop a WMA compaction process to get the highest possible density based on an approved roller's density gain per pass, in accordance with Section 424.3.4.4, Compaction Equipment. The Project Manager will approve the process, establish a new target value for density and establish a new Acceptance lot only for the portion of the Project addressed herein (except for the Roadway test strip) before paving begins or continues. Density shall not fall below 91%. If a lot does not meet either of the revised density requirements, the Project Manager will, with the concurrence of the Assistant District Engineer for Construction, do the following:

1. Accept and pay for the lot of WMA at 50% of the Bid Item Unit Price; or
2. Reject the in-place material and require the Contractor to remove and replace at no cost to the Department.

424.3.6.4 Independent Assurance Testing

The Department will perform Independent Assurance sampling and testing in accordance with Section 901.3, "Independent Assurance Testing."

424.3.7 Dispute Resolution

For any test incorporated into the pay factor, if a dispute exists between the Department and the Contractor about the validity of the test result, either party may invoke a referee lab. The State Asphalt Engineer will maintain a list of labs that are willing and capable of performing referee testing. All referee labs shall be AASHTO Materials Reference Laboratory (AMRL) certified for the test(s) to be performed. Neither the Department's Project staff, nor the Contractor will know who is performing the referee testing. The State Asphalt Engineer will select a Laboratory, without disclosing the name of the lab to Department Project Personnel or Contractor personnel, from the following, not in priority order:

1. A District Laboratory not from the District in which the Project resides; or
2. A private Laboratory currently listed on the State Material's Bureau's list of approved private labs not involved in the subject Project in any manner, such as mix design submittal, preliminary testing for design, etc. Only laboratories that are in the routine business of providing testing and designs will be considered. Contractor owned laboratories will not be allowed.

When a referee lab is used, the referee lab's test results will be used in determining the pay factor. The referee lab must be invoked in writing within ten (10) Calendar Days of receiving the test results from the other party. If not invoked within ten (10) Calendar Days, the test results are deemed accepted. The results will be used to determine pay factors. The Department's prior test results or the Contractor's prior test results for the test in question will

be discarded. If the composite pay factor decreases from applying the referee lab's results, the Contractor shall pay for the testing performed by the referee lab. If the composite pay factor increases from applying the referee lab's results, the Department will pay for the testing performed by the referee lab. If the composite pay factor remains unchanged, the cost shall be split with each party responsible for 50% of the total cost.

For all testing incorporated into the pay factor, each party shall generate an additional sample from the Department's Acceptance Samples and the Contractor's Quality Control Samples used in pay factor analysis. Failure to provide the referee samples prior to testing the initial sample will result in the Project Manager suspending the Project at no cost to the Department. Additional time will not be added to the Contract for Project suspension caused by failure to comply with Dispute Resolution Process. Work shall not resume until the Contractor provides the delayed sample(s) and satisfies the Project Manager, in writing, that future samples will be provided in compliance with this requirement. The extra sample(s) is (are) to be retained by the Department. The Department will retain the samples at the Project location inside a locked cargo container, provided by the Contractor at no cost to the State. The State will provide the lock for the cargo container. Once the pay factor is determined dispose of the unused samples at no cost to the Department. In no case will the unused samples be disposed of prior to the ten (10) Calendar Day period in which the Dispute Resolution process may be invoked. For Pavement Density, the Contractor shall provide an additional core only for each core provided to the Department for Acceptance. The additional core will be stored and retained in the provided container. Should the Contractor invoke the Dispute Resolution Process for Density, the second core will be provided to the Referee Lab., The density pay factor for the material in question will be based solely on the Referee Lab result, not including Department or Contractor results.

Failure to comply with the requirements contained herein will result in the pay factor being calculated in accordance with the applicable Sections of 424, Superpave (QLA and Non-QLA), and 901, Quality Control/Quality Assurance (QC/QA). No test results will be replaced by referee results.

424.4 METHOD OF MEASUREMENT

If the Department measures *WMA* by the square yard, the Department will use the average width of the *WMA* in place and the length from station to station along the centerline of the Roadway when calculating quantities.

424.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>WMA Complete</i>	Ton or Square Yard
<i>WMA</i>	Ton or Square Yard

The Department will pay for accepted quantities at the Bid Item Unit Price, adjusted in accordance with Section 424.5.1, "Price Adjustments." Providing and transporting all cores, samples and storage containers shall be Incidental to the Pay Items above.

424.5.1 Price Adjustments

424.5.1.1 Projects with Bid Quantities of 15,000 Tons or Greater

The Department will pay for accepted quantities of *WMA* or *WMA Complete* at the Bid Item Unit Price, adjusted in accordance with Section 901.5, "Quality Level Analysis." The *WMA* will be evaluated 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 424.5.1.1:1, "Weighting Factors," to calculate each lot's composite pay factor. The pay factor for the entire Project will be calculated by applying weighted averages, based on tonnage contained within each lot, to each lot's composite pay factor. If the composite pay factor for a lot is greater than 1.0, the pay factor will be set at 1.0.

**Table 424.5.1.1:1
Weighting Factors**

Characteristic	"f" Factor (%)
Mat Density	35
Air voids	35
Voids in the mineral aggregate (VMA)	20
Asphalt Content*	10

*If the individual pay factor for asphalt content is less than 0.75, it will be set at 0.75 for the purpose of calculating payment.

424.5.1.2 Projects with Bid Quantities Less than 15,000 Tons

The Department will pay for accepted quantities of *WMA* or *WMA Complete* 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 424.3.6.2.1:1, "Acceptance Testing Tolerances." If the mean of the test results for any of the listed properties is outside of the testing tolerances as listed in Table 424.3.6.2.1:1, "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. In no case will the pay factor be greater than 1.00.

424.5.1.2.1 Price Adjustment for Pavement Density (Bid Quantities Less than 15,000 Tons)

The Department will also adjust the Bid Item Unit Price for the *WMA* or *WMA Complete* Pay Item, based on the Roadway density, in accordance with Section 901, Quality Control/Quality Assurance (QC/QA), specifically Section 901.5, Quality Level Analysis steps one (1) through nine (9). If the density pay factor for a lot is greater than 1.0, the composite pay factor will be set at 1.0 for purposes of payment. The Department will apply the price adjustments to the *WMA* Bid Item Unit Prices for each lot.

SECTION 450: PORTLAND CEMENT CONCRETE PAVEMENT (PCCP) (QLA)

450.1 DESCRIPTION

This Work consists of constructing Portland cement concrete pavement (PCCP) on a prepared Subgrade, Base Course or HMA/WMA.

450.2 MATERIALS

Portland cement, air-entraining admixtures, chemical admixtures, mineral pozzolans, water, and aggregate will meet the requirements of Section 509, "Portland Cement Concrete."

450.2.1 Dowels and Tie Bars

Dowels and tie bars will meet the applicable requirements of Section 540.2, "Steel Reinforcement Materials."

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-LS concrete mix that has been reviewed and approved in accordance with Section 509 by the State Concrete Engineer. If the concrete is not slip-formed, an approved Class AA-HPD concrete mix shall be used instead of Class F.

Mix and place all concrete in accordance with Section 510.3, "Construction Requirements."

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 510.3.2, "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 (1) 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. Do not use pavers with vibrators in front of the auger.

Equip slip-form pavers with internal vibrators that meet or exceed the following Specifications at 10,000 cycles per minute (cpm) under no-load conditions:

1. Amplitude (peak to peak) = 0.070 inch; and
2. Centrifugal force = 1,200 lb

Equip the slip-form paver with an electronic monitoring device capable of the following:

1. Displaying the operating frequency of each internal vibrator;
2. Continuously recording at a minimum the following:
 - a. Time of Day,
 - b. Station location,
 - c. Paver track speed, and
 - d. 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 of the vibrators; but do not exceed 18 inches, center-to-center. Ensure that the space from the outer edge of the pavement to the center of the outside vibrator does not exceed nine (9) inches, or $\frac{1}{2}$ the maximum recommended spacing, whichever is less.

450.3.2.5 Concrete Jointing Equipment

Provide enough sawing Equipment and/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 Project Manager and State Materials Bureau. Provide at least one (1) additional saw or insertion tool in good working order. Keep an ample supply of saw blades (and skid plates, if the "early entry dry cut" saws are used) at the Work site during sawing operations.

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 Consolidating 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.

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.

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 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.

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 propelled only by its own mechanisms.

450.3.3.2.2 Other Paving

For paving operations that are not slip formed, the Contractor will place Class AA-HPD concrete pavement between stationary side forms. Consolidate 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 hours 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

Temperature and weather limitations are defined in Section 511.3.4, "Temperature and Weather Limitations." Keep the concrete temperature between 50 °F to 90 °F at the time of placement. In addition for cold weather placement refer to Section 511.3.3.1 "Cold Weather Concrete."

450.3.3.4 Rate of Evaporation Limitations

The Contractor shall continuously monitor the evaporation potential at a height not to exceed 5 feet above the surface of the concrete as determined from Figure 511.3.3.5:1, "Surface Evaporation from Concrete" at the actual placement location. Computerized Equipment, furnished by the Contractor, is set to automatically take the required readings shall be used for this purpose. Readings shall be taken at least once every 5 minutes beginning at least 15 minutes before the placement begins, and continuing until the final application of the curing compound has been completed. All readings shall be graphically plotted on a continuous time scale.

Do not place (or continue to place) PCCP if the average evaporation potential over any 10 minute period of time is greater than 0.2 lb per square foot per hour. If the evaporation exceeds the 0.15 lb per square foot per hour, one (1) or more of the following actions shall be implemented to reduce the rate of evaporation, as approved by the Project Manager:

1. Use an evaporation retarder (If used, this cannot be used as a finishing aide);
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. This can be accomplished 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

During marginal weather placement of any PCCP by the Contractor is at his own risk. Repair or replace concrete that is determined to be damaged due to weather conditions by the Assistant District Engineer (Construction), at no additional cost to the Department.

450.3.4 Joints

Submit the proposed joint layout plan in .pdf format to the Project Manager, State Pavement Engineer and the State Materials Bureau for review and approval at least four (4) weeks before starting concrete slab construction. The proposed joint layout plan shall have the lane markings clearly depicted. Attempts shall be made in the submitted jointing plan for mainline paving not to place longitudinal joints in the wheel path. After receiving the recommendations and/or responses from the State Pavement Engineer and from the State Materials Bureau, the Project Manager will either approve or reject the submittal within 10 Working Days from the date of submittal.

Construct joints at the locations, intervals, and dimensions shown in the approved joint layout plan, and seal them in accordance with Section 452, "Sealing and Resealing Concrete Pavement Joints." Ensure no re-entrant corners. For typical slabs the longitudinal joint spacing shall not exceed 12 feet and the transverse joint spacing shall not exceed 15 feet. The maximum slab length-to-width ratio shall not be greater than 1.25:1 for the primary traveled lanes and longitudinal joints shall be placed within the lane stripe or as approved by the Project Manager and NMDOT Pavement Engineer. Avoid tapered joints if possible. If a tapered joint is formed, place a control joint at:

1. One-half the distance between the end of the taper and the opposite end, if the base leg is less than or equal to ten (10) ft and longer than five (5) ft; or
2. Third points along the base leg, if the base leg is longer than ten (10) ft.
3. No slabs will have angles less than 60 degrees.
4. Joints shall be "dog-legged" through curve radius points. Dog leg should be at least 24 inches in length to the radius point.
5. 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 the initial sawcut at least one third the pavement depth. Do not allow the saw to cut so deep that any reinforcement is damaged.

Begin sawing of the joints as soon as possible after the concrete has hardened enough to permit a person to stand on the surface without leaving visible tracks or indentations. All sawcutting must be completed no later than four (4) hours after the concrete has hardened enough that a person can stand on the surface without leaving visible tracks or indentations. In all cases, regardless of setting characteristics, all sawcutting must be completed before the concrete is seven (7) hours old.

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, but not less than 1/3 the thickness of the concrete. 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.

All PCCP panels containing uncontrolled cracks shall be removed and replaced at no cost or additional time to the Department. The Project shall not be granted final Acceptance until all panels containing uncontrolled cracks have been removed and replaced.

Change saw blades (and the skid plates, when using the early entry dry cut method) as often as required to control and minimize spalling. Maintain a sufficient supply of replacement saw blades and skid plates at the Project site to insure that the sawing operations will proceed without interruption until completed.

Saw joints sequentially. However, the Contractor may saw control transverse joints at intervals shown in the Contract, or at intervals 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.

450.3.4.1 Longitudinal Joints

Place tie bars perpendicular to the longitudinal joints using approved Equipment, or secure the joints with chairs or baskets. Do not place tie bars within 15 inches of transverse joints. Only paint or coat tie bars if it is necessary to repair the corrosion-resistant coating.

The combined width of all concrete slabs tied together shall be not more than 40 feet.

Should the tie bars be found to be closer than one (1) inch to the bottom of the sawed joint, or closer than two (2) inches to the bottom of the slab, or if the spacing between tie bars is found to be greater than 30 inches, the Contractor shall cease paving operations until it can be successfully demonstrated that the required tolerances will be met. The control joint shall

then be made by sawing in hardened concrete in accordance with the plan details and with Section 450.3.4.

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 420 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 as approved by the Project Manager. Submit shop drawings of the welded dowel assemblies to the Project Manager for approval by State Pavement Engineer. Do not place concrete until the Department approves the welded dowel assemblies.

Dowel bars shall be installed within the tolerances and of the size, grade and spacing specified. Horizontal support wires or shipping braces shall be non-deformed bars or wires with a diameter less than or equal to 0.307 inches (gauge 0 wire). The number of horizontal support wires or shipping braces shall be limited to a maximum of five (5) per assembly. The center of the dowel assembly or insertion location shall be marked on both sides of the pavement slab for reference in sawing the joint. Dowel bars shall be furnished in a rigid welded assembly or, when the Contractor demonstrates that the placement can be made within required tolerances, placed by a dowel insertion machine. Assembly should be securely fastened to the base/subbase and constructed to firmly hold all the centerline of all dowel bars at T/2 depth with a minimum of three (3) inches cover, parallel to each other and to the pavement grade and alignment. See Detail indicated in the Contract Plans or standard Plan serials for the applicable section. Dowel placement tolerances are:

Horizontal translation = two (2) inches

Horizontal Skew = 3/8 inch

Vertical Translation = 1/4 inch

Vertical Skew = 3/8 inch

Longitudinal Side Shift/Translation = one (1) inch

The Contractor is responsible for ensuring that the dowels remain properly aligned and in the proper locations before and during the placing procedure. Do not cut the tie wires holding the baskets together before placing the concrete.

Thoroughly and uniformly coat each dowel and each tie wire along its full length with an approved form release agent not more than twelve (12) hours before concrete placement. Do not use grease to lubricate the dowels. If the concrete placement is postponed or delayed the dowels will be re-coated.

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, and is approved by the Project Manager.

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 five (5) foot of a control joint or weakened plane. If concrete placement stops, the final slab must measure at least five

(5) foot. If the final slab is less than five (5) foot, remove the excess concrete to the preceding joint, as directed by the Project Manager. Unanticipated construction joints need to be tied.

The Contractor is responsible for preventing uncontrolled cracking and/or loss of pavement durability by whatever means necessary, including but not limited to placing construction joints and/or contraction joints wherever necessary.

450.3.4.4 Final Location of Dowels and Tie Bars

Within 72 hours of concrete placement confirm that the final location of the transverse dowel bars and the longitudinal tie bars comply with the specified location and placement tolerances for every transverse joint and longitudinal joint in the first 120 linear feet of paving, or as otherwise specified. Equipment used to determine the final location shall be a Magnetic Tomography (i.e.: MIT Scan 2) or Magnetic Field Detection (i.e.: Hilti Ferrosan FS 10) or Ground Penetrating Radar equipped with dual side-by-side antennas or approved equal approved by the Project Manager and State Concrete Engineer.

If all of the dowels and tie bars are properly located and aligned on the first 120 linear feet, then the frequency used to confirm the final location of the dowels can be reduced to one (1) randomly selected longitudinal and transverse joint for within each 1000 linear feet for the duration of the Project and/or as directed by the Project Manager. Paving can only proceed when all surveyed steel and dowels are confirmed by the Project Manager to be in proper location for each 1000 foot increment.

1. If the dowel bars or the tie bars do not comply with the Project Requirements, then all placement of concrete must stop until the Contractor can provide a corrective action plan to ensure the dowel bars and the tie bars are located in accordance with Project requirements. At the discretion of the Assistant District Engineer for Construction, either remove and replace the dowels and/or tie bars that do not comply with this specification or allow the non-complying bars to remain at a reduced price determined by the Assistant District Engineer. Do not resume placement of concrete operations until approved by the Assistant District Engineer (Construction) in concurrence with the State Pavement Engineer and State Concrete Engineer. When the placement operations are resumed, the final location of the dowel bars and tie bars shall be confirmed in accordance with Paragraph 1 above.

The Contractor will be responsible for providing the appropriate Equipment and qualified personnel to provide the specified test and report to the Project Manager. This Work will be incidental to concrete pavement.

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 MRI, measured in accordance with Section 401 "Pavement Smoothness Measurement."

Correct pavement edge slumping (exclusive of specified edging) in excess of ¼ inch before the concrete hardens. If edge slump exceeds ¼ inch within 10 feet, 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 the appropriate tools to produce a well-defined and continuous radius with a smooth and dense mortar finish that is not segregated nor prematurely sealed. Minimize disturbance of the slab surface during finishing operations. It is the Contractor's responsibility not to over-work the surface of the fresh concrete. Any plastic shrinkage cracks that occur shall be repaired or replaced at the discretion of the Project Manager at no cost in time or money to the department.

Thoroughly clean the sawed area and, after completion of the sawing process. Seal the joint immediately, if required by the Project Manager.

Give the pavement a final wearing surface by tining or grooving as required in Section 450.3.5.1 "Texturing of PCCP."

450.3.5.1 Texturing of PCCP

When tining, use a mechanical device such as a wire broom or comb having a single row of tines 1/8 inch +/- 1/64 inch width. The depth of groove in the plastic concrete shall be 1/8 inch +/- 1/16 inch. Tining will be Longitudinal unless otherwise specified in the Contract.

Longitudinal Tining: The tines shall be uniformly spaced at 3/4 inch intervals. Use Equipment with horizontal and vertical controls to ensure straight, uniform depth grooves. A two (2) inch to three (3) inch wide strip of pavement surface shall be protected from longitudinal surface grooving for the length of and centered over the longitudinal joint.

Transverse Tining: The tines shall be randomly spaced from 3/8 inch to 1 5/8 inch with no more than 50% of the spacing exceeding one (1) inch. Leave a four (4) inch to six (6) inch wide un-tined strip of pavement surface centered over each transverse joint.

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 abutting pavement is to be placed, the texturing shall extend as close to the edge as possible without damaging the edge. If abutting pavement is not to be placed, the six (6) inch area nearest the edge or one (1) foot from the face of the curb shall not be textured. All uniform width slabs of 20 feet or narrower and less than 600 feet in length, as well as mainline and ramp pavement during Equipment breakdowns, may be textured by hand methods.

When diamond grooving is specified or allowed in the Contract Plans, allow concrete to cure, but no sooner than 48 hours groove the surface of the concrete in accordance with Section 455, "Diamond Grinding and Grooving of Portland Concrete Cement Pavement." Unless otherwise approved by the Project Manager, make grooves as required by the Project Specifications.

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-foot intervals near the right-hand edge of the pavement indicating the Roadway station.

450.3.5.2 Protection of Fresh Concrete

To protect the fresh concrete from unanticipated storm events, keep enough waterproof sheeting at the placement location to cover the maximum anticipated amount of pavement that can be placed in a three (3)-hour period. Reserve this sheeting exclusively to protect the pavement.

450.3.5.3 Surfacing Smoothness Requirements

Test the longitudinal smoothness of the PCCP finished surface in each through traffic lane and passing lane with an approved Profile, in accordance with Section 401, "Pavement Smoothness Measurement."

The Department will exclude the following locations from the Profiler measurement. Evaluate them using a straightedge in accordance with Section 401, "Pavement Smoothness Measurement."

1. Shoulders, ramps, tapers, holding lanes, turn-outs, Medians, concrete pavement slab removal and replacement Projects, intersections not paved integrally with the mainline, and other non-mainline pavement.

450.3.5.4 Straightedge Measurements

Measure the surface of PCCP not subject to Profiler measurements using an approved 10-foot straightedge at both right angles and parallel to the centerline. Correct surface deviations greater than ¼ inch within ten (10) feet.

450.3.6 Curing

Begin application of the approved curing system as soon as possible after the concrete is placed.

- Do not wait until the bleed water has disappeared.
- Do not wait until all of the concrete has been placed if the curing system can be applied sooner.
- No further finishing operations shall be performed after the curing system has been applied.

Ensure that the entire surface of the newly placed concrete has been completely covered by applying the approved curing system at the earliest opportunity.

The use of an Evaporation Retarder is permitted. The Evaporation Retarder must be used in strict accordance with the manufacturer's directions. Once the Evaporation Retarder has been evenly applied to the concrete, do not touch or finish any portion of the coated concrete until it is ready for the final surfacing treatment. The Evaporation Retarder may not be used as a finishing aide or in any manner to facilitate finishing the surface of the concrete.

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 in any way.

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 and dispersion.

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.

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 Calendar Days, or the concrete has achieved an in-place compressive strength of 3000 psi, as determined by the Maturity Method.

450.3.6.2 Use of Sheetting 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 inches. 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 Calendar Days or until the compressive strength has reached 3000 psi, as determined by the Maturity Method. Immediately patch holes in the sheeting.

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 a least seven (7) Calendar Days or until the concrete has reached a compressive strength of 3,000 psi as determined by the Maturity Method, in accordance with Section 510.3.4.2.2 In-Place Concrete Strength Measurements," unless the Project Manager directs otherwise.

Clean the pavement of loose Materials and debris before opening to traffic.

450.3.10 Sampling and Testing

Sample and test the aggregate production and PCC mixture in accordance with Section 901, Quality Control /Quality Assurance (QC/QA), and the Department's "Minimum Testing Requirements for QLA Portland Cement Concrete Pavement". Department personnel may test locations other than the random locations generated for statistical analysis. These tests will not be used for pay factor determination, but may be used to determine Acceptance or rejection of localized material.

450.3.10.1 Contractor Quality Control

Administer a Quality Control Plan, referred to hereafter as "the plan" to provide a product in accordance with the Contract. Ensure the plan conforms to Section 901.2, "Contractor Quality Control." Submit the Plan a minimum of two (2) weeks prior to PCCP pre-placement meeting and at a minimum comply with the "Contractor Quality Control Plan Guidelines". The "Contractor Quality Control Plan Guidelines" are available from the Project Manager or State Construction Bureau. No PCCP operations are allowed until the Plan has been approved by the Project Manager and District Lab Supervisor.

Ensure the plan addresses all elements that affect the quality of the portland cement concrete paving, including but not limited to:

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;
13. Thickness;
14. Placement phasing;
15. Rumble strips if required; and
16. Non Destructive Testing Methods (including Project calibration process).

Make sure the plan identifies personnel responsible for sampling and testing of PCCP, and how to contact them at any time. Make sure 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 (2) qualified technicians, as follows:

1. The Process Control Technician (PCT) is responsible for performing inspection, sampling, and testing 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.
2. The Quality Control Technician (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 what corrective actions can be taken, and how and when the actions will be initiated.

The plan will detail 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."

450.3.10.2 Department Quality Assurance

450.3.10.2.1 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 450.3.10.2.1:1, "Acceptance Limits."

Table 450.3.10.2.1:1

Acceptance Limits

Characteristic	Specification limits, from TV
Entrained air (from the appropriate Freeze/Thaw Risk Zone)	± 1.5%
*Target Compressive Strength (From approved mix design)	± 1,000 psi
Thickness (From Project Specifications)	+ 1 inch/-1/4 inch

Unless otherwise provided in the Contract, target values for Acceptance shall be as follows:

Entrained air	Target Air Content for the Freeze/Thaw Risk Zone in which the Project is located
Compressive strength	Target strength from mix design
Thickness	Nominal plan thickness +1 inch/-1/4 inch

*Target Compressive Strength will be the average compressive strength of the first thirty (30) tests from the Contractor's QLA testing program. If the Contractor's data does not validate with the departments data, the Target Compressive Strength will be the average of the first ten (10) department tests.

450.3.10.3 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—Reserved

450.5 BASIS OF PAYMENT

The Department will adjust the *Concrete Pavement* unit Bid 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 unit Bid price by the composite pay factor. The Department will use Table 450.5:1, "Composite Pay Factor," to calculate the composite pay factor. Composite Pay factors greater than 1.0 will be paid for as 1.0.

Table 450.5:1
Composite Pay Factors

Measured characteristic	Factor "f"
Entrained air	50
Compressive strength	50
Thickness	50

Pay Item	Pay Unit
<i>Concrete Pavement</i>	Square Yard

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 450.3.5.1, "Texturing 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—Reserved

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 either using cores located in a random pattern with at least two (2) cores in each test area or by drilling holes greater than ½ inch diameter completely through the PCCP and determining the thickness from the drilled hole. Core holes shall be filled with self-leveling sealant material as specified in Section 452 "Sealing and Resealing Concrete Pavement Joints" including round closed-cell bondbreaker as described in Section 452.2.3

“Bondbreaker.” These repairs shall be considered Incidental. The Contractor shall complete all 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 measurements is not less than 1/4 inch from the required thickness, and when any measurement is not less than 3/4 inch 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—Reserved

451.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Concrete Pavement ___ inch	Square Yard

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.

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**

Property	Test Method	Requirement
Tensile Stress, 150% Elongation, 21 Day cure @ 77oF and 45 – 55% R.H., psi	ASTM D 412 Die C	150 - 200
Tack-Free Time, h, maximum	ASTM C 679	2 - 6
Adhesion & Cohesion under cyclic movement	ASTM C 719	Pass
Artificial Weathering	ASTM C 793	Pass
Weight (mass) Loss, %, maximum	ASTM C 792	10
Ozone and U.V. Resistance	ASTM C 793	Note 1
Movement Capability and Adhesion	Note 2	
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 inch 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 one (1) inch 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 inch ± 1/8 inch 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—Reserved

452.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Sealing Concrete Pavement Joints	Linear Foot

454.1 DESCRIPTION

This Work consists of cracking and seating existing portland cement concrete pavement.

454.2 MATERIALS—Reserved**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 inches to 24 inches, with a maximum dimension of 30 inches. Ensure that 80% of pavement pieces are smaller than 24 inch. The Project Manager will determine the adequacy of pavement breakage.

Perform cracking one (1) 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—Reserved

454.5 BASIS OF PAYMENT

Pay Item
Cracking and Seating Concrete Pavement

Pay Unit
Square Yard

**SECTION 455: DIAMOND-GROUNDING AND DIAMOND-GROOVING OF PORTLAND
CEMENT CONCRETE PAVEMENT (PCCP)**

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.

Diamond grinding is a pavement preservation technique that corrects a variety of surface imperfections on both concrete and asphalt pavements. The diamond blades used for grinding are composed of industrial diamonds and metallurgical powder.

455.2 MATERIALS—Reserved

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 diamond 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 Diamond Grinding and Grooving Operations

Begin and end longitudinal diamond 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 diamond 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 diamond 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 inch apart in elevation. Make the grooves from 0.08 inch to 0.16 inch wide, and the peaks from 0.08 inch to 0.12 inch 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

Pay Item	Pay Unit
<i>Diamond Grinding of PCCP</i>	Square Yard
<i>Diamond Grooving of PCCP</i>	Square Yard

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501.1 DESCRIPTION

The Work consists of providing and driving 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 501.2.1:1
Applicable Pile Standards**

Material description	Standard
Structural Steel piles and columns (HP)	ASTM A 572, Grade 50
Splice plates for Structural Steel piles	AASHTO M 270, Grade 50
Castings for pile shoes	ASTM A 148
Steel pipe (longitudinal or continuous spiral welded) piles and columns	ASTM A 252, Gr. 3
Backing rings for steel pipe pile splices	ASTM A 252, Gr. 3
End plate for closed end pipe piles	AASHTO M 270, Grade 50
Portland cement concrete, Class G	Section 509, "Portland Cement Concrete Mix Designs."
Precast pre-stressed concrete piles	Section 518, "Pre-Stressed Concrete Members."
Paint	Section 544, "Protective Coating of New Structural Steel."

501.2.2 Piles**501.2.2.1 Steel Piles**

Use no more than one (1) field splice to make steel piles that are from 30 ft to 80 ft long. Use no more than two (2) field splices to make steel piles longer than 80 ft. The minimum acceptable splice length is five (5) ft. Do not use more than two (2) splices per steel pile. The Department will not accept camber and sweep more than the mill tolerance.

501.2.2.2 Continuous Spiral Weld Pipe Piles

Provide longitudinal or spiral welded pipe, on the Department's Approved Products List, with only complete full joint penetration welds conforming to the requirements of AWS D1.1 – Structural Welding Code.

501.2.2.3 Pre-cast Pre-stressed Concrete Piles

Manufacture pre-cast pre-stressed concrete piles in accordance with Section 518, "Pre-Stressed Concrete Members."

501.2.2.4 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."

Perform field welding inspection in accordance with 541.3.7.4 Field Welding.

501.2.3 Submittals

Submit the following to the Project Manager:

1. Three (3) certified copies of MTRs for the following:
 - 1.1. Structural Steel piles;
 - 1.2. Pile columns;
 - 1.3. Steel pipe piles and pipe pile columns;
 - 1.4. Splice plates;
 - 1.5. Backing rings;
 - 1.6. End plates;
 - 1.7. Pile 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;" and
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 seven (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 or for delivered energy for hydraulic hammers. Provide certificate of calibration from a National Institute of Standards and Technology traceable Laboratory

performed no more than six (6) 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 compression of the cushion material.

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 four (4) inches 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 Foundation Engineer, use an extra length pile with splices (if necessary) 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 nominal pile capacity in accordance with Table 501.3.1.3:1, "Required Hammer Energy."

**Table 501.3.1.3:1
Required Hammer Energy**

Nominal Pile Capacity (Kips)	Minimum Manufacturer's Rated Hammer Energy (Ft - lb)
≤ 225	45,000
226 – 350	50,000
351 – 400	55,000
401 – 450	60,000
≥ 451	Wave Equation Analysis required

501.3.1.4 Approval of Driving System

The Foundation 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 driving system will be approved 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 nominal capacity) can be achieved at less than ten (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, "Wave Equation Analysis Allowable Driving Stress;"
5. When dynamic tests are specified in accordance with Section 504, "Load Testing of Bearing Piles," Acceptance of the hammer system will be 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
Wave Equation Analysis Allowable Driving Stress**

Description	Maximum stress ^{a,b}
Steel piles	
Compressive stress	90% of yield strength (0.90 F _y)
Concrete piles	
	85% of the compressive strength ^c minus the effective pre-stress
Compressive stress	(0.85 F' _c - effective pre-stress)
Tensile stress	(3√F' _c + effective pre-stress)

^aIf 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 Foundation Engineer is substituted. If necessary, provide heavier piles at no additional cost to the Department.

^bIf 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.

^cCompressive strength at 28 Days.

501.3.2 Driven Pile Capacity

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The nominal pile capacity will generally be the required factored design resistance of the pile divided by the specified AASHTO LRFD resistance factor, unless specified otherwise. The specified AASHTO resistance factor depends on the specified pile testing and the specified method for monitoring the pile capacity. Determine resistance factors in accordance with Table 501.3.2.1, "LRFD Resistance Factors for Driven Piles," unless otherwise specified.

Table 501.3.2.1
LRFD Resistance Factors for Driven Piles

Capacity monitoring test method	Method	LRFD Resistance Factor
Static load test	Wave Equation Analysis	0.8
Dynamic load test	Wave Equation Analysis	0.65
None performed	Wave Equation Analysis	0.5
None performed	Dynamic Formula	0.4

In some cases, the required nominal pile capacity shown may be higher than the factored pile design resistance divided by the specified LRFD resistance factor. In these cases, the required nominal pile capacity includes resistance to be encountered penetrating unsuitable layers in addition to the required factored design resistance divided by the specified LRFD resistance factor.

501.3.2.1 Determination of Pile Capacity with Impact Hammer

501.3.2.1.1 Wave Equation Analysis

The Foundation Engineer will determine the nominal 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 $\pm 25\%$ or more, the Foundation 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 nominal pile capacity only if specified or approved by the Foundation Engineer. Drive piles to the depth necessary to obtain the nominal pile capacity according to the following equation and in accordance with Section 501.3.5.2, "Minimum Penetration Elevation":

$$R_n = 2 \times F \times E \times \ln(10N) \quad (1)$$

Where,

R_n = nominal bearing resistance, (kips)

F = a constant that varies with hammer and pile type

Air/Steam hammers; all piles $F = 1.8$

Open ended diesel hammers with concrete $F = 1.2$

Open ended diesel hammers with steel piles $F = 1.6$

Closed ended diesel hammers $F = 1.2$

E = developed energy (ft-kips)

N = average penetration resistance in blows per inch for the last four (4) inches of

driving

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 Foundation Engineer approves the use of pre-bored holes, drill the holes to the depth established by the Foundation 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 Application of Pre-Bored Holes

Only use pre-bored holes as specified, or when demonstrated to the satisfaction of the Foundation 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 ten (10) blows, the set is less than 3/4 inch with the hammer delivering the minimum energy required;
2. Pre-cast concrete piles: when, in ten (10) blows, the set is less than one (1) inch 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.

501.3.3.2.2 Diameter of Pre-bored Holes

The Foundation 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."

501.3.3.2.3 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."

501.3.3.2.4 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 concrete. Place concrete in accordance with Section 502.3, "Construction Requirements." Fill the part of the pile above the rock socket with sand or other suitable material.

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 501.3.3.2.5:1
Diameter of Pre-Bored Holes in Soil

Pile type	Diameter
Cylindrical concrete piles	two (2) inch smaller than the outside pile diameter
Square concrete piles	Minimum pile width
H-piles	two (2) inch smaller than the diagonal measurement of pile

Table 501.3.3.2.5:2
Diameter of Pre-Bored Holes in Rock, Shale, or Conglomerate

Pile type	Diameter
Cylindrical concrete and pipe piles	Outside pile diameter
Square concrete piles and H-piles	Diagonal measurement of pile

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 proceeding with driving.

501.3.3.4 Conditions to Proceed

The Contractor shall not drive production piles until it meets the following conditions:

1. The Foundation 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 form is then approved by the Project Manager;
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 completed and stamped with New Mexico P.E. seal by the Foundation Engineer and approved 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 Foundation 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 Foundation Engineer determines that damage caused by one (1) 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 inches of penetration until the pile tip is within five (5) 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 ten (10) or 20 blows, as directed by the Foundation 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 nominal 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 nominal 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 nominal capacity. If the piles do not develop the required nominal 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 Foundation 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 (any risk zone) concrete with a 4 1/2 inch to eight (8) inch slump. Provide a superplasticizer in accordance with 510.3.4.4 from the Department's *Approved Products List* to achieve the 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 (3) feet above the water level. If the Project Manager approves the piles, fill them with Class A (any risk zone) concrete with a 4 1/2 inch to six (6) inch slump. , Provide a superplasticizer in accordance with 510.3.4.4 from the Department's *Approved Products List* to achieve the slump. Place the concrete in at least the upper ten (10) 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 nominal 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 inch per foot from the vertical or batter shown. The pile variance will be no more than three (3) inches 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 inch per foot from the vertical or batter shown, with the tops of the piles at cut off elevation varying no more than three (3) inches from the Plan position.

501.3.6.2.3 Edge Distance

Do not place piles within nine (9) inches 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 15° 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 Foundation 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 nominal capacity. The Department will only measure up to two (2) splices per pile in order to drive the piles beyond the specified penetration elevation to meet the required resistance.

501.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Driven Piles (type)</i>	Foot
<i>Pre-bored Holes for Bearing Piles, ____ in diameter</i>	Foot
<i>Pile Splices</i>	Each
<i>Pile Shoes</i>	Each
<i>Pile Cut-Offs</i>	Foot

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 Foundation 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 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.
- K. Pile splices provided within the Plan pile length.

502.1 DESCRIPTION

This Work consists of constructing drilled shafts. Drilled shaft construction, with or without under-reamed bottoms ("bell bottoms"), includes excavation, bottom hole cleaning, 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 (2) Projects within two (2) years of the Bid date involving drilled shaft construction for the conditions expected and use a Superintendent with experience from one (1) of those Projects who will provide all oversight responsibility of all aspects of drilled shaft construction covered in Section 502. Provide the latest NMDOT drilled shaft inspection form of each drilled shaft element signed by the Drilled Shaft Superintendent indicating drilled shaft construction completed in accordance with Section 502 requirements.

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 502.2.1:1 Applicable Bearing Pile Standards	
Material description	Standard
Portland cement concrete, Class G	Section 510, "Portland Cement Concrete"
Reinforcing steel cage	Section 540, "Steel Structures"
Reinforcing steel HP pile	ASTM A 572, Grade 50
Steel pipe (longitudinal or continuous spiral welded) piles and columns	ASTM A 252, Grade 3

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 inside diameter equal to or greater than 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 0.25 in per foot of diameter. Ensure that under-reaming tools do not allow the base diameter to exceed three (3) times the specified shaft diameter. The Foundation Engineer may approve a change in other under-reaming Plan dimensions to accommodate the Equipment. When the Foundation 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 0.5 inch to three (3) inch. If the Contractor cannot drill the material with conventional earth augers, the Contractor shall use special drilling Equipment, such as core barrels, rock tools and other Equipment, as necessary. Blasting is not allowed.

502.3.1.2 Slurry Equipment

Use desanding Equipment to keep the slurry sand content to less than eight percent (8%) by volume for mineral slurry and less than one percent (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 capable of sampling slurry from the bottom of the hole and withdrawing the sample without loss or contamination of sample fluid.

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 ten (10) inch. 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 initially placed at the top of the tremie 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 five (5) inch. 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;
8. Details for placing reinforcement including support and centralization methods; and
9. Details for placing concrete including operational procedures for free fall, tremie or pumping methods.

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. Administrative approvals are subject to field verification of performance.

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, 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 as determined in 502.3.7 Acceptance, 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 five (5) ft below finished grade and leave in place. Restore the proof shaft sites to their original condition.

502.3.3.5 Safety

Do not allow workers to enter the excavation for any reason.

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 inches of water above the base over a one (1) hr period without pumping;
2. The shaft remains stable without caving, sloughing or swelling over a four (4) hr period immediately following excavation;
3. The Contractor can remove loose material and water before inspection and concrete placement; and
4. Use of low strength grout collars to stabilize running sands or unstable zones within the drilled shaft excavation.

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:

1. Drilling the shaft;
2. Removing accumulated water and loose material from the excavation;
3. Approval of bottom hole conditions by Certified Drilled Shaft Inspector;
4. Placing the reinforcing cage; and
5. 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 Foundation Engineer. Before withdrawing the casing, ensure that the level of concrete in the casing is at least ten (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 in accordance with 502.3.8 Correction of Defective Drilled Shafts.

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 (2) casings during excavation and concrete placement where an oversized hole or temporary casing is approved by the Project Manager. When approved by the Foundation Engineer to allow drilling an oversize hole to aid in the placement of the permanent casing, post grout the exterior annular space outside of the permanent casing, 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 five (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 Foundation 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		
Property (units)	Requirements (at time of introduction or before concreting)	Test Method
Density (pcf)	62.4 – 64.0	Density Balance
Viscosity (seconds/quart)	50–120	Marsh Funnel
pH	8–11.7	pH Paper
Sand Content (% by volume)	0–1	API Method
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

Property (units)	At time of slurry introduction	In hole at time of concreting	Test method
Density (pcf)	N/A	64.0 – 75.0	Density Balance
Viscosity (seconds/quart)	28–45	N/A	Marsh Cone
PH	8–10	8–10	pH paper
Sand Content	N/A	0–4	API Method
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 Certified Drilled Shaft 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 (2) sets of tests during the first 8 h of slurry processing. Decrease the testing frequency to one (1) set every eight (8) 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 Foundation 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 (4) shaft diameters of another.

502.3.4.2.1 Underream and Overream

Use sidewall overreaming when the Foundation 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 Foundation 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 that are not anticipated in the Contract. 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 Certified Drilled Shaft Inspector as shown in Section 502.4.3, "Obstruction Removal."

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 Foundation 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 ten (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 Foundation 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 Foundation 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 inches. For dry shafts, ensure that the water depth does not exceed three (3) inches before pouring concrete. Inspect slurry displacement shafts using the methods that the Foundation Engineer deems appropriate. Receive approval of bottom hole conditions from Certified Drilled Shaft Inspector prior to continuing with the Work.

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.

502.3.4.2.4.2 Remedial Work for Substandard Excavation

If the Foundation 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 Certified Drilled Shaft Inspector 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 ten (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. 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 three (3) inches. 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. Place plug within tremie or pump line to ensure concrete does not segregate prior to developing concrete pressure head within tremie or pump line and that plug does not discharge from tremie or pump line prior to concrete developing continuous flow. Do not begin underwater placement before placing the tremie or pump line within one (1) 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 five (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 Foundation 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 three (3) inches 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 inch per foot of depth. Do not vary alignment of a battered drilled shaft by more than 0.5 inch per foot of depth from the specified batter;
3. Ensure that the top of the reinforcing steel unit is no more than six (6) inches above and no more than three (3) inches below Plan elevation; and
4. Ensure that the top elevation has a tolerance of +1 inch or -3 inch 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 (3) 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 five (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 core hole confirms the defect, the Department will not pay the coring costs. If the core hole 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 New Mexico registered professional Engineer for all foundation elements affected by the proposed corrections. Make corrections to drilled shafts r, 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 Certified Drilled Shaft 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.

502.4.4 Certified Drilled Shaft Inspector

Provide a Certified Drilled Shaft Inspector to oversee and inspect all aspects of the drilled shaft construction and sign the NMDOT Drilled Shaft Inspection Reports. Provide certification through NMDOT TTCP or International Association of Foundation Drilling, also identified as ADSC.

502.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Drilled Shaft Foundation____Diameter</i>	Foot
<i>Permanent Casing____Diameter</i>	Foot
<i>Steel Shape Reinforcement</i>	Pound
<i>Soil Borings</i>	Foot
<i>Rock Cores</i>	Foot
<i>Obstruction Removal</i>	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; and
- G. Certified Drilled Shaft Inspection.

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 (6) 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.

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 six (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 (1) 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 (2) 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 (2) 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 (7) holes drilled with a 7/32 inch diameter bit, tapped to accommodate ¼ in bolts;
- 1.2. Steel HP piles: Five (5) holes drilled with a 5/16 inch diameter bit through the

web;

- 1.3. Precast concrete or cast-in-place concrete piles: Seven (7) ¼ inch x 1 ½ inch holes with ¼ inch expandable anchor studs set in the holes to accommodate ¼ inch 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 six (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 ten (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 (1) 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 (3) 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 seven (7) Days of 3,000 psi;
2. After seven (7) Days, weigh the three (3) concrete test cylinders and report the average unit weight to the State Geotechnical Engineer.

Test one (1) concrete cylinder at seven (7) Days. If the compressive strength is at least 3,000 psi, test the other two (2) cylinders. Report the average of the three (3) breaks to the State Geotechnical Engineer.

Perform the dynamic test on the test pile the same Day that the cylinders are broken;

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 (2) cylinders tested the same Day or to wait up to a maximum of 14 additional Days before breaking the last two (2) cylinders. The Day the last two (2) 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 the last two (2) cylinders are broken;

There will be no added compensation to the Contractor and no time extension to the Contract if Delays occur because the concrete does not achieve the required strength at seven (7) Days.

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 501.3.1.4:1, "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 (1) 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 five percent (5%) of the pile diameter or two (2) inches;
3. If failure occurs, remove the test load in four (4) approximately equal amounts with a five-minute interval between removals;
4. For pile load tests where piles are 24 inch 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:

$$S_f = S + (0.15 + 0.008D) \quad (1)$$

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 inches:

$$S_f = S + \frac{D}{30} \quad (2)$$

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—Reserved

504.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Pile Testing Mobilization</i>	Lump Sum
<i>Pile Load Test</i>	Each
<i>Pile Pullout Test</i>	Each
<i>Pile Dynamic Test</i>	Each
<i>Case Pile Wave Analysis Test</i>	Each

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 (1) year of experience with the integrity testing methods. Use a licensed professional Engineer having at least three (3) 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 two (2) inch 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 two (2) inch 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 analyzer has both signal conditioning and power supply with high signal-to-noise ratios and variable frequency filtering to mitigate steel reinforcing and surface waves vibration noise. Ensure that the data is displayed in the field so that a preliminary data quality evaluation is possible;
2. Provide a receiver that is a suitable velocity transducer or accelerometer and place on the pile head.

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 six (6) inches above the shaft bottom and the tube tops are 12 inches 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 two (2) Days to ten (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 inch 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.

505.3.3.3 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—Reserved

505.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>CSL Consultant Testing</i>	Each
<i>CSL Department Testing</i>	Each
<i>LSI Consultant Testing</i>	Each
<i>LSI Department Testing</i>	Each

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.

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 inch. 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 inch and 1/2 inch; 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 one (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 inch;
2. Surface defects:
 - 2.1. Smooth formed surfaces not greater than $\pm 3/16$ inch within five (5) feet;
 - 2.2. Textured-finish surfaces not greater than $\pm 5/16$ inch within five (5) feet.
3. Differences in diagonal lengths not greater than 1/2 inch.

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 one (1) inch. 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 one (1) inch. 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 inch. 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 \pm 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 one (1) ft.

506.2.6 Reinforced Soil 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 (4) cycles. Determine gradations in accordance with AASHTO T 27 and Table 506.2.6:1, "Backfill Gradation Requirements," unless otherwise specified.

Table 506.2.6:1
Backfill Gradation Requirements

Sieve size	% passing
Four (4) inch	100
No. 40	0–60
No. 200	0–15

Provide backfill with a PI, no greater than 6 in accordance with AASHTO T 90.

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 15% passing a 1/2 inch sieve and no more than five percent (5%) passing a No. 4 sieve). If using "rock backfill," place a separator geotextile over the top of the backfill Material before placing the top two (2) ft of backfill. Also place a separator geotextile between the rock backfill and the random fill as the reinforced soil backfill is placed. 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 two (2) ft of backfill does not contain stones larger than three (3) inches at their greatest dimension and is free of rock backfill.

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 inch 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 506.2.6.2:1 Electrochemical Requirements		
Characteristic	Requirement	Test method
Ph	5–10	AASHTO T 288
Resistivity	>2,500 ohm/cm	AASHTO T 288
Chlorides	<100 ppm ^a	AASHTO T 291
Sulfates	<200 ppm ^a	AASHTO T 290
Organic content	<one percent (1%)	AASHTO T 267

The Department will not require electrochemical testing for backfills when the gradation is less than 20% passing a 3/4 inch sieve and less than five percent (5%) passing the No. 200 sieve. Recycled concrete aggregate is not allowed.

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.

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 (3) complete sets of half-size prints for preliminary review. The State Bridge Engineer will return one (1) set of prints to the Contractor with notations. Make necessary corrections and submit eight (8) 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 (3) 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 506.2.8.2:1
Design Parameters**

Description	Value
Factor of safety against overturning	2.0
Factor of safety against sliding	1.5
Service life	75 years
Service life (supporting structure loads)	100 years
Soil unit weight (retained)	120 lb/ft ³
Soil unit weight (reinforced)	125 lb/ft ³
Friction angle (retained soil)	30°
Friction angle (reinforced soil)	34°
Coefficient of sliding friction	a
Allowable bearing pressure	a

^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 inch x 36 inch 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 inches on all sides, or as shown in the Contract. Before wall construction, proof-roll the foundation with a minimum of three (3) passes of an eight (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 hours 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 ten percent (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 inch if measured with a ten (10) ft straightedge. Ensure that the overall horizontal tolerance (plumbness) of the vertical wall does not exceed .5 inch per ten (10) ft. Ensure that the offset at any panel joint does not exceed 0.4 inch.

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 180 (Modified Proctor), Method D (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 95% of maximum density as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified), 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 as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified), 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 three percent (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 eight (8) inches. 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 two (2) ft beyond the limits of the material designated for removal.

506.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>MSE Wall</i>	Square Foot
<i>Excavation of Unsuitable Foundation Material</i>	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 (6) months, including at least one (1) 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 seven (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 alkalis 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 509.2.3:1
Fly Ash Requirements**

Characteristics	Class C	Class F
Sum of Al_2O_3 , SiO_2 , and Fe_2O_3	—	>85%
Moisture content, maximum %	1.0	1.0
Loss on ignition, maximum %	3.0	3.0
Magnesium Oxide (MgO), maximum %	5.0	5.0
Available Alkalis, maximum %	1.5	1.5
Calcium Oxide (CaO), maximum % ^a	50.0	8.0

^aNMDOT will only consider a fly ash as Class F if the CaO is less than eight percent (8%). Fly ash meeting the requirements of ASTM C 618 and containing more than eight percent (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.

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 (6) months including at least one (1) 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 (2) 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 509.2.4.1:1
Aggregate Test Methods**

Aggregate test	Method
Sampling	AASHTO T 2
Clay lumps	AASHTO T 112
Amount of Material passing No. 200 sieve	AASHTO T 11
Absorption & Specific Gravity of Coarse Aggregate	AASHTO T-85 or TP 77

Table 509.2.4.1:1
Aggregate Test Methods

Aggregate test	Method
Absorption & Specific Gravity of Fine Aggregate	AASHTO T-84 or TP 77
Sieve analysis	AASHTO T 27
Soundness with magnesium sulfate	AASHTO T 104
Sand equivalent	AASHTO T 176
Soft fragments	AASHTO T 112
Flat and elongated pieces	ASTM D 4791
Alkali-Silica Reactivity	AASHTO T303 or ASTM C1293

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 509.2.4.2.1:1
Deleterious Materials Tolerances for Coarse Aggregate

Substance	Maximum % by weight
Soft fragments	2.0
Coal and lignite	0.25
Clay lumps	2.5
Materials passing No. 200 sieve	2.0
Flat and elongated pieces	^a
^a Ensure that Material larger than 3/8 inch 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.

509.2.4.2.2 Coarse Aggregate Quality Requirements

Provide coarse aggregate with an AI of 25 or less, calculated in accordance with Section 901, "QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)." 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

Table 509.2.4.2.3:1
Coarse Aggregate Gradation Requirements

Sieve size	% of aggregate passing sieve				Class G
	1.5 in	1.0 in	0.75 in	0.5 in	
2.0 inch	100	—	—	—	—
1.5 inch	95–100	100	—	—	—
1.0 inch	—	95–100	100	—	100
3/4 inch	35–70	—	90–100	100	90–100
0.5 inch	—	25–60	—	90–100	—
3/8 inch	10–30	—	20–55	40–70	20–55
No. 4	0–5	0–10	0–10	0–15	0–10
No. 8	—	0–5	0–5	0–5	0–5
No. 200	0.0–2.0	0.0–2.0	0.0–2.0	0.0–2.0	0.0–2.0

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 one percent (1.0%) passing the No. 200 sieve, all of the particles retained on or above the 3/8 inch sieve must have at least one (1) Fractured Face. The Contractor may eliminate the Fractured Face requirement by washing the aggregate to produce a combined aggregate of which less than one percent (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 509.2.4.3.1:1
Deleterious Material Tolerances for Fine Aggregate

Substance	Maximum % by weight
Soft fragments	2.0
Coal and lignite	1.0
Clay lumps	3.0
Materials passing No. 200 sieve	3.0

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 five (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 509.2.4.3.3:1
Fine Aggregate Gradation Requirements**

Sieve size	% Passing
3/8 inch	100
No. 4	90–100
No. 8	70–95
No. 16	45–80
No. 30	25–60
No. 50	5–30
No. 100	0–8
No. 200	0.0–3.0

The Department may accept fine aggregate with more than three percent (3%) percent passing the No. 200 sieve, but not more than five percent (5%) passing the No. 200 sieve if the combined fine and coarse aggregates passing the No. 200 sieve does not exceed three percent (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 (1) 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 (3) 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**

Material	Requirement
Fly ash (Class F)	Section 510.2.9, “Fly Ash”
Blended cement (Only Class F Fly Ash may be used)	Section 510.2.4.4, “Blended Portland Fly-Ash Cement”
Ground granulated blast furnace slag (GGBFS), Grade 100 and 200	AASHTO M 302
Silica fume	AASHTO M 307
Lithium nitrate (LiNO ₃)	Section 510.2.11, “Lithium”

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**

Material	Dosage Rate
Fly ash (Class F)	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%
Blended cement	As required, but not less than 20% by weight of cement only
GGBFS	As required, but not less than 25% by weight of cement only
Silica fume	As required, but not less than ten percent (10%) by weight of cement only
Lithium nitrate	0.55 gal/yd ³ of solution for each pound of cement sodium equivalent

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 (2) 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 509.2.8.1:1 Concrete Classes for Laboratory Design of Concrete Mixtures				
Class	Use	Specified compressive strength at 28 Days, (psi)	Laboratory design slump^a (in)	Percent air content^b
A	Cast in-place structural	3,000	4.5 to 5.5	—
AA	Cast in-place structural	4,000	4.5 to 5.5	—
D	Non-structural	2,500	4.5 to 5.5	—
E	Slip form structural	2,500 ^c	2.0 to 2.5	—
F	Slip form structural	3,000 ^c	2.0 to 2.5	—
F-LS	PCCP Low Shrinkage	3,000	2.0 to 2.5	

Table 509.2.8.1:1 Concrete Classes for Laboratory Design of Concrete Mixtures				
Class	Use	Specified compressive strength at 28 Days, (psi)	Laboratory design slump ^a (in)	Percent air content ^b
G	Drilled shafts	3,000	—	No entrained air agent allowed
HPD	Bridge decks and other low shrinkage applications	4,000	4.5 to 5.5	—
Special	The <i>Contract Requirements</i> for the individual Project will address special mix requirements.			

^aAs determined by AASHTO T 119.

^bProject risk zone requirements apply; see Section 510.3.2, "Freeze-Thaw Risk Zones."

^cThe specified age for Class E and Class F is 14 Days.

509.2.8.1.1 Details for Table 510.2.9.1:1, "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 (1) of the following equations. Use the equation that produces the largest value to determine the minimum allowable compressive strength.

$$f'_{cr} = f'_c + (1.34 \times k \times s) \quad (1)$$

$$f'_{cr} = f'_c + (2.33 \times k \times s) - 500 \quad (2)$$

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 509.2.8.1.1:1 k-Factor for Increasing Standard Deviation	
Total number of tests	k-Factor
15	1.16

Table 509.2.8.1.1:1 k-Factor for Increasing Standard Deviation	
Total number of tests	k-Factor
20	1.08
25	1.03
≥30	1.00

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 inch;
4. A sand/aggregate ratio between 40% and 42% by total aggregate volume;
5. A maximum air content no greater than three percent (3.0%);
6. No air entrainment agent;
7. A slump range of seven, 7.0 inch \pm one, 1.0 inch, except when placing under a drilling fluid;
8. A slump range of eight, 8.0 inch \pm one, 1.0 inch 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 two (2) h 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 509.2.8.2:1 Statewide Concrete Risk Zones			
District no.	County name	Station name	Concrete risk zone
1	Dona Ana	(County wide)	Low
1	Grant	(County wide)	Low

**Table 509.2.8.2:1
Statewide Concrete Risk Zones**

District no.	County name	Station name	Concrete risk zone
1	Hidalgo	(County wide)	Low
1	Luna	(County wide)	Low
1	Sierra	(County wide)	Low
1	Socorro	(County wide)	Medium
2	Chaves	(County wide)	Low
2	Curry	(County wide)	Medium
2	De Baca	(County wide)	Medium
2	Eddy	(County wide)	Low
2	Lea	(County wide)	Low
2	Lincoln	(County wide) ^a	Medium
2	Lincoln	Ruidoso	High
2	Otero	(County wide)	Medium
2	Roosevelt	(County wide)	Medium
3	Bernalillo	(County wide) ^a	Medium
3	Bernalillo	Sandia Crest	High
3	Sandoval	(County wide)	Medium
3	Valencia	(County wide)	Medium
4	Colfax	(County wide)	High
4	Guadalupe	(County wide)	Medium
4	Harding	(County wide)	Medium
4	Mora	(County wide)	High
4	Quay	(County wide)	Medium
4	San Miguel	(County wide)	Medium
4	Union	(County wide)	Medium
5	Los Alamos	(County wide)	Medium
5	Rio Arriba	(County wide) ^a	Medium
5	Rio Arriba	Chama	High
5	Rio Arriba	Dulce	High
5	Rio Arriba	El Vado Dam	High
5	Rio Arriba	Gavilan	High
5	Rio Arriba	Lindrith	High
5	Rio Arriba	Tres Piedras	High
5	San Juan	(County wide)	Medium
5	Santa Fe	(County wide)	Medium
5	Taos	(County wide)	High
5	Torrance	(County wide)	Medium
6	Catron	(County wide)	High
6	Cibola	(County wide)	High
6	McKinley	(County wide) ^a	High
6	Sandoval	(County wide)	High

^aExcept 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 design PCC mixtures by the State Materials Bureau. Provide a professional civil Engineer licensed by the State of New Mexico with a minimum of three (3) years experience in proportioning and testing PCC mixes to directly supervise all testing.

509.2.8.3.1 Combined Gradation

The combined gradation procedure is optional for all concrete mixes except for Class F-LS and High Performance Deck (HPD) mixes. Class F-LS and 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:

$$CF = \frac{Q}{Q + I} \times 100 \quad (3)$$

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 inch 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
Recommended Workability Factor and Coarseness Factor Targets**

Nominal Maximum Aggregate Size	Workability Factor	Coarseness Factor
3/4 inch	32 - 36	65 - 75
1/2 inch	40-42	10-20

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; and
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 seven (7)-Day strength;
 - 1.2 56-Day strength at least 108% of the 28Day test;
2. For Class F-LS Concrete mixtures, the minimum average flexural strength for three (3) beams cast in the Laboratory shall be 650 psi at 28 Days, when tested in accordance with AASHTO T-97
3. Structural concrete mixtures must achieve a minimum durability index:
 - 3.1 Greater than or equal to 85 for Low-Risk Zones;
 - 3.2 Greater than or equal to 90 for Medium-Risk Zones; and
 - 3.3 Greater than or equal to 95 for High-Risk Zones;
4. Determine the durability index from at least one (1) 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 $73.3^{\circ}\text{F} \pm 3.0^{\circ}\text{F}$ for the first seven (7) Days followed by 21 Days in lime saturated water at a temperature of $100.0^{\circ}\text{F} \pm 3.0^{\circ}\text{F}$.
5. If the specimen cannot be tested immediately after curing, place immediately in a freezer at a maximum temperature of 10.0°F until testing;
6. Hardened air void system characteristics required of all structural concrete classes, when examined in accordance with the ASTM C 457 linear traverse method include:
 - 6.1 A minimum air content of five percent (5.0%);
 - 6.2 A specific surface greater than 600 in-1; and
 - 6.3 A spacing factor less than 0.008 inch;
7. 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;
8. Provide chloride ion permeability at 28 Days for structural concrete tested in accordance with ASTM C 1202 that is:
 - 8.1 Less than or equal to 3,000 coulombs for Low-Risk Zones; or
 - 8.2 Less than 2,500 coulombs for Medium-Risk Zones; or

- 8.3 Less than 2,000 coulombs for High-Risk Zones;
9. Cure concrete for chloride ion permeability the same way as the durability index specimens in accordance with #2, above;
 10. The maximum shrinkage value for Class F-LS concrete mixtures and for HPD concrete mixtures is 0.05% at 56 Days when tested with three (3) inch x four (4) inch x 16 inch prism or three (3) inch x three (3) inch x ten (10) inch prism and cured in a standard cure for the first seven (7) Days. Following the seven (7) Day initial cure, cure in a relative humidity of 50% and test in accordance with AASHTO T 160;
 11. 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 by TTCP-Concrete or 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 aggregates and aggregate gradations shall be certified by TTCP or ACI Concrete Laboratory Level I. Those technicians performing strength 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;
 - 4.1. Ensure that the following information and the required documentation are 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. Sand equivalent of fine aggregate;
- 5.1.13. Dry-rodded coarse aggregate unit weight;
- 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 (3) cylinders tested at seven (7) Days, 28 Days, and 56 Days, except for Class E, Class F and Class F-LS mixes which shall have two (2) cylinders tested at 7, 14, 28 and 56 Days);
- 11.1.2. Type of fracture of each cylinder;
- 11.1.3. Flexural strength test results for Class F-LS (average of three (3) beams)
- 11.1.4. Durability index (for structural mixes only);
- 11.1.5. Hardened air void analysis (for structural mixes only);
- 11.1.6. Rapid Chloride Permeability (for structural mixes only); and
- 11.1.7. Expansion data from AASHTO T 303;
- 11.2. Existing Concrete Mixtures:
- 11.2.1. Consecutive compressive strength data with individual specimen test results from seven (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 yd³ of each concrete class, but not more than 750 yd³ 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 – Reserved

509.4 METHOD OF MEASUREMENT – Reserved

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.

510.1 DESCRIPTION

This Work consists of placing Portland Cement Concrete (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 Portland Cement Concrete Mixture

Use a portland cement concrete mixture that has been reviewed and approved in accordance with Section 509 for 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 as that shown on the approved mix design.

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 or Type 2 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 TTCP.

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 as those used at the plant where the mixture is approved and as shown on the approved mix design;
2. Use the same admixtures as those used at the plant where the mixture is approved and as shown on the approved mix design;
3. Prepare a written QC plan for the alternate batch facilities, personnel and operations that adequately addresses how the alternate batch plant will assure the quality of the mixture;
4. The operations at the alternate batch facility has confirmed compliance with the approved QC plan with other mixtures;
5. Provide concrete performance statistics that assure the same level of performance can be achieved from the alternate batch facilities.

510.3.1.4 Plastic Properties

The allowable slump range for non-superplasticized Class AA, Class HPD and Class A concrete is 3.5 inches \pm 1.0 inch. The allowable slump range for Class E and Class F Slip-Formed Concrete is 1.5 inches \pm 1.0 inch. All test procedures and frequencies will be performed in accordance with the Minimum Testing Requirements. Measure the air content in accordance with AASHTO T 121. The air content determined by AASHTO T 121 will be used to confirm compliance with the specified air content for structural concrete.

1. Low Risk Freeze/Thaw Zone – from 4.5% to 8.0%; or
2. Medium Risk Freeze/Thaw Zone – from 5.0% to 8.0%; or
3. High Risk Freeze/Thaw Zone – from 6.0% to 8.0%.

510.3.1.5 Troubleshooting

If the approved mixture design fails to meet requirements, the Project Manager will immediately contact the PTL that designed the mixture and the State Concrete Engineer. The PTL shall work with the State Concrete Engineer to make the necessary changes to resolve

the problems. 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 on the same scale as the portland cement, weigh the cement first, 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 the portland cement or portland cement/fly ash concrete mixture 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. Using weighing 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 weighing 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.

Provide cement, and combined cementitious weights within \pm one percent (1.0%) 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 varies from the target weight by more than \pm one percent (1.0%), the Department will immediately notify the Contractor to take corrective action. If the weight is no more than two percent (2.0%) above or 1.5% below the target weight, the Department may, at the Project Manager's discretion, accept a maximum of five (5) loads out of the first ten (10) consecutive loads of concrete delivered of any continuous placement with these weight discrepancies, regardless of whether the discrepancies are for the same material or for other weighed Materials. Any batches of concrete produced after the first ten (10) have been batched that have cement or total cementitious weights that are more than \pm one percent

(1.0%) will be rejected and not allowed to be placed on the Project. 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 material from adjacent stockpiles or from 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 six (6) inches 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

All gradation tests performed to fulfill the requirements of this section must be performed by TTCP certified technicians.

The Project Manager may cancel concrete placements that have gradation data that is more than seven (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 (1) of the following ways:
 - 2.1. If placing more than 1000 yd³ per week, provide new gradation results every 1000 yd³;
 - 2.2. If regularly making placements that total less than 1000 yd³ per week, provide new gradation results once per week.

- 2.3. If placements are irregular and limited to no more than two (2) placements in a single week, provide new gradation results at least 24 hours before the first scheduled placement in any week.
3. The Contractor's responsibilities to monitor gradations are not related to the QC/QA testing 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 ± 3 percentage points of the value in the approved mixture design;
 - 4.2. Workability factor is ± 2 percentage points of the value in the approved mixture design;
5. The aggregate batch weights will automatically be adjusted when the gradation information determined by the Supplier is entered into the Field Report form. The supplier will be required to use the most recent gradations to determine if the Coarseness Factor or the Workability Factor does not comply with 4.1 or 4.2 above. If the Coarseness Factor or the Workability Factor does not comply with 4.1 or 4.2 above, the mix batch weights must be adjusted to bring these factors into compliance. 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 \pm two percent (2%) of the target weight. For target weights less than 1,000 lb, batch to within \pm 50 lb of the target weight.

If any of the first ten (10) loads of concrete have a fine or coarse aggregate weight that differs from the target weight by more than two percent (2%), but not more than \pm three percent (3%), the Department may, at the Project Manager's discretion accept the concrete. The Department will allow no more than five (5) loads out of the first ten (10) consecutive loads of concrete of any continuous placement to exceed the maximum allowable weight tolerances. Any batches produced after the first ten (10) that differ from the target weight by more than \pm two percent (2%) will be rejected from the Project and can not be placed on the Project. Dispose of rejected loads at no additional cost to the Department.

510.3.2.4.4 Moisture Control

1. For a manually operated facility or for hoppers not equipped with automatic moisture sensors, measure the moisture content of each stockpile not monitored by automatic moisture sensors at least every four (4) hours, or as required by changing moisture conditions within the stockpiles
2. For plants equipped with automatic moisture probes, for each stockpile monitored by an automatic moisture probe, measure moisture content manually at least once a Day. Compare the manual measurement immediately before preparing the first concrete load to the measurement shown by the moisture sensing Equipment. If the measurements differ by more than 0.5%, re-correlate the moisture probe.
 - 2.1 For stockpiles not monitored by an automatic moisture probe, follow the requirements of 510.3.2.4.4(1).
3. Send a certificate showing the moisture content determined by manual methods in accordance with Paragraph 4 below, and the moisture correlation to the Project Manager with the first load of concrete. If this information is not included with the

first load of concrete delivered to the Project, that load of concrete and all subsequent loads of concrete are subject to rejection until the information is received at the Project.

4. Determine the aggregate moisture content to the nearest 0.5% in accordance with one (1) of the following procedures:
 - 4.1 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
 - 4.2 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.
5. Provide the following information on the moisture certificate to the Project Manager:
 - 5.1 Pan weight (it is not acceptable to tare out the pan weight on scales equipped to do so);
 - 5.2 Wet weight of the pan and the sample;
 - 5.3 First dry weight of the pan and the sample;
 - 5.4 Second dry weight of the pan and the sample;
 - 5.5 Third dry weight of the pan and the sample (if necessary);
 - 5.6 Absolute moisture content of the sample;
 - 5.7 The moisture probe reading from the tested sample (if equipped); and
 - 5.8 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 \pm three percent (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 two (2) inches. Revolving-drum mixer trucks must be used to transport concrete with a slump in excess of two (2) inches. Transport concrete produced in a dry-batched concrete plant in revolving-drum mixer trucks.

510.3.3.1 Non-Agitator Trucks

Use only non-agitating trucks with bodies 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 two (2) min, before discharging;
2. For concrete mixed inside an Agitator Truck: mix at the designated mixing speed for a minimum of five (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 five (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 cement is exposed to the aggregates until the concrete has been placed 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:

1. The concrete temperature is 80 °F or above for Bridge decks or approach slabs,
2. The concrete temperature is 85 °F for other concrete.

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.

Concrete arriving at the Project with a temperature greater than 90 °F can not be used.

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 Assistant District 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.

If the Department allows a mixing time extension, prepare a trial batch consisting of at least one (1) 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. If the dosage used is found to provide a final setting time within 20 – 30 minutes after the concrete has been unloaded, then the Contractor will be approved for the use of the designated hydration stabilizer at the dosage determined from this trial.

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 shown in the Minimum Testing Requirements. 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. Obtain representative samples of concrete from the approximate middle of the truck being tested for the required properties from the point of discharge into the structure being placed. The Department will provide test results to the Contractor after the final compressive strength tests for each set of test specimens is completed with a copy to the Supplier on a weekly basis;
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 four (4) inch x eight (8) inch single use plastic cylinder molds with plastic lids. Use cylinder molds that are six (6) inch x 12 inch if the nominal maximum size of the aggregate is equal to or greater than 1.5 inch
3. Use a rod to consolidate the concrete for 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. Provide all necessary support for all testing and to maintain sufficient safe storage space, including but not limited to water bath container, water for initial curing of concrete cylinders, heating or cooling as necessary, generators (and alternate power sources, as needed) and all vibratory Equipment and all Equipment required to operate the vibratory Equipment as required by Section 510.3.4.3.
5. Immediately after molding, begin curing of 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 to the start of initial curing. Use water that complies with Section 510.2.4, "Water," for the initial curing.

All cylinder curing containers for testing of the concrete must be in the same location, and within 50 ft of the testing site, chosen in advance by Department inspection personnel unless an alternative location has been approved by the Project Manager prior to the placement. The Project Manager can not authorize any location that does not provide sufficient time for the casting of the test specimens and subsequent delivery to the initial curing location within the 25 minutes allowed to begin initial curing of the test specimens.

Maintain the water-filled containers with the test cylinders undisturbed for a minimum of 21 h, but not more than 48 h, from the time of placement. Ensure that the level of water never drops below the tops of the cylinders.

6. 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 at a temperature of 73 +/- 3 °F until they are ready to be transported. Do not ship test cylinders until they are at least 48 h old.

7. The party that prepared the test specimens is responsible for transporting them from the initial curing environment to the final curing location. 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 perform all testing in accordance with the Minimum Testing Requirements.

510.3.4.3.2 Continuous Concrete Placements

It is common practice to place and test concrete at the same time, therefore:

As concrete is being placed and tested, concrete tests which are outside the allowable concrete test ranges may be encountered and are to be immediately reported to the Project Manager. Concrete that has already been placed shall be removed if the slump is more than one (1) inch over the specified limits and air is more than ½% below the minimum air specified. The Project Manager then can determine to place or halt the placement of the remaining concrete. The Project Manager can determine if the placed concrete needs to be removed or if it can remain. In the event that two (2) consecutive trucks or any two (2) out of six (6) trucks are outside the allowable testing ranges, concrete shall not be placed in the structure until the concrete testing is performed prior to the placement operation and the allowable concrete test ranges are shown to be in the allowable range. If concrete from five (5) consecutive trucks are delivered within allowable concrete testing parameters, then the placement and testing of concrete can once again be performed concurrently.

Payment of concrete that deviated from required parameters will receive a \$50/cu yd pay reduction in addition to the outcome of the final pay factors for the concrete.

510.3.4.4 Superplasticizers

If using a superplasticizer, 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 eight (8) inches 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 for compliance by averaging two (2) 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 the result from a single cylinder 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 4 cylinders for each set. Test the first cylinder at seven (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 five percent (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, 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 (1) 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 was cast into the concrete being evaluated and subsequently removed for testing. The hole remaining after removal of the cast-in-place-cylinder must be filled with a non-shrink grout or a Type K cement;
7. **The Rebound Test, ASTM C 805 (as modified herein)** This procedure must be performed in accordance with directions from the State Concrete Engineer. At a minimum, a test shall consist of at least 14 credible rebounds obtained from an area approximately 18 inches in diameter. The highest two (2) and the lowest two (2) rebounds will be deleted and the remaining 10 rebound results averaged to determine the rebound number from the test location.
8. **Field Curing.** Cast cylinders in accordance with AASHTO T 23, and cure in accordance with AASHTO T 23, Section 10.2.1.

Before using any method of measuring in-place concrete strength in the field (with the exception of Method 8 - "Field Curing"), submit complete supporting documentation for the method proposed for use and intended procedures to be followed to the Project Manager for approval by the State Materials Bureau.

Do not use field cured cylinders to determine the in-place strength for any structural applications. The Department will not permit any test samples to be extracted from Bridge decks, prestressed members or approach slabs. Prohibited testing for these Structures includes core testing, pull-out tests, or cast-in place cylinder test methods.

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 Compressive Strength Compliance of Concrete Based on Cylinders

The Department will accept concrete based on the compressive strength cylinder tests when the compliance tests equal or exceed the specified strength. If the compliance test is

less than the specified strength, the test will be considered acceptable if both of the following requirements are met:

1. The running average of three (3) consecutive individual strength tests meets or exceeds the specified strength; and
2. No Individual Strength Test as defined in 510.3.5.1.1 falls below the specified strength by more than 500 psi.

If the compliance test does not meet cylinder-based Acceptance requirements, the Department will review the strength tests and notify the Contractor whether the concrete will be accepted 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 Project at no additional cost or time to the Department and require the Contractor to comply with Section 510.3.1.5, "Troubleshooting". If the corrective actions taken by the Contractor are insufficient, the Department may suspend Work again, at no additional cost or time to the Department, until the Project Manager determines acceptable action as proposed by the Contractor.

The Contractor may use any of the in-place strength-test methods in accordance with Section 510.3.5.2, "In-Place Concrete Strength Measurements," to investigate areas of concern if normal Acceptance tests do not comply with Section 510.3.5.3, "Acceptance of Concrete Based on Cylinders." However, the Schmidt Hammer test shown in Section 510.3.5.2.7 can not be used for final Acceptance or to determine the pay factor. Do not use core testing, pull-out testing, or cast-in place cylinder test methods for any investigation of concrete contained in Bridge decks, prestressed members or approach slabs.

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 concrete structure will be dry under normal service conditions, cure the cores inside the plastic bags at a temperature range between 60 °F to 80 °F for seven (7) Days before testing. Test the cores dry.

If the concrete structure 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.

Obtain the cores 49 Days after concrete placement (21 Days for Class E or Class F concrete). Take at least three (3) cores from any area of concern to evaluate the area of 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

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As an alternative to using cores for testing in-place compressive strength, Method 2, 3, 4, 5, 6 or 7 can be used to investigate the in-place strength of the concrete in question. For Bridge decks, prestressed members and approach slabs, use only in-place strength-test methods 2, 3, 5 or 7 described in Section 510.3.5.2, "In-Place Concrete Strength Measurements." Submit a written request to the Project Manager for permission to use the selected method. Do not proceed until receipt of written approval from the State Materials Bureau. Method 7 can only be used to investigate the areas of concern, and can not be used for final Acceptance or for determination of the pay factor.

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 (1) 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 Flow Chart 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 the compliance strength test is 85% or more of the specified strength then the Contractor may choose to have a Hardened Air Content Test on a core obtained from the concrete in question performed by a Department approved Petrographer in accordance with ASTM C-457, linear traverse method. If the result of the hardened air content analysis meets the requirements below, the concrete will be paid for at full price.

1. A minimum air content of 50%;
2. A specific surface greater than 600 in-1; and
3. A spacing factor less than 0.008 inch.

510.3.5.5.1 Cylinder Based Price Adjustments

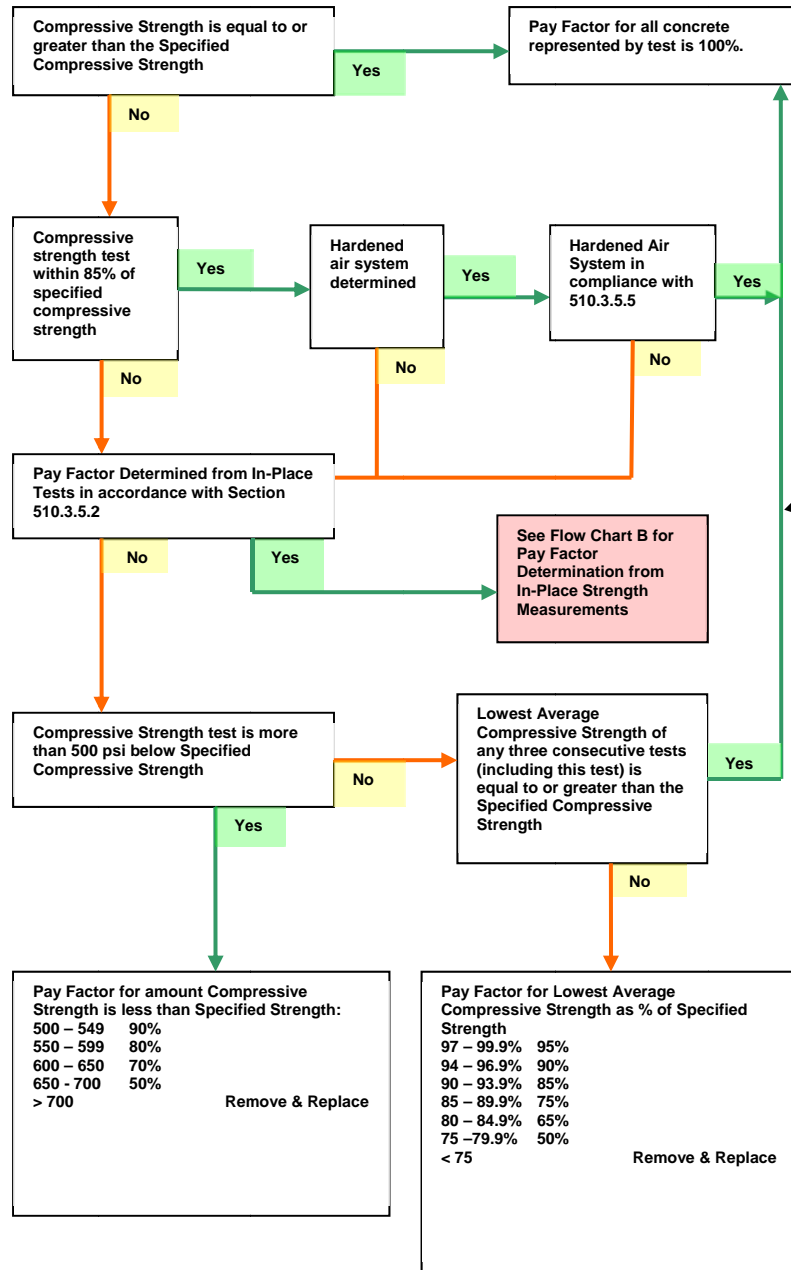
If low strength concrete is accepted based on lab-cured cylinders, the Department will pay for concrete in the lot represented by the low strength tests in accordance with Flow Chart A: "Price Adjustment Percentages for Low Strength Concrete Based on Lab-Cured Cylinders."

510.3.5.5.2 Price Adjustments based on In-Place Strength Tests

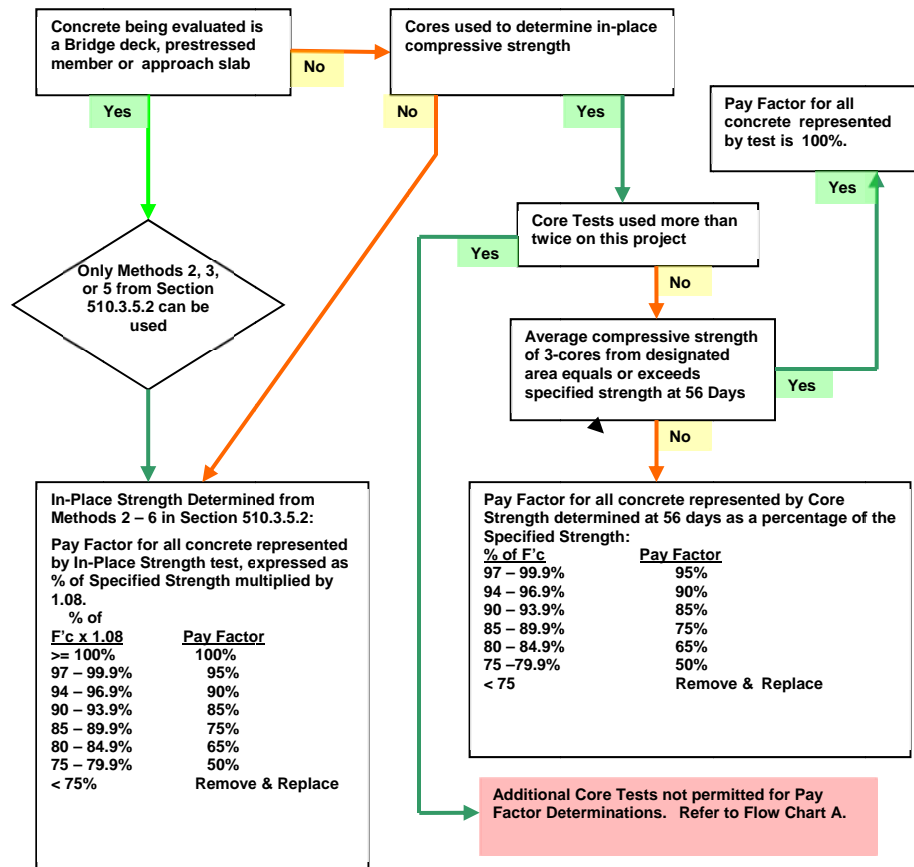
1. If the Department accepts low strength concrete based on core tests, the Department will pay for the concrete represented by the cores in accordance with "Flowchart B: Pay Factor Determination for Portland Cement Concrete by In-Place Strength Tests"
2. If the concrete strength is based on one (1) of the in-place test methods specified in Section 510.3.5.2, "In-Place Concrete Strength Measurements", methods 2 through 6, The Price Adjustment Factor will be determined by first multiplying the specified strength by 1.08. This value will then be used as the denominator to determine the percentage of the measured in-place strength compared to the adjusted specified strength. The pay factor shown in Flow Chart B: Price Adjustment Percentages for Low Strength Concrete Based on In-Place Strength Tests for that percentage will be

applied to all of the affected concrete. The Department will not allow use of field cured cylinders to determine price adjustments.

**Flowchart A: Price Adjustment Percentages for Low Strength Concrete
Based on Lab-Cured Cylinders**



Flowchart B: Pay Factor Determination for Portland Cement Concrete by In-Place Strength Tests



510.4 METHOD OF MEASUREMENT—Reserved

The Department will measure concrete or concrete items in accordance with the section of these *Standard Specifications* for which the concrete is used.

510.5 BASIS OF PAYMENT—Reserved

The Department will pay for concrete in accordance with the section of these *Standard Specifications* for which the concrete is used.

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 designed in accordance with Section 509 and approved for use on NMDOT Projects by the State Materials Bureau for the freeze/thaw risk zone in which the Project is located. A higher risk zone concrete may be substituted.

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

Use curing material in accordance with 510.2.3.

511.2.3.2 Certificates of Compliance for Curing Materials

Submit a Certificate of Compliance in accordance with Section 106, "Control of Materials".

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 Concrete Placement**

Concrete shall be placed and tested for compliance with the Project Specifications in accordance with Section 510.

511.3.2 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. The design of the falsework and foundation will be required if one (1) or more of the following conditions apply:

1. If the height of the Structure is greater than ten (10) ft, (excluding concrete Culverts with bottom slabs);
2. Where the supported span is greater than 15 ft;
3. Where traffic, other than workmen involved in constructing the Structure, will travel under the falsework.

Place the falsework on an adequate foundation. The maximum foundation bearing pressure is 2,000 pounds per square foot unless a Geotechnical investigation indicates a higher value can be used. Provide methods for measuring settlement or movement of falsework and forms under load. If falsework shows settlement of no greater than 3/8 inch of the vertical supports, 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 one (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.

511.3.3 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 inch, unless required otherwise in the Contract, and give them a bevel or draft for easy removal of projections such as girders and copings.

511.3.3.1 Form Lumber

Use lumber that is planed on at least one (1) side and the two (2) edges for exposed concrete surfaces. Place the planed face so that it will be the formed surface for the concrete being placed.

511.3.3.2 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 inch depth of cover from the concrete surface.

511.3.3.3 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.

511.3.3.4 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."

511.3.3.5 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.

511.3.4 Temperature and Weather Limitations

Keep the concrete mixture temperature between 50 °F to 90 °F at the time of placement.

511.3.4.1 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 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 (3) Days after placing. Do not let the surface temperature fall below 40 °F during the next four (4) Days after placing, or until the in-place strength determined by the *Maturity Method*, as described in Section 510, "Portland Cement Concrete" indicates 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 110 °F. During the heating or mixing process, do not add cement to water and aggregate combinations that are hotter than 90 °F.

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. Allow 14 Days for review. Ensure that the plan details the methods and Equipment to maintain the required concrete temperatures.

Information submitted will include, but not be limited to:

- Whether or not outside heating sources will be used (and how the exhaust will be vented away from the fresh concrete);
- What the target mix temperature will be;
- How the concrete will be protected from the ambient conditions;
- How soon after the placement the protection from the ambient conditions will be implemented;
- Who will be responsible for insuring that the proper protection from the environment is properly implemented;
- How the actual temperature of the concrete will be monitored;
 - How often will this be checked;
 - Who will do the checking;
- What actions will be taken if the temperatures fall below the target points;
- Who will be responsible for taking the necessary actions;
- Who the contact will be if Department Personnel need to talk transmit notices or information about the cold weather conditions.

511.3.4.2 Hot Weather Concrete

Place hot weather concrete in accordance with ACI 305, *Hot Weather Concreting*.

511.3.4.3 Wind Break

If a wind break is used, the wind break shall be a minimum height of eight (8) ft- 0 inches and constructed in a perimeter enclosing the Bridge deck, approach slabs, sleeper footings and/or transition slabs (if applicable). All areas of the freshly placed concrete must be protected by the wind break. The nature and type of windbreak to be used shall be approved by the Project Manager prior to placement of any Superstructure concrete.

511.3.4.4 Fogging System

If a fogging system is used, 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 511.3.3.5:1. 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 five (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 at a height of approximately five (5) feet above the protected concrete.

The area to be fogged shall be the entire area of the freshly placed concrete, which has not had the final 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 one (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. Do not finish or otherwise mix any of the fogging water into the fresh concrete.

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 any placement loads without deformation.

The use of a Mono-Molecular Film (MMF) evaporation retarder shall only be used in strict accordance with the manufacturer's recommendations. If used, it shall be applied and no further finishing efforts will be permitted in any location that has received the MMF. Under no circumstances shall the MMF be used as a finishing aid in the working of the concrete surface.

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 two (2) ft.

Do not place concrete faster than the rate used for the design of the forms. Adjust the rate for the temperature of the concrete being placed.

511.3.4.5 Rate of Evaporation Limitations (applies to Bridge decks, approach slabs, Sidewalks, curbs, CBC (top and bottom slabs), slipped formed concrete Structures, all PCCP, structural shotcrete, and concrete slope paving) (review listing of Structures-how to match top paragraph)

Do not place concrete unless the average combination of air temperature, temperature of fresh concrete, relative humidity, and wind velocity (Evaporation Potential) at the site over any ten (10) minute period is less than 0.20 lb per square foot per hour in accordance with Figure 512.3.7.5:1, "Surface Evaporation from Concrete," by using a continuous reading computerized weather station set to intervals not greater than five (5) minutes apart. Measurements of the wind speed, relative humidity and ambient air temperature used to determine the Surface Evaporation from the Concrete shall be taken at a height of approximately five (5) feet above the deck. Utilize an automated system that does not require any human support or effort after its initial set-up. Continue obtaining and recording the Surface Evaporation from the Concrete 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 (1) 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.

511.3.5.1 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.

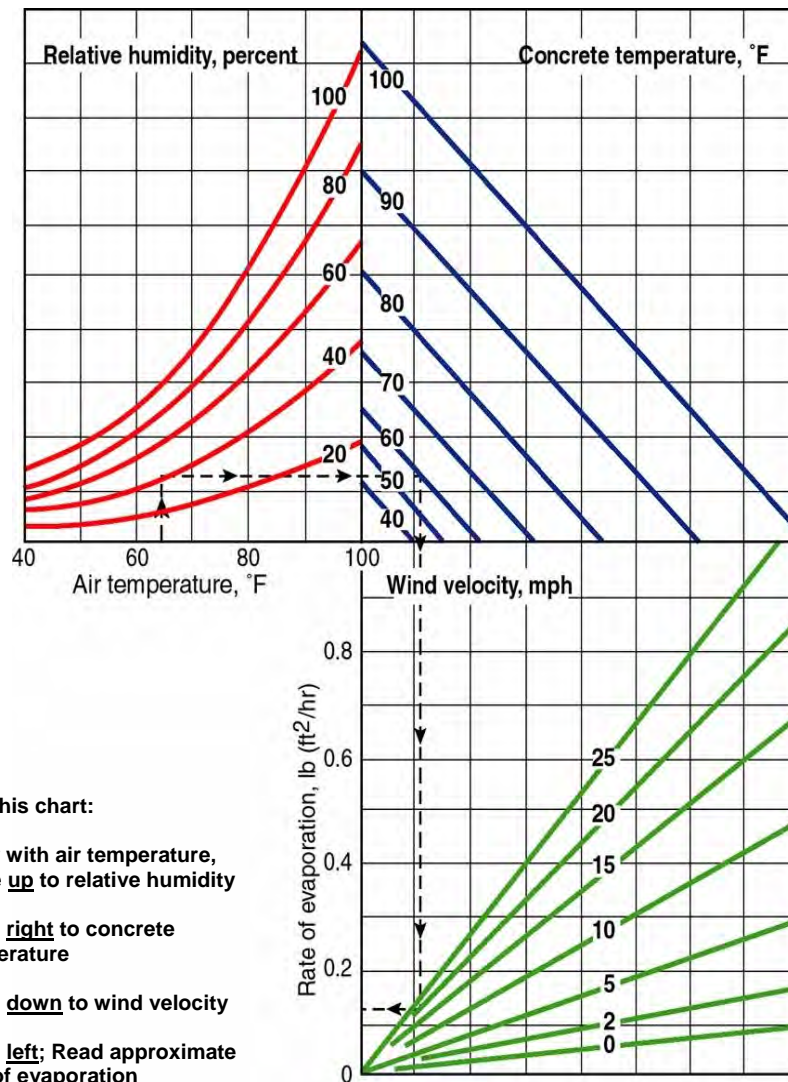
Where the Contract requires steep slopes, equip the chutes with baffle boards or use short lengths that reverse the direction of movement.

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 five (5) ft, unless confined by closed chutes or pipes. For walls equal to or less than 10 inch thick, such as Culvert walls, concrete may have a free fall of less than nine (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.

Figure 511.3.3.5:1
Surface Evaporation from Concrete



511.3.5.2 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 (1) 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 (4) 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.

Make sure that the discharge of the concrete from the pump is as close as possible to the bottom of the structure being placed, but in no case shall it be allowed to drop a distance greater than four (4) feet.

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.

511.3.5.3 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 (1) belt to the next is no greater than 18 inches. At the end of the last belt, do not allow the concrete to free-fall more than four (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.

511.3.5.4 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.

511.3.5.5 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 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.

511.3.5.6 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 80% of specified **compressive strength but no less than 2,500 psi**, as determined by the *Maturity Method*, in accordance with Section 510.3.5.2, “In-Place Concrete Strength Measurements.” Concrete box Culverts and

CBC wingwalls shall not be backfilled until specified compressive strength has been achieved. 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 seven (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 six (6) ft high or less. Construct box Culvert walls higher than six (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.

511.3.5.7 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 (1) 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.

511.3.6 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**

Structural component	Minimum time for removal
Bottom of beams	14 Days
Bridge decks ^a	seven (7) Days
Floor slabs	seven (7) Days
CBC Floors	seven (7) Days
CBC Covers	seven (7) Days
Walls	24 h
Columns	48 h
Sides of beams	24 h
All other parts	24 h

^aAdditional requirements of Section 512, "Superstructure Concrete," shall apply.

If one (1) 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.

511.3.7 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.

511.3.7.1 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 inch to 1 1/2 inch 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 inches. Provide raised keys in accordance with the Plans.

511.3.7.2 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 five (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.

511.3.7.3 Water Stops and Flashings

Provide and place water stops and flashings. Splice or solder water stops and flashings to form continuous watertight joints.

511.3.7.4 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.

511.3.8 Miscellaneous Construction

511.3.8.1 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 diamond 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 inch to 1/8 inch per foot. Correct depressions that retain water.

511.3.8.2 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*.

511.3.9 Finishing

Perform finishing after removing forms in accordance with the Contract.

511.3.9.1 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."

511.3.9.2 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 inch deep from the face of the concrete. Fill tie holes and honeycombs with mortar composed of one (1) part cement and two (2) 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."

511.3.9.3 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 (1) part cement and four (4) 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 one (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;
9. Exposed surfaces of miscellaneous concrete Structures extending above Shoulder line grade and inside walls of concrete underpass Structures.
10. Concrete box Culverts used for drainage, on the soffit and streamside faces of headwalls and wingwalls, and for six (6) inches down the back side of wingwalls; and
11. The interiors of sidewalls to one (1) ft back from the face of the Culvert at the tops of the sidewalls, and extending on a 45° line downward and inward.

511.3.9.4 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.

511.3.9.5 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 one (1) ft x one (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 seven (7) Days before applying the Class 4 finish.

511.3.9.6 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, except in the areas where using epoxy Bridge deck overlays;
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 one (1) ft below the final groundline.

Do not treat the underside of pier caps, sides, and end surfaces of concrete approach slabs.

511.3.10 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 two (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 seven (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 seven (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 511.3.10:1
Curing of Concrete Structures

Method designation	Curing method description
Method 1	Water curing
Method 2	Curing compound
Method 3	Form curing
Method 4	Combination of Method 1 and Method 2
Structure description	Curing methods
Bridge decks ^a	4
Approach slabs	4
Concrete curbs, gutters and Sidewalks	1 or 2
Top surfaces of:	
Pier caps, abutment Bridge seats	1 or 2
Wingwalls and parapet walls	1 or 2
Other concrete ^b	1, 2, or 3

^aSee Section 512.3.10.1, "Curing," for additional curing requirements for Bridge decks.

^bUnless 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.

511.3.10.1 Method 1, Water Curing

Keep the concrete Structures thoroughly and continuously wet and covered for at least seven (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 inches. 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.

511.3.10.2 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 one (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 (1) 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 (2) 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 seven (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.

511.3.10.3 Method 3, Form Curing

Leave forms in place for at least seven (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.

511.3.10.4 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.

511.3.10.5 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 (1) 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

The Department will measure all pay items using the dimensions shown in the Contract or approved modifications.

511.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Structural Concrete, Class ____</i>	Cubic Yard
<i>Structural Concrete, Class ____, ____ inch</i>	Square Yard
<i>Substructure Concrete, Class ____</i>	Cubic Yard
<i>Special Surface Finish</i>	Square Foot
<i>Waterproofing</i>	Square Foot
<i>Wind Break</i>	Lump Sum
<i>Fogging System</i>	Lump Sum

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, waterproofing membranes for new concrete surfaces, 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.

Wind Break and Fogging System will be paid for only if the Plans list these items in the Estimated Quantities table.

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 or High Performance Deck (HPD) concrete.

Cast-in-place concrete placed in Bridges above the bearings will be High Performance Deck (HPD) 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 High Performance Deck (HPD) concrete.

Approach slabs, transition slabs, and integral pier and abutment caps will be constructed with High Performance Deck (HPD) 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 High Performance Deck (HPD) concrete.

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 (1) 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 (1) representative of the concrete Supplier.

The recommended agenda checklist is available from the Bridge Bureau.

512.3.2 Profile Survey of Girders

After placing girders and before setting screeds, take a profile along each line of girders. If actual top of girder 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 girders, unless the Contractor designs a lateral bracing system to resist the entire torsion load from the deck overhang. The maximum vertical deflection of the screed rail due to the rotation of the exterior girder shall be $\frac{1}{4}$ " or less. The Contractor shall submit the drawings for the lateral bracing system and design calculations stamped by a NM Licensed Professional Engineer to the Bridge Bureau for approval. The lateral resistance of the steel intermediate diaphragms for the prestressed girders shall not be included in the Contractor's

lateral bracing system design. The cost of the lateral bracing system and its design shall be included in the cost of the Bridge.

Submit Plans and design calculations for the proposed girder bracing system to the Project Manager for approval at least 45 Days before the anticipated placement date.

512.3.4 Forms

Use deck forms that produce the desired results.

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, 50, and 80.. 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 pounds per square foot. Use steel ventilated at a minimum rate of 1/2 inch² 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 inch.
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 girders less two (2) inches, 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 girder 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 one (1) inch 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. All welding must be performed by a certified welder in accordance with the applicable documents and welder qualifications listed in Section 541.3.

Place bottom reinforcing bars with a minimum cover of one (1) inch. 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 (1) or more of the following inspection procedures a minimum of two (2) 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 ten (10) foot intervals parallel to and six (6) inches from the edge of the steel beam and at ten (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 two (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 girders and forms to prevent upward movement during concrete placement.

Do not allow the spacing between adjacent reinforcement bars to vary more than 1/2 inch from the dimensions shown in the Contract. Place and maintain reinforcement bars within 1/4 inch of the vertical dimensions shown in the Contract. Do not allow the concrete cover over the top layers of reinforcement to be less than two (2) inches.

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 inch outside diameter and 1 15/16 inch inside or heavier. Firmly support rails on adjustable steel supports. Securely fasten supports in place and do not space them more than 30 inches apart. The Department will not allow the Contractor to weld the supports to top flanges of steel girders or girders, or to the stirrups of concrete girders.

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 girder, 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 (two) inches to 2 7/16 inches. 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 (1) or two (2) 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 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.

Place concrete for abutment and/or pier diaphragms monolithically with Bridge deck; no exceptions.

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 (1) 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 (1) 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 Evaporation Limitations

Comply with Section 511.3.7.5 Evaporation Potential.

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 ten (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 two (20 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.

The Contractor will provide a ten10 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 (1) 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 three (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 straight-edging 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 three (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 one (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 seven (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 ten (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 inch, measured from the bottom of the straightedge. Provide a finished surface of concrete or asphalt approaches that does not vary more than 1/4 inch, 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 inch. Place expansion joints below grade, from 1/16 inch to 3/16 inch. The Department will reject expansion joints installed at elevations above the Roadway grade.

Remove smaller discontinuities or high spots greater than 3/16 inch 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 inch. If diamond grinding cannot satisfactorily correct portions of decks, remove and replace them at no additional cost to the Department.

After rubbing and diamond 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 if specified in the Contract. Otherwise cut grooves perpendicular to the centerline of the Roadway.

Begin grooving 18 inches from the gutter line or face of rail and run in a continuous pattern to 18 inches from the opposite gutter line or face of rail. The Contractor may increase the 18 inch dimension on one (1) side of the deck to as much as 27 inches, if the clearance of the grooving machine does not allow a closer approach to the railing.

Provide grooves that begin and end within from two (2) inches to four (4) inches of expansion joints, contraction joints, and ends of the slab.

Lay out the grooving accurately before cutting begins. Provide grooves that are 0.125 inch \pm 0.02 inch wide and from 1/8 inch to 1/4 inch deep.

If using transverse grooving, space grooves in a random pattern from 1/2 inch to 7/8 inch centers. If using longitudinal grooving, space grooves from 5/8 inch to 7/8 inch 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 inch. 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 inch 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 ten (10) foot straightedge and ensure the surface does not vary more than 1/4 inch 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 seven (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.

The Contractor shall construct Bridge deck prior to approach and transition slabs; no exceptions. Approach and transition slabs shall be constructed to match grade and elevation of the adjoining Bridge deck as shown in the Project Plans or as directed by the State Bridge Engineer if adjustments are required to match the completed Bridge deck.

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

PAY ITEM	PAY UNIT
<i>Superstructure Concrete</i>	Cubic Yard
<i>High Performance Deck (HPD)</i>	Cubic Yard
<i>Structural Concrete Class ____</i>	Cubic Yard

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; and
- C. Lateral bracing system.

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. Class AA HPD concrete will be used for barrier railings concrete on Bridges in
2. 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. Slip forming of concrete barrier railings for Bridges will not be allowed.

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 inch within 20 ft.

For Bridges set on curves, ensure that the horizontal deviations from the horizontal curve do not exceed 3/4 inch within 20 ft.

Ensure that the overall vertical tolerance of the outside surface of the barrier railings is less than 3/8 inch 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 inches.

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. Spalled concrete will be repaired under Section 533 "Concrete Structure Repair" at no cost to the Department. Place the holes for attachments at least six (6) inches 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

Pay Item	Pay Unit
<i>Concrete Barrier Railings</i>	Foot

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

Pay Item	Pay Unit
<i>Reinforced Concrete for Minor Structures</i>	Cubic Yard

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. Approval of a Flowable fill mix design by the State Materials Bureau will be valid for a period of 5 years unless revoked due to performance problems.

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."

Table 516.2.4:1
Aggregate Mixture Gradation Requirements

Sieve size	% passing
One (1) inch	100
3/8 inch	95 – 100
No. 4	80 – 100
No. 8	60 – 95
No. 16	45 – 80
No. 30	25 – 60
No. 50	5 – 45
No. 100	5 – 35
No. 200	0 – 30

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 in the Laboratory

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 eight (8) inch to 11 inch.
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.
8. Cast the test specimens in four (4) inch x eight (8) inch test cylinders, perforated on the bottom with four (4) 1/4 inch diameter holes for free draining;
9. Keep the test cylinders in a moist environment, but do not cure in a curing tank.
10. Cast six (6) compressive strength test cylinders in the Laboratory. Test two (2) cylinders at seven (7) Days, two (2) at 28 Days, and two (2) at 56 Days.

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 Testing Flowable Fill in the Field

Obtain the State Materials Bureau's approval of the flowable fill mix properties before using the mix in the field.

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 six (6) inches 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 six (6) blows or more than 25 blows are required to drive the rebar exactly 12 inches into the fill. Do not use compressive strength test cylinders for field-testing purposes.

516.3.3 Pre-Placement Requirements

Before placing flowable fill, remove any loose or uncompacted soils from the area to be filled. Ensure that all areas in which soils or construction Materials have sloughed off or collected are completely cleared. **DO NOT PLACE FLOWABLE FILL AGAINST LOOSE OR UNCOMPACTED SURFACES/MATERIAL.**

Ensure that all pipes or other embedded items which would otherwise float to the top of the flowable fill are adequately secured to prevent their floating out of position.

516.3.4 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. Place the flowable fill in layers no more than four (4) ft high for areas that require forming. Do not place the individual layers until flowable fill in a previously placed layer has

been in place at least two (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."

516.3.5 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 one (1) inch, if standing on a four (4) inch x four (4) inch wooden block.

516.3.6 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

PAY ITEM

Flowable Fill

PAY UNIT

Cubic Yard

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 four (4) inch × eight (8) inch compressive strength test cylinders in accordance with AASHTO T 23. If the Contractor places more than five (5) yd³ of concrete in a Day, the Contractor shall make at least three (3) cylinders from the placed concrete. If the Contractor places less than five (5) yd³ of concrete in a single Day, the Contractor shall cast at least three (3) cylinders from a random sample for each 20 yd³ of placed concrete from consecutive pours.

A compressive strength test is the average of two (2) 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 the actual batch weights used in each batch of concrete and the measured moisture contents for each of the aggregates contained within each batch into the Field Report Form provided to the Contractor at the same time the approved mix was provided. Insure that all test results for compressive strength and fresh concrete properties, including slump, air content and unit weight, are also entered into the Field Report.

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."

Allow Department personnel access to obtain test samples and to perform Independent Assurance testing at the Department's discretion.

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 (1) of the following plants:

1. A Precast Concrete Institute (PCI), National Precast Concrete Association (NPCA) or American Concrete Pipe Association (ACPA) certified plant regularly engaged in design, fabrication and construction of precast concrete components, or
2. An on-site Project specific facility inspected and approved by the Project Manager.

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. 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 fabrication and 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.

Submit certificates of compliance for cement, reinforcing steel, anchor bolts, supplemental cementitious Materials and liquid admixtures.

517.3.3 Notice of Beginning Work

Give the Project Manager and the Precast Inspector adequate notice before starting Work in the plant as follows:

1. Plants in the State of New Mexico: seven (7) Calendar Days;
2. Plants in the Contiguous United States: 21 Calendar Days;
3. Plants outside the Contiguous United States: 60 Calendar Days.

Do not perform Work before the Project Manager and the Precast Inspector give written authorization for fabrication.

Request inspections at least three (3) Calendar Days in advance.

517.3.4 Approval of Plants and Equipment

Obtain approval of the Precast Inspector for plants and Equipment used in manufacturing precast concrete members before Work begins. The Precast Inspector may

forbid the use of machinery, Equipment, or appurtenances that prove unacceptable. In the event that the Contractor fabricates Materials on site, the Project Manager shall then approve on site plants and Equipment.

517.3.5 Shop Drawings

Fabricate precast concrete Structures in accordance with the Department's *Standard Drawings*. For modified or Project specific precast concrete Structures, submit shop drawings to the State Bridge Engineer for review and Acceptance. Provide shop drawings that show sizes, shapes, dimensions, and concrete cover for the reinforcing steel and other items embedded in the concrete.

Allow 30 Calendar Days for review and Acceptance of the drawings by the State Bridge Engineer.

517.3.5.1 Calculations

Submit design calculations to the State Bridge Engineer 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 design and calculations at least 30 Calendar 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 and Precast 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. 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 as soon as possible but not more than two (2) hours after casting. 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 in accordance with the Specifications for the item being cast. 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 two (2) h to six (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 two (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 (4) consecutive Days after completion of steam curing.

Remove side forms from six (6) h to two (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. Provide a Class 2 surface finish for visual surface defects/pitting on Structures other than temporary Structures.

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 two (2) inches; and
3. Not interfere with the placement of reinforcing steel or concrete.

Stack members in storage only with approval of the Project Manager and the Precast 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, girders, or other pre-stressed concrete Bridge members.

518.1.1 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.

518.2 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."

Enter the actual batch weights used in each batch of concrete and the measured moisture contents for each of the aggregates contained within each batch into the Field Report Form provided to the Contractor at the same time the approved mix was provided. Insure that all test results for compressive strength and fresh concrete properties, including slump, air content and unit weight, are also entered into the Field Report.

518.2.1.4 Testing Requirements for Release Strength

Use the Maturity Method as required in Section 510 or make additional field cured cylinders for in-place strength tests (to determine application of pre-stressing forces). Make at least four (4) field cured cylinders from concrete placed on each casting bed.

The test results shall confirm the compliance with the release strength requirement shown in the Plans.

518.2.1.5 Acceptance Requirements

Compressive strength test shall confirm compliance with Section 510, "Portland Cement Concrete." A test is defined as the average of two (2) or more cylinders from the same sample

broken at the same age. Make and cure at least two (2) cylinders per girder or pile from concrete placed in each member and in accordance with AASHTO T 23.

Break at least two (2) cylinders per girder or pile as selected by the Department's Inspector.

Ensure the compressive strength is in accordance with the required 28-Day compressive strength. The Department will not accept girders or piles with test results less than 90% of the 28-Day required strength. Girders or piles greater than 90% and less than 100% of the 28-Day required strength will be evaluated by the State Bridge Engineer for possible Acceptance.

Girders or piles will not be shipped until the required ultimate compressive strength is confirmed by Maturity Method or compressive strength tests.

518.2.2 Steel Products

518.2.2.1 Reinforcing Steel

Provide steel reinforcement in accordance with Section 540, "Steel Reinforcement."

Reinforcing bars that project from the tops of girder and those within four (4) ft of girder ends shall be uncoated deformed low-carbon, chromium, steel bars conforming to ASTM A1035 or uncoated deformed stainless steel bars conforming to ASTM A955.

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 for further testing if requested by the Department's Inspector. 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 (1) parallel lay strand at least eight (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 eight (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 ten (10) ft long for each size tendon, including anchorage assemblies;
4. At least eight (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; and
5. At least two (2) 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 six (6) weeks in advance of the anticipated time for use, to allow testing.

518.2.2.2.6 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 physical 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:

1. A sample, a list of chemicals and their proportions, and instruction for use;
2. Evidence that the pre-stressing steel will be protected from rust and other results of corrosion; and
3. A Certificate of Compliance.

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.

518.2.2.3 Structural Steel

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Provide Structural Steel items in accordance with Section 541, "Steel Structures."

Straighten steel shoe plates prior to casting them in girders.

518.2.2.4 Debonding and Camber Control Sleeves

Sleeves shall have such strength, durability, chemical resistance, and other properties so that the sleeves will provide complete debonding between strands and concrete as called for on the drawings. Debonding and camber control sleeves product information shall be submitted for approval by the State Bridge Engineer.

518.2.3 Mortar

Provide non-shrink mortar used to grout keyways in precast box girders in accordance with Section 521, "Non-Shrink Mortar" with the additional requirement that the non-shrink mortar shall be a commercial pre-blended product from the Department's Approved Product List.

518.3 CONSTRUCTION REQUIREMENTS

518.3.1 Precast Concrete Institute Certified Plant

All prestressed concrete structural members shall be manufactured in a plant certified by the Precast Concrete Institute (PCI). The manufacturer must have a B4 Certification for Prestressed Deflected-Strand Bridge Member. Certifications must be maintained throughout the production of prestressed concrete structural members. Production will immediately stop if at any time the manufacturer's certification is revoked, regardless of the status of completion of contracted Work. Production will not be allowed to re-start until the necessary corrections are made and certification has been re-established.

The Department will not be responsible for time, additional compensation or other Project impacts due to lack of certification.

518.3.1.1 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.

518.3.2 Fabrication

518.3.2.1 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.

518.3.2.2 Placement of Reinforcing Bars and Appurtenances

Place and secure reinforcing bars, 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 girders.

518.3.2.4 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. Place and secure shoe plates on girders 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 girders 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 including camber and sweep 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 tipping and flushness of shoe plates within 1/16 inch.
2. The tolerance of steel diaphragms attachment holes shall be no greater than 1/16 inch.

518.3.2.5 Finishing Concrete Surfaces

Score top surfaces of girders transversely over the entire flange width to a minimum depth of 1/4 inch and a maximum of 3/8 inch. Clean the top surface of girders after initial set to remove laitance, dirt and debris 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 inch per ten (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 three (3) inches or less 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."

518.3.2.6 Curing

Steam cure or water cure precast, pre-stressed members. Do not use a curing temperature greater than 160 °F. Uniformly increase the temperature to the maximum temperature over a period not less than seven (7) hours. Additionally uniformly reduce the curing temperature such that at least seven (7) hours are required to reduce the temperature of the curing environment.

Perform steam curing in accordance with Section 517, "Precast Concrete Structures."

518.3.2.7 Lifting, Handling, Storing and Transporting Precast Members

Do not handle members until after applying the pre-stressing force.

At all times keep webs of pre-stressed girders vertical and keep the long axis approximately level. Keep the points of support and direction of reactions in accordance with approved shop drawings.

Limit the camber growth to a value not to exceed the predicted camber at erection dimension by two (2) inches at the time of deck slab placement. Camber growth is to be limited by methods such as weighting, fabrication scheduling or other acceptable means. Submit plan for review to the State Bridge Engineer prior to limiting camber growth. The plan must be prepared by a Professional Engineer licensed in the State of New Mexico.

Lift girders for handling, transport and erection by means of devices designed or recommended by the Fabricator and approved by the State Bridge Engineer prior to use.

Do not crack, spall, or otherwise damage members during lifting, handling, hauling, storing, erecting, or transporting. Replace members damaged by improper handling.

Do not transport members to the job site until the required ultimate compressive concrete strength is attained.

518.3.2.3 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 (1) wire in any strand is broken and the area of broken wires does not exceed two percent (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.

518.3.2.3.1 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 six (6) inch 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 ten percent (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 gages, or load cells used for tensioning pre-stressing steel before and during tensioning operations.

518.3.2.3.2 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 inch. Do not cut off stressing tails of 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 five (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 five percent (5%) for tendons longer than 50 ft, or seven percent (7%) for tendons shorter than 50 ft. Correct errors before proceeding.

518.3.2.3.3 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 two (2) splices within the entire spool. Do not use strands 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 (1) strand. Trim strands in piles flush with the top and bottom of the piles.

518.3.3 Bracing for Girders

Tie and brace the girders immediately after erection to prevent overturning. Leave ties and bracing in place until the girders are permanently secured for lateral stability. If steel girder diaphragms are used, install diaphragms during girder erection.

518.3.4 Grouting Keyways in Precast Box Girders

The keyways between adjacent precast box girders shall be grouted per Section 521 "Non-Shrink Mortar". The non-shrink mortar shall be commercial pre-blended non-shrink mortar that the Contractor only has to add water. The non-shrink mortar shall be from the Department's Approved Product List.

518.3.5 Quality Control and Quality Assurance

518.3.5.1 Working Drawings

The Contractor shall furnish Working Drawings in conformity with subsection 105.2 "Plans and Working Drawings" for all Pre-stressed Concrete Members. The Working Drawings that are submitted to the NMDOT shall contain the endorsement seal of a Professional Engineer registered in the State of New Mexico and with 5 years experience with prestressed concrete experience. NMDOT review of the Working Drawings does not relieve the Contractor of the responsibility for the adequacy of the prestressed members. The Contractor shall submit supporting calculations for the Working Drawings. The NMDOT will review the initial submittal within 30 Calendar Days. Any re-submittals will be reviewed within 14 Calendar Days.

The Working Drawings shall include the following:

- 1) All unit dimensions.
- 2) Location, size, and type of prestressing strands.
- 3) Initial and final jacking forces.
- 4) Location, description, and detail of structural reinforcing items.
- 5) Location of all hold-down devices.
- 6) Location and shop drawings of all steel items. Shop drawings shall be per AASHTO/NSBA G1.3, Shop Drawing Presentation Guidelines.
- 7) Details for steel diaphragm connections.
- 8) Blockout and keyway dimensions, if any.
- 9) Location and detail of debonded strands.
- 10) Rebar schedule per ACI Detailing Manual SP-66
- 11) Framing plan with the Fabricators mark numbers.
- 12) Embeds for overhang brackets and permanent steel deck forms.
- 13) Stresses in the top and bottom of the pre-stressed concrete members during detensioning of the strands.
- 14) The predicted girder shortening, camber at release, and camber at 90 Days.
- 15) Detail Drawings, written procedures, and calculations for the special design such as camber control using prestressing top strands.
- 16) Handling, storing and transportation details.

518.3.5.2 Notification of Fabrication for Pre-stressed Concrete Members

- a) *Start of Work.* Prior to beginning the Work, the Contractor shall provide written notice to the Quality Assurance (QA) Representative, as defined in subsection 518.3.5.3, so that QA services may be provided. The written notice shall be received at least seven (7) Days before fabrication begins.

The anticipated production schedule, including the start of Work, phase Work and shipment dates shall be submitted in writing to the QA Representative before any Work begins. Fabrication shall not be started until the Working Drawings submittal have been returned with the NMDOT Engineer's review stamp, indicating Reviewed, no exception taken; or Reviewed, revise as noted and delivered to the Contractor's site of fabrication.

- b) *Production Schedule Changes.* Accelerated changes to the proposed production schedule, including start of Work, phase Work, and shipment dates, shall require advance written notification be provided to the QA Representative. The written notice of change shall be received at least 48 hours before fabrication begins, unless otherwise approved in writing by the QA Representative.
- c) *Notice of Shipment.* The QA Representative shall be notified in writing, at least 72 hours before shipment of prestressed members to the job site.

- d) *Notification.* Failure to notify the designated QA Representative as described in this section may be cause for rejection.

518.3.5.3 Inspection of Pre-stressed Concrete Members

- a) *Quality Control and Quality Assurance.* Quality Control (QC) of prestressed concrete fabrication is the responsibility of the Contractor. The Contractor shall designate a QC Manager who shall be responsible for product quality requirements as defined in the Specifications and the Contractor's approved QC Plan (QCP). The QC Manager shall possess and maintain certification at Level II minimum, from the Prestressed Concrete Institute (PCI), and shall have one (1) year minimum of construction related experience. The QC Manager shall not be supervised by the Contractor's production section.

Quality Assurance and product Acceptance are the prerogatives of the NMDOT. The Department's Inspector will be the QA Representative and acts for and in behalf of the NMDOT on all matters within the scope of the Contract documents. QA administration will be performed to the extent necessary to assure Contract compliance.

Repeated out of tolerance Work, including dimensional Non-Conformance, shall be considered as recurring deficiencies. Recurring deficiencies shall be considered as evidence that required QC is not being provided. When the QA Representative determines that fabrication operations are producing recurring defects that do not conform to the Contract and the QCP requirements, the Contractor will be notified that the present Work is unacceptable. Work shall not continue until the QC Manager has submitted a written proposal addressing corrective procedures that the Contractor will take to prevent recurrence of the non-conforming Work. Fabrication shall not resume until the proposal has been reviewed and accepted in writing by the QA Representative.

- b) *Quality Control Plan (QCP).* The Contractor shall submit a written QCP to the QA Representative prior to the beginning of fabrication. The QCP shall be reviewed and approved in writing by the Contractor's QC Manager. The QCP shall list all methods utilized by the Contractor to ensure that the Work conforms to Contract requirements. The QC section is responsible for establishing the QCP, as well as conformance to the QCP. Fabrication shall not begin until the QCP has been reviewed and accepted in writing by the QA Representative.

If Work methods for a specific Project or product are not listed in the original QCP, the Contractor shall submit written addenda addressing the proposed methods that are necessary to meet Contract requirements. Fabrication shall not begin until the addenda have been reviewed and accepted in writing by the QA Representative.

The QCP shall address the following:

- 1) Names and qualifications of the QC Manager and personnel conducting inspection and testing. This list shall be updated when changes in personnel occur. Copies of the training certificates of the personnel conducting inspection and testing shall be submitted to QA Representative.
- 2) List of material Suppliers and certified testing laboratories used; the list shall be updated when vendors change.
- 3) Materials sampling and testing schedule, showing testing methods and frequencies.
- 4) QC inspection methods and procedures for all stages of fabrication operations.
- 5) Methods for curing products and test specimens.
- 6) Method and sequence for tensioning strands, including methods used for verifying equal distribution of jacking forces.
- 7) Method and sequence of detensioning strands.
- 8) Written report format for Materials sampling, testing, and inspection for all phases of the Work.
- 9) Copies of all concrete mix designs to be used, including mix design

- computations and test data.
- 10) Provisions for fabrication operations during cold, windy, or hot weather conditions.
 - 11) Procedures for patching small production holes and holes left by strand hold-down devices.
 - 12) Procedures for identifying, evaluating and reporting defects, including dimensional Non-Conformance, discovered during QC/QA inspections and testing.
 - 13) Procedures for notifying the QA Representative and the State Bridge Engineer of structural defects, and submittal of written proposal for repairs.
- c) *Frequency.* QC inspection and testing at all intervals of forming, tensioning, steel and concrete placement, curing, and storage operations shall be performed in accordance with the accepted QCP and Contract requirements. The QCP shall contain provisions for increased frequencies of inspection and testing when operations or products do not conform to the Contract.
- d) *Written Records and Reports.* The QC Manager shall review and submit the following completed records and reports to the QA Representative before the product receives Acceptance by the QC section:
- 1) Prestressing Steel - Tensioning reports for each setup, showing the jacking force calculations; initial and final jacking force used; calculated and final net measured elongation; applicable stressing corrections for seating, slippage, shortening, rotation movement, and temperature; Certified Mill Test Reports for prestressing steel used.
 - 2) Concrete - A daily report of each mix design used, showing the fresh concrete slump, temperature, unit weight, and air content (if specified). The daily report shall also include the following data:
 - a) date and time of casting
 - b) bed and setup location
 - c) ambient conditions
 - d) total cubic yards placed
 - e) girder mark and unique sub-mark identifications
 - f) actual product curing temperature charts or graphs
 - g) actual curing enclosure humidity charts or graphs
 - h) average release strength in psi
 - i) date and time of release strength
 - j) copies of individual batch tickets when requested by the QA Representative
 - 3) Pre-pour Inspection Records shall include the items to be checked as listed in the QCP.
 - 4) Post-pour Inspection Records shall include the items to be checked as listed in the QCP. These records shall include all discovered variances from product dimensional tolerances.
 - 5) Report of minor repairs made to each individual product.
 - 6) The following written records shall be submitted to the QA Representative before product shipment:
 - a) Length measurement of girders within three (3) Days prior to shipping.
 - b) Product camber measurement within seven (7) Days prior to shipping.

518.4 METHOD OF MEASUREMENT - Reserved

518.5 BASIS OF PAYMENT

Pay Item

Pay Unit

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 steel, reinforcing steel and embedded steel items for precast prestressed concrete Bridge members.
- B. The Quality Control and Quality Assurance requirements.
- C. Shipping and erecting Pre-stressed Concrete members.

519.1 DESCRIPTION

This Work consists of constructing a pneumatically applied non-structural shotcrete onto rock, soil or structural shotcrete onto 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

Structural shotcrete shall have a design strength of 4000 psi at 28 Days. If structural shotcrete is required, use a shotcrete mix that has been designed and proportioned in accordance with Section 509, and complies with the designated hardened properties for the class of concrete required in the specifications. All mix constituents must comply with Table 519.2:1 "Applicable Specification Sections". Determine all hardened properties in accordance with Section 519.2.6 Acceptance Sampling and Testing.

Non-structural shotcrete shall have a design strength of 3000 psi at 28 Days. If the shotcrete is non-structural, the non-structural shotcrete mix design may be developed in accordance with Section 509 without using the special boxes required in Section 519.2.6.

All shotcrete mix designs must be reviewed and approved by the State Concrete Engineer before being used on NMDOT Projects. 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
Applicable Specification Sections

Material/construction requirements	Section
Portland cement	Section 509, "Portland Cement Concrete Mix Designs"
Fly Ash	Section 509, "Portland Cement Concrete Mix Designs"
Pozzolans	Section 509, "Portland Cement Concrete Mix Designs"
Curing Materials and admixtures	Section 509, "Portland Cement Concrete Mix Designs"
Water	Section 509, "Portland Cement Concrete Mix Designs"
Fine aggregate	Section 509, "Portland Cement Concrete Mix Designs"
Coarse aggregate	Section 509, "Portland Cement Concrete Mix Designs"
Neat cement grout	Section 521, "Non-Shrink Mortar"
Bar reinforcement	Section 540, "Steel Reinforcement"
Welded wire fabric	Section 540, "Steel Reinforcement"
Surface evaporation	Section 512, "Superstructure Concrete"

519.2.1 Water

Use water in the shotcrete mix that is free of elements that could stain the mix and in

519.2.2 Anchor Bars

Provide anchors of appropriate size to hold reinforcement in place. The Department will allow maximum anchor spacing of 24 inches 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 six (6) inches long and the long leg at least two (2) feet long.

519.2.3 Welded Wire Mesh

Provide non-galvanized eight (8) gauge steel with a four (4) inch x four (4) inch mesh (4 x 4-W2.1 x 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 inch and 1 3/8 inch;
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

For non-structural shotcrete; a pre-mixed and prepackaged concrete product, with or without steel fibers, specifically manufactured as a shotcrete product for on-site mixed shotcrete, may be used if approved by the State Materials Bureau.

519.2.6 Acceptance Sampling and Testing for Structural and non-structural Shotcrete

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 inch² x eight (8) inch deep;
2. Constructed from wood and sealed plywood; and
3. 45° sloped sides to allow rebound to escape.

Use at least one (1) 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:
 - 5.1. Supervisor, at least one (1) year of experience as a shotcrete nozzle operator and at least two (2) years of experience on shotcrete Projects.

5.2. Nozzle operator and delivery Equipment operators, at least one (1) 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 (1) 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 (3) four (4) inch 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 (1) 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 $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$, and a relative humidity of $98 \pm$ two percent (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 for Structural Shotcrete

Shoot two (2) 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 (1) set of panels for each nozzle operator in the morning and one (1) set of panels for each nozzle operator in the afternoon for a full Day's production.

Produce test panels in accordance with ASTM C 1140, a minimum 12 inch² × eight (8) inch 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 four (4) inch × eight (8) inch cores (length/diameter ratio of 2:1).

The mean compressive strength is acceptable if the average of three (3) 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 (1) 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 two (2) inch to 2 1/2 inch 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 inch internal diameter.

Only use the "thin-stream" method for non-structural shotcrete 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 (1) of the following systems:

1. Central Mixing with transit delivery; or
2. Transit mixing and delivery.

519.3.2.1.1 Central Mixing and Supply

Batch and mix ingredients in accordance with Section 510. 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.

519.3.2.2 Dry Mix Process for Non-Structural Shotcrete

Batch the cement and aggregate by weight directly at the Project site within the tolerances required in Section 510.

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 balling).

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 inch to 2 1/2 inch 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 (1) 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 inch 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 inch 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 reinforcing bars placed with maximum spacing of 12 inch 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.

Remove and replace reinforcing steel displaying deep pitting or loss of more than 20% of cross-sectional area as directed by the Project Manager.

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 (3) 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 (2) spaces in both directions at intersections, and securely fasten.

Fasten mesh to preset or existing anchors and reinforce using 12 gauge or heavier tie wire on a grid not less than 12 inch². Avoid large knots of tie wire that could result in sand pockets and voids during shotcreting.

Provide a minimum clearance of 3/4 inch behind installed reinforcing steel or mesh and existing concrete forms or bare rock.

519.3.2.4.4 Structural Anchors

Unless otherwise specified in the Contract, place anchor bars (for structural applications) at a maximum spacing of 24 inches on a grid pattern over the entire area.

Provide the types of anchors in accordance with the Contract and either mechanically set or grout, as specified.

Ensure anchors develop the minimum pullout force in accordance with the Contract. Randomly test anchors at a frequency in accordance with the Contract to verify pullout force. The Department will not accept a pull out force less than 150 lb. If anchors fail to meet the minimum acceptable pullout value, remove and replace immediately and take corrective action. Also, test the anchors in the same relative location as those that failed. The Project Manager will determine the area for corrective measures.

519.3.2.4.5 Non-Structural Anchors

For non-structural applications (slope blankets, etc.), install anchor bars at ten (10) foot centers on a grid pattern over the entire area in one (1) inch diameter holes drilled into the rock or soil approximately 24 inches deep.

Completely fill the drilled hole with neat cement grout using a grout tube extending to the bottom of the hole.

Push the anchor bar into the grout-filled hole and center it such that the short leg of the "L"-shaped bar points upward and parallel to the slope and is located approximately 1 1/2 inches from the rock or soil surface.

519.3.2.4.6 Weep Holes

For slope blankets, provide weep holes throughout the shotcrete mat on maximum ten (10) foot centers, horizontally and vertically.

The weep hole drains will consist of two (2) inch diameter Schedule 40 PVC slotted drainpipe, two (2) feet in length, placed within predrilled holes and sloped five percent (5%) to drain. The exposed end will extend from one (1) inch to three (3) inch outside the slope.

The Department will not allow pre-drilled holes with diameters larger than three (3) inches.

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 four (4) ft in a grid pattern. Cut back metal depth gauges to 1/4 inch 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 shotcrete 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 (1) 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 (1) 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 inch of the shotcrete surface, to prevent corrosion staining of the surface.

When applying a 3/8 inch maximum aggregate size shotcrete, the Department will allow a final flash coat layer (1/4 inch to 3/4 inch thick) using 1/4 inch 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 (1) 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 inch 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 seven (7) Days. Perform moist curing using one (1) 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.

If it is anticipated that shotcrete will be placed when the ambient temperature will fall below 35 °F, a Cold-Weather Shotcrete Plan must be prepared and submitted to the Project Manager at least 30 Days before the intended application. The Cold Weather Shotcreting Plan must be reviewed and approved by the State Concrete Engineer before shotcrete is permitted to be placed at temperatures below 35 °F.

Monitor the Surface Evaporation of the Shotcrete in accordance with Section 512. Do not

proceed with shotcrete application if the average rate of surface evaporation of the shotcrete over any 10 minute period exceeds 0.2 lb per square foot per hour, in accordance with Section 512, "Superstructure Concrete." Do not allow the prevailing ambient conditions (relative humidity, wind speed, air temperature, and direct exposure to sunlight) to cause either plastic shrinkage or early drying shrinkage cracking.

All cracked Structural shotcrete, regardless of the cause, shall be removed and replaced at no cost to the Department.

Subsequent efforts to prevent further cracking problems shall include, but not be limited to:

1. Rescheduling of 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

The Department will measure shotcrete using the dimensions shown in the Contract or approved modifications.

519.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Structural Shotcrete</i>	Square Yard
<i>Non-structural Shotcrete</i>	Square Yard

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 ducts with a diameter at least 1/4 inch 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 steel to prevent displacement during concrete placement.

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. The person shall be certified by the American Segmental Bridge Institute's *Grouting Certification Program or equivalent as approved by the State Bridge Engineer*.

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 inch 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 inch 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 minutes 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 seconds.

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.

The Contractor may use water to flush metal 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 seconds. 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 hours 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 (1) 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—Reserved

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 pre-packaged, 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 hours. 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-packaged 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 521.2.3:1
Fine Aggregate Gradation Requirements**

Sieve size	% Passing	
	Minimum	Maximum
3/8 inch	100	—
No. 4	90	100
No. 8	65	95
No. 16	45	70
No. 30	35	45

Table 521.2.3:1
Fine Aggregate Gradation Requirements

No. 50	10	20
No. 100	2	8
No. 200	0	4

Note: Sand shall pass the No. 8 sieve for mortar used to fill voids with width or depth less than 3/4 inch.

Provide sand for use in mortar that does not exceed half the size of the recess, hole, or space to be filled.

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 three (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 hours, 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—Reserved

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 adhesive anchorage systems.

522.2 MATERIALS

Use chemical adhesive anchorage for the installation of steel anchors in concrete Structures.

522.2.1 Chemical Adhesive Anchor Devices

Select chemical adhesive 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 Adhesive Anchor System Ultimate Tension Load Requirements." Use chemical adhesives of organic and inorganic compounds (including epoxies, polyurethanes, methacrylates and vinyl esters) to develop bond to concrete.

Table 522.2.1:1
Chemical Adhesive Anchor System Ultimate Tension Load Requirements

Anchorage bolt diameter (inch) or bar size	Minimum ultimate tension load (pounds) per ASTM E488
One (1) inch	37,700
¾ inch	28,900
3/4 inch	21,200
5/8 inch	14,700
1/2 inch	9,400
3/8 inch	5,300
1/4 inch	2,400
No. 6	21,200
No. 5	14,700
No. 4	9,400

(Based on ASTM A307 anchor, Grade 60 rebar and 3,000 psi concrete)

522.2.1.1 Hardware

Provide ASTM A 307 Grade A threaded rod with nut (ASTM A 563A Hex) and washer (ASTM F 844) or ASTM A 193 Grade B7 threaded rod with nut (ASTM A 194 Grade 2H) and washer (ASTM F 436). The thread rod, nut and washer shall be zinc coated per AASHTO M 298, Class 50 (ASTM B 695, Class 50). If stainless steel anchor is specified in the contract, provide ASTM F 593 threaded rod with nut (ASTM F 594) and washer (ASTM A 240).

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 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 test results for expansion anchors in accordance with ASTM E 488 to the Project Manager. Submit independent certified test results for adhesive-

bonded and other bonding compounds in accordance with ASTM E 1512 to the Project Manager. Use ASTM A 307 Grade A steel for anchor bolts (rods), Grade 60 steel reinforcing bars, and 3,000 psi concrete for these independent certified tests.

Test chemical adhesive anchor device systems installed per manufacturer's recommendations.

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 Adhesive Anchor System Ultimate Tension Load Requirements."

522.3 CONSTRUCTION REQUIREMENTS

Prepare holes and installation of the chemical adhesive anchors in accordance with the manufacturer's recommendations and instructions, including weather and temperature limitations. Do not install chemical adhesive 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 and depth of the holes in accordance with the chemical adhesive anchor manufacturer's instructions, using drilling methods and drill bits specifically intended by the manufacturer for the particular anchorage.

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 two (2) inches 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 adhesive anchors, thoroughly clean holes by brushing with a metal or nylon brush and cleaning with water or air blasting. Ensure holes are dry before installing anchors. Diamond core drilling of the holes is not permitted.

522.3.3 Finishing

After the Contractor inserts the anchor into the full depth of the drilled hole, the Contractor shall strike flush the excess adhesive with the concrete surface. After placing the anchors, do not move anchors and do not load the anchors until adhesives are fully cured.

522.3.4 Field Proof Load Tests

Submit the testing method to the State Materials Bureau before beginning the field pullout tests. Use an applied test load for the chemical adhesive anchors field pullout tests in accordance with Table 522.3.5:1, "Chemical Adhesive Anchor Design Loads."

The Contractor shall perform proof load tests only if the Contract requires. The NMDOT may perform proof load tests at NMDOT discretion. If the Contract requires proof load tests, use nondestructive loading and stop the tests when the design tensile forces have been sustained for at least three (3) minutes without creep or deflection.

Use anchor that attain the specified test loads without permanently displacing the anchor 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. In

the event that proof load tests fail to meet requirements, the Contractor shall submit a corrective action plan for deficiencies.

522.3.4.1 Acceptance

The Department will accept anchor if the specified test load is attained without permanently displacing the anchor or damaging the concrete.

522.3.4.2 Field Test Procedure

If the Contract requires proof load tests, the Project Manager will designate a random portion of not less than five percent (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, "Chemical Adhesive Anchor Design Loads."

522.3.5 Design Loads

Ensure chemical adhesive anchor systems are in accordance with Table 522.3.5:1, "Chemical Adhesive Anchor Design Loads."

Table 522.3.5:1 Chemical Adhesive Anchor Design (Proof) Loads	
Anchorage bolt diameter (inch) or bar size	Design load and tensile test load (pounds) per ASTM E488
One (1) inch	9,425
¾ inch	7,225
3/4 inch	5,300
5/8 inch	3,675
1/2 inch	2,350
3/8 inch	1,325
1/4 inch	600
No. 6	5,300
No. 5	3,675
No. 4	2,350

522.3.6 Welding

Welding to post-installed anchors is not permitted.

522.4 METHOD OF MEASUREMENT—Reserved

522.5 BASIS OF PAYMENT

The Department will make no separate payment for this Work, unless otherwise specified in the Contract.

SECTION 523: CEMENTITIOUS-GROUTED DOWELS AND ANCHORS

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 chemical adhesive anchorage for the installation of steel anchors in concrete Structures. Cementitious grouted dowels and anchors shall only be used when shown in the Contract.

523.2.1 Mortar (Grout)

Provide mortar (grout) in accordance with Section 521, "Non-Shrink Mortar."

Provide preblended mortar (grout), in accordance with the manufacturer's recommendations and instructions regarding proportioning, mixing, maximum water content, application, and curing temperatures and conditions.

523.2.2 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 (Proof) 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, Cementitious-Grouted Dowels and Anchors Design (Proof) Loads."

**Table 523.3.1:1
Cementitious-Grouted Dowels and Anchors Design (Proof) Loads**

Reinforcing bar size or threaded rod diameter	Design tensile load for cementitious mortar (lb)
No. 8	5230
No. 7	4000
No. 6	2930
No. 5	2030
No. 4	1300
One (1) inch	4700
7/8 inch	3600
3/4 inch	2630
5/8 inch	1830
1/2 inch	1170

523.3.1.1 Field Proof Load Tests

Submit the testing method to the State Materials Bureau before beginning the field pullout tests. Use an applied test load for the anchors field pullout tests in accordance with Table 523.3.1:1, Cementitious-Grouted Dowels and Anchors Design (Proof) Loads.

The Contractor shall perform proof load tests only if the Contract requires. The NMDOT may perform proof load tests at NMDOT discretion. If the Contract requires proof load tests, use nondestructive loading and stop the tests when the design tensile forces have been sustained for at least three (3) minutes without creep or deflection.

Use anchor that attain the specified test loads without permanently displacing the anchor 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. In the event that proof load tests fail to meet requirements, the Contractor shall submit a corrective action plan for deficiencies.

523.3.2 Embedment Depth

Provided the required embedment depth as shown in the Contract Drawings.

Maintain a distance of 1 1/2 inch or greater from the bottom of structural deck slabs and two (2) inches 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.

Provide a drilled hole diameter 3/4 inch greater than the diameter of steel anchors and dowels. Diamond core drilling of the holes is not permitted. Clean holes of dust, drilling debris, and other Deleterious Materials, saturate holes with water, and remove free water before placing the dowels or anchors.

Do not drill with a lubricant; water is not a lubricant.

523.3.4 Placing of Anchors and Mortar (Grout)

Use sufficient mortar (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 mortar (grout) and hole and between the mortar (grout) and anchor or dowel.

523.3.5 Curing

Cure mortar (grout) for a period of at least three (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 (grout) in accordance with Section 511.3.9, "Curing."

523.3.6 Temperature Limitations

Place and cure mortar (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—Reserved

523.4 BASIS OF PAYMENT

Section 523: Cementitious-Grouted Dowels and Anchors

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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 60, 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 shall consist of raising Superstructure members slightly and modifying bearing units in substantial compliance with the pertinent portions of the Standard Specifications and the details shown on the Plans or as directed by the Project Manager.

529.2 MATERIALS

All Materials incorporated permanently into the Work shall meet the requirements as shown on the Plans.

529.3 CONSTRUCTION REQUIREMENTS

Load-carrying Superstructure members shall be slightly raised and temporarily supported by methods approved by the Bridge Engineer to permit modifications to be made to the designated bearing units. Unless the existing concrete deck has been removed, all beams or girders in a span shall be simultaneously raised and supported.

Bearing modifications shall be performed in a manner that will not damage any members being retained in the structure. The Bridge Engineer shall approve proposed steel cutting and weld removal methods.

When shown on the Plans, traffic will be permitted to operate on the Bridge or Bridges during these operations.

Unless otherwise provided, painted area damaged by the Work shall be cleaned and repainted as provided in Section 546, Recoating Structures and Section 547 Safety and Environmental Requirements for Paint Operations. No payment will be made for recoating damaged areas.

The Contractor will submit drawings, design calculations, and jacking procedures to the State Bridge Engineer for Acceptance. Submit at least 14 Calendar Days before Work is planned to begin. The submittal package will need to be stamped by a NM Licensed Professional Engineer.

529.4 METHOD OF MEASUREMENT

Pier and abutment bearing modifications shall be measured as a completed unit, including Incidental Work, any temporary support required, submittal, and any Materials incorporated into the Work, unless noted otherwise on the Plans.

529.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Pier and Abutment Bearing Modifications</i>	Lump Sum

530.1 DESCRIPTION

This Work consists of preparation for repair of concrete Bridge decks and Portland cement concrete pavement (PCCP).

The Work includes the following:

1. Scarifying the existing deck surface or PCCP;
2. Removing loose and unsound concrete, including concrete patching Material;
3. Removing and replacing corroded reinforcing bars;
4. Other operations necessary to prepare deck or PCCP for repair to the satisfaction of the Project Manager.

530.2 MATERIALS

530.2.1 Water

Provide water for cleaning and soaking the deck surface or PCCP in accordance with Section 509.2.6, "Water."

530.3 CONSTRUCTION REQUIREMENTS

530.3.1 Equipment

Use Equipment approved by the Project Manager as proposed by the Contractor.

530.3.1.1 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.

530.3.1.1.1 Sawing Equipment

Use sawing Equipment capable of sawing concrete to the required depth.

530.3.1.1.2 Mechanical Concrete Removal Equipment

Use mechanical Equipment for scarification and removal of deteriorated concrete capable of uniformly scarifying or removing existing concrete to the required depth.

530.3.1.1.2.1 Sandblasting and Shotblasting Equipment

Use sandblasting or shotblasting 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.

530.3.1.1.2.2 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 inch 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.

530.3.1.1.2.3 Hand Tools

Use hand tools, such as hammers and chisels, as necessary, for removal of final particles of unsound concrete.

530.3.1.1.3 Hydro-demolition

Hydro-demolition may be used for deck or PCCP preparation upon approval by the State Bridge Engineer.

530.3.2 Preparation of Surface

530.3.2.1 Scarification

Uniformly scarify the top surfaces of existing decks or PCCP as called for in the Plans. Provide a scarified surface with a rough texture to promote bond to the concrete repair material. Scarify deck or PCCP areas not accessible to the scarification machinery using approved chipping hammers or hand tools.

530.3.2.2 Deck Sounding

After scarification, sound the deck or PCCP under the direction of the Project Manager and mark areas of unacceptable concrete, including full depth areas. After removal of unsound concrete in accordance with Section 530.3.3.3, resound and repeat process until all remaining concrete is sound. Blast clean only after the Project Manager approves the concrete deck area.

Other methods of nondestructive evaluation may be proposed by the Contractor for the sounding of the concrete. Proposed methods may only be used if approved by the State Bridge Engineer.

530.3.2.3 Deck Preparation

After scarification and deck sounding is complete, remove unsound and deteriorated concrete in the marked areas in accordance with Section 533. Remove complete thickness of deck concrete at locations where less than 50% of the original deck or PCCP thickness remain, except in very isolated random locations as determined by the Project Manager.

Remove unsound concrete to a depth that will provide a 3/4 inch minimum clearance around the 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.

530.3.2.4 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 inch 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 inch. 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.

530.3.2.5 Cleaning of Prepared Deck and PCCP Surface

Clean deck and PCCP surfaces to which the concrete 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 two (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.

530.4 METHOD OF MEASUREMENT

The Department will verify the measured quantities with the Contractor daily. Deck Preparation is measured after completion of Deck Scarification and deck sounding. Concrete used for repair will be paid for under the appropriate concrete pay item as specified in the Plans.

530.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Deck Scarification</i>	Square Yard
<i>Deck Preparation</i>	Square Yard
<i>Replacement Reinforcing Bars Grade 60</i>	Pound

530.5.1 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. Deck sounding;
- B. Removal of unsound concrete;
- C. Disposal of old concrete and debris;
- D. Cleaning of prepared deck and PCCP surfaces;
- E. Cleaning of existing steel reinforcement;
- F. Placement and removal of forms; and
- G. Removing old bars.

SECTION 531: PERMANENT ANTI-GRAFFITI PROTECTIVE COATING

531.1 DESCRIPTION

This Work shall consist of furnishing and applying a permanent (non-sacrificial) anti-graffiti protective coating to concrete and steel surfaces at the location(s) shown in the Contract, in accordance with manufacturer's recommendations and as approved by the Project Manager.

531.2 MATERIALS

Permanent anti-graffiti protective coating shall be a product conforming to one (1) of the following:

1. Appears on the Department's "Approved Products Listing;"
2. Is designated in the Contract; or
3. Approved by the Project Manager.

Permanent anti-graffiti protective coating shall be a transparent clear coating which will not alter the color of the underlying special surface finish for concrete surfaces or topcoat for steel surfaces. The protective coating shall act as a barrier to graffiti. The protective coating shall be capable of being cleaned of graffiti by use of a high pressure water sprayer or by use of commercially available cleansers or solvents, with common hand tools (rags, brushes, etc.).

531.3 CONSTRUCTION REQUIREMENTS

Permanent anti-graffiti protective coating shall be applied to concrete and steel surfaces after completion of the special surface finish for concrete surfaces or topcoat for steel surfaces. The Contractor shall apply the protective coating in compliance with all manufacturer's recommendations. The type of protective coating and method of application must be approved by the Project Manager prior to use. The Contractor shall furnish all Materials, storage, handling, tools, Equipment, labor, and other appurtenances necessary to complete the Work.

531.4 METHOD OF MEASUREMENT

Permanent anti-graffiti protective coating will be measured by the square foot.

531.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Permanent Anti-Graffiti Protective Coating</i>	Square Foot

SECTION 532: PENETRATING WATER REPELLENT TREATMENT

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 100% solution by weight of silane or alkyltrialkoxo 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		
Characteristic	Requirement	Test method
Reduction in absorption of water	80% minimum	NCHRP #244 Series II
Reduction in chloride ion content	80% minimum	NCHRP #244 Series II
Penetration	0.15 in minimum	NM L-34 ^a
Vapor permeability	99.5%	NM L-35 ^a

^aThese tests are available from the State Materials Bureau.

532.2.2 Submittals

Submit a manufacturer's Certificate of Compliance to the Project Manager for each Material lot or shipment.

Provide a one (1) pint sample from each lot in a glass container with a nonreactive plastic screw-on lid. Do not allow the sample to contact any 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.

Validation for surface preparation shall be performed by applying adhesive tape to the surface. When the tape is removed there shall be no laitance or debris adhered to the tape.

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 more restrictive temperature limits are recommended by the manufacturer. Do not apply the solution to concrete surfaces when the wind speed is greater than ten (10) mph.

532.3.2.2 Application Equipment

Use Equipment that can apply the solution to all surfaces until they are all saturated and no further solution can be absorbed. Obtain written approval of the Equipment used 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. 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 applying the solution but not less than full saturation and no further solution can be absorbed.

Lightly apply water to treated surfaces between 12 h and four (4) Days after treatment to verify coverage where directed by the Project Manager.

If the Contract specifies both a water repellent treatment and a special surface finish, apply the penetrating water repellent first. Wait seven (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 measure Penetrating Water Repellent Treatment the Contractor applies to concrete Structures as indicated in the Plans.

532.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Penetrating Water Repellent Treatment</i>	Square Yard

SECTION 533: CONCRETE STRUCTURE REPAIR

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 533.2.2:1
Enriched Mortar Physical Property Requirements

Property	ASTM Test	Requirements
Compressive strength, minimum	C-109	1 Day: 2,500 psi
		seven (7) Days: 3,000 psi
		28 Days: 4,000 psi
Bond strength, minimum	C-882	1 Day: 1000 psi
		seven (7) Days: 2000 psi
		28 Days: 3000 psi
Linear length change, maximum	C-157	28 Days wet: +0.05 % ^a
		28 Days dry: -0.05 %
Coefficient of thermal expansion (in/in/°F)	C-531	3.9×10^{-6} to 7.1×10^{-6}
Freeze/thaw resistance @ 300 cycles, minimum	C-666	85% durability

^aThe 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

Table 533.2.3:1
Enriched Concrete Physical Property Requirements

Property	ASTM Test	Requirements
Compressive strength, minimum	C-39	1 Day: 2,300 psi
		seven (7) Days: 2,800 psi
		28 Days: 3,500 psi
Bond strength, minimum	C-882	1 Day: 900 psi
		seven (7) Days: 1,800 psi
		28 Days: 2,200 psi
Linear length change (%), maximum	C-157	28 Days wet: +0.04 % ^a
		28 Days dry: -0.04 %
Coefficient of thermal expansion (in/in/°F)	C-531	3.9×10^{-6} to 7.1×10^{-6}
Freeze/thaw resistance @ 300 cycles, minimum	C-666	85% durability

^aThe 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

Sieve size	% passing	
	Minimum	Maximum
3/4 inch	100	—
1/2 inch	90	100
3/8 inch	40	70
No. 4	0	15

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 (3) four (4) inch x eight (8) inch 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 seven (7) Day and 28 Day compressive strength requirements.

Manufacturer's certified strength tests for the pre-blended concrete may be accepted instead of field tests or tests by the State Materials Bureau.

533.3 CONSTRUCTION REQUIREMENTS

533.3.1 Preparation of Repair Areas

The Contract will specify approximate repair areas. The Contractor shall field verify, locate and mark the precise areas of delamination and repair. Obtain Project Manager's concurrence of Work areas and establish pay quantities. The Contractor shall cut ¾ inch deep sawcuts around all repair areas prior to chipping and/or other removal methods.

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 inch 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 four (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

533.3.1.3.1 Bridge Decks, Reinforced Slabs on Grade

Preserve existing reinforcing steel exposed during concrete removal, Chip at least 3/4 inch deep into the adjacent concrete around the entire bar in the removal area. Sandblast exposed reinforcing steel before placing new mortar or concrete.

Strengthen corroded or damaged existing bars by splicing an equal sized bar at least two (2) ft longer than the corroded or damaged length. The minimum splice length shall be one (1) ft on each end.

533.3.1.3.2 Other Reinforced Concrete Repairs

Preserve existing reinforcing steel exposed during concrete removal. If the bond between exposed bars and adjacent concrete breaks, chip at least 3/4 inch 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 two (2) ft longer than the corroded or damaged length. The minimum splice length shall be one (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 one (1) inch, and use enriched concrete where the repair depth is one (1) inch or greater. If the repair depth is four (4) inches or greater, use the appropriate class concrete or enriched concrete.

533.3.3 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 five (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.

533.3.4 Placing, Finishing, and Curing

Do not mix mortar and concrete in repair areas. Use forms if necessary.

533.3.4.1 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.

533.3.4.2 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.

533.3.4.3 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."

533.3.5 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.

533.3.6 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."

533.3.7 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.

533.3.8 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 four (4) inches, the Department will measure the Work by the square yard. If the repair depth exceeds four (4) inches, 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

Pay Item	Pay Unit
<i>Repair of Concrete Structures</i>	Square Yard

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 534.2.1:1
Epoxy Injection Material Requirements

Property	Requirements		
	Test	Type I	Type II
Slant shear strength, minimum ^a	AASHTO T 237	3,000 psi	3,000 psi
Set time @ 77 °F, maximum	AASHTO T 237	18 h	^b
Pot life @ 77 °F, minimum	AASHTO T 237	10 min	60 min
Viscosity @ 77 °F ± 3 °F (poises) ^c	ASTM D 2196	2.5–9.0	90 ± 20
Specific gravity @ 77 °F	—	1.1	1.1
Tensile strength, minimum	ASTM D 638	4,000 psi	4,000 psi
Compressive strength, Minimum	ASTM D 695	6,000 psi	6,000 psi

^aIf bonded to saturated surface dry samples, cure for seven (7) Days at 40 °F and 90 to 100% relative humidity. The Department will use a joint width of 3/16 inch for Type I, and 3/8 inch for Type II for testing purposes.

^bAdhere to the manufacturer's specified set time for construction purposes on these wider cracks.

^cBrookfield #3 spindle, 60 RPM after mixing at slow speed for three (3) min.

Use Type I epoxy Material for cracks less than 1/4 inch wide. Use Type II epoxy Material for cracks 1/4 inch 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 seal 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 inch and to the full crack depth or six (6) inches, whichever is smaller.

The Project Manager will specify core sample locations. Submit at least one (1) 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 (2) or more ports simultaneously.

534.3.4 Re-bonding Delaminated Areas by Epoxy Injection

534.3.4.1 Injection Ports

Use at least one (1) 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 (2) 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

Pay Item	Pay Unit
<i>Epoxy Injection Type</i>	Gallon

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 535.2.1:1
HMWM Property Requirements**

Property		Test	Requirements
Resin Specifications:			
Viscosity, centipoises ^a		—	8–25
Specific gravity		—	1.00–1.07
Flash point, °F, minimum	Pinsky-Martens CC		180
Tensile elongation, %, minimum	ASTM D 638		5
Performance Properties of Resin:			
Cure speed:		—	—
Surface cure, hours, maximum @ 73 °F			8
@ application temperature		—	24
Gel time, minutes, @ application temperature, 50 ml sample		—	20–90

^aBrookfield 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 535.2.2:1
Physical Properties of Low-Viscosity, Low Surface Tension Crack Sealer**

Property	Value
Compressive strength (psi), ASTM D 695 minimum @ seven (7) Days	5,500
Tensile strength (psi), ASTM D 638, minimum @ seven (7) Days	3,100
Tensile elongation, %, ASTM D 638, minimum @ seven (7) Days	30
Water absorption, % by weight, ASTM D 570, maximum @ 24 h	0.10
Shore D hardness, 77 °F, minimum	65
Gel time, minutes - 7.0 ounces	48–52
Adhesion to concrete	100% failure in concrete
Surface tension, maximum	32 Dynes/cm
Percent solids	100

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

Sieve size	% passing	
	Minimum	Maximum
NO. 8	95	100
No. 16	30	70
No. 30	0	3
No. 100	0	1

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. Apply penetrating water repellent treatment prior to crack sealing, if specified in the Contract.

535.3.2 Surface Preparation

Clean concrete surfaces from three (3) inches to five (5) inches 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 one (1) gal per

200 ft for crack sealing and one (1) gal per 100 ft² for surface sealing. The Department may require two (2) or more applications of sealer for cracks ¹/₃₂ inch 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 eight (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.

535.4 METHOD OF MEASUREMENT—Reserved

535.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Crack Sealing</i>	Linear Foot
<i>Concrete Surface Treatment</i>	Square Yard

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 536.2.1:1
Epoxy Physical Requirements

Property	Test method	Minimum	Maximum	Remarks
Viscosity	ASTM D 2393 Brookfield RVT, Spindle #3 @ 20 rpm	7 poises	25 poises	—
Gel time	ASTM C 881, Paragraph 11.2 modified	15 min	45 min	—
Compressive strength @ 3 h	ASTM C 579 modified (with plastic inserts)	1,000 psi	—	Mixed with aggregate
Compressive strength @ 24 h	ASTM C 579 modified (with plastic inserts)	5,000 psi	—	Mixed with aggregate
Tensile strength (neat) @ seven (7) Days	ASTM D 638	2,200 psi	5,000 psi	—
Elongation (neat) @ seven (7) Days	ASTM D 638	30%	80%	—
Adhesive strength @ 24 h	ACI 503R, Appendix A, VTM 92	250 psi	—	Mixed with aggregate with 100% failure in concrete
Permeability to chloride ion @ 28 Days	AASHTO T 277	—	100 coulombs	—
Absorption (neat) @ 24 h	ASTM D 570	—	one percent (1%)	—
Thermal compatibility	ASTM C 884	No delamination of overlay		Mixed with aggregate
Infrared spectrum	AASHTO T 237, Paragraphs 5 and 6	To be established for each component		—

Table 536.2.1:2
Epoxy Urethane Physical Requirements

Property	Test method	Minimum	Maximum	Remarks
Viscosity	ASTM D 2393 Brookfield RVT, Spindle #3 @ 20 rpm	35 poises	70 poises	—
Gel time	ASTM C 881, Paragraph 11.2 modified	15 min	45 min	—
Compressive strength @ 3 h	ASTM C 579 modified (with plastic inserts)	1,000 psi	—	Mixed with aggregate
Compressive strength @ 24 h	ASTM C 579 modified (with plastic inserts)	5,000 psi	—	Mixed with aggregate
Tensile strength (neat) @ seven (7) Days	ASTM D 638	2,200 psi	5,000 psi	—
Elongation (neat) @ seven (7) Days	ASTM D 638	30%	100%	—
Adhesive strength @ 24 h	ACI 503R, Appendix A, VTM 92	250 psi	—	Mixed with aggregate with 100% failure in concrete
Permeability to chloride ion @ 28 Days	AASHTO T 277	—	100 coulombs	—
Shore D hardness	ASTM D 2240	60	70	—
Flexural creep, total movement in seven (7) Days	California Test Method 419	0.0065 in	—	—
Flexural yield strength	ASTM D 790	5,000 psi	—	—
Absorption (neat) @ 24 h	ASTM D 570	—	one percent (1%)	—
Thermal compatibility	ASTM C 884	No delamination of overlay		Mixed with aggregate
Infrared spectrum	AASHTO T 237, Paragraphs 5 and 6	To be established for each component		—

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.

536.2.2.1 Certificates of Compliance and Product Data Sheets

At least 15 Days before using the polymer concrete Bridge deck overlay, 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 polymer concrete Bridge deck overlay components.

536.2.3 Testing

The Project Manager will accept the Materials based on the certified Laboratory report.

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 536.2.4:1
Required Aggregate Properties**

Property	Test method	Minimum	Maximum	Remarks
Soundness loss, 5 cycles in magnesium sulfate	AASHTO T 104	—	eight percent (8%)	—
Micro-Deval	AASHTO T 327	—	ten percent (10%)	Aggregate must meet the gradation shown in Table 536.2.4:2, "Required Aggregate Gradation"
Moh's hardness	—	7	—	—
Moisture content	AASHTO T 255	—	0.2%	—

**Table 536.2.4:2
Required Aggregate Gradation**

Sieve size	% passing	
	Minimum	Maximum
No. 4	100	—
No. 8	15	25
No. 16	0	5
No. 30	0	1
No. 200	0	0.2

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 Surface Preparation

536.3.1.1 Surface Preparation

Prepare the concrete to produce a surface relief equal to the International Concrete Repair Institute (ICRI) Surface Preparation CSP 5-7, or ASTM E 965 pavement macrotexture depth of from 0.04 inch to 0.08 inch. Provide concrete surface profile chips to the Project Manager for inspection and Acceptance of prepared surface. ICRI concrete surface profile chips will become the property of the Department.

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. The use of hand held machine mixing equipment or hand mixing equipment is prohibited.

Use a self-propelled aggregate spreader that uniformly applies the dry aggregate at the manufacturer's recommended application rate.

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 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, replace any defective squeegees.

Use hand tools, as necessary, for placing the overlay.

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 inch x 18 inch plastic sheet to the deck for at least two (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 eight (8) h after application; or
2. The epoxy or epoxy urethane's gel time is less than ten (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

Materials shall be applied using mechanical metering, mixing and distribution machinery as recommended by the manufacturer of the overlay system. Components A and B shall be applied within the temperature range recommended by the manufacturer. Broadcasting on concrete shall be performed in accordance with the manufacturer's directions and the method approved by the Project Manager.

Apply the overlay as two (2) 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 ten (10) pounds of aggregate per square yard, or enough to completely cover the epoxy or epoxy urethane.

Apply the second application of polymer at a rate of at least five (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

No vehicular traffic or equipment shall be allowed on the overlay during the curing period.

Cure each application of overlay (polymer and aggregate) free from vehicular traffic as recommended by the manufacturer and approved by the Project Manager and 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 $\pm 1/4$ inch per three (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 five (5) year warranty for the overlay Material and installation.

In addition to the requirements set forth in Section 103.6 "Requirement of Contract Bonds", provide a maintenance bond or warranty bond for the time frame indicated in this section.

The maintenance bond or warranty bond shall commence upon the Departments Acceptance of the Work.

A Department representative, Project Manager or District designee, will evaluate the overlay performance annually using a pre-established joint team consisting of a Contractor and the 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 or audible 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. Corrective Work application and method shall be approved by the Department prior to the execution of the corrective work.

536.4 METHOD OF MEASUREMENT—Reserved

536.5 BASIS OF PAYMENT

Pay Item

Pay Unit

<i>Epoxy Polymer Concrete Bridge Deck Overlay</i>	Square
<i>Yard Epoxy Urethane Polymer Concrete Bridge Deck Overlay</i>	Square Yard

536.5.1 Work Included in Payment

The following Work and items will be considered as included in the payment and will not be measured or paid for separately:

- A. Concrete surface profile chips

537.1 DESCRIPTION

This Work consists of providing and applying polyester concrete overlay for Bridge deck, approach slab, transition slab, and PCCP repairs and/or grade corrections.

537.2 MATERIALS**537.2.1 Prime Coat**

The prime coat used with the polymer concrete shall be a wax free, high molecular weight methacrylate resin conforming to the requirements in Table 537.2.1:1, "Prime Coat Physical Requirements:"

Table 537.2.1:1
Prime Coat Physical Requirements

Property	Test method	Minimum	Maximum	Remarks
Viscosity	ASTM D 2196	—	0.25 poise	—
Specific Gravity	ASTM D1475	0.90 min	—	—
Flash Point	ASTM D3278	180 F	—	—

The promoter/initiator system for the methacrylate resin shall consist of a metal drier and peroxide. If supplied separately from the resin, at no time shall the metal drier be mixed with or allowed to contact the peroxide directly. Do not store the containers in a manner that will allow leakage or spillage from one (1) material to contact the container or material of the other.

537.2.2 Polyester Resin Binder

Polymer concrete shall consist of polyester resin binder. The resin shall be an unsaturated isophthalic polyester-styrene co-polymer and shall conform to the requirements in Table 537.2.2:1, "Polyester Resin Physical Requirements:"

Table 537.2.2:1
Polyester Resin Binder Physical Requirements

Property	Test method	Minimum	Maximum	Remarks
Viscosity	ASTM D 2196	0.75 poise	2.0 poise	Test before addition of initiator
Specific Gravity	ASTM D 1475	1.05	1.10	Test before addition of initiator
Tensile strength (neat) @ 7 Days	ASTM D 638	2,200 psi	5,000 psi	—
Elongation (neat) @ 7 Days	ASTM D 638	35%	80%	—

Table 537.2.2:1
Polyester Resin Binder Physical Requirements

Property	Test method	Minimum	Maximum	Remarks
Adhesive strength @ 24 h	ACI 503R, Appendix A, VTM 92	250 psi	—	Mixed with aggregate with 100% failure in concrete
Absorption (neat) @ 24 h	ASTM D 570	—	one percent (1%)	—
Styrene Content	ASTM D 2369	40%	50%	% mass as volatiles before addition of initiator
Infrared spectrum	AASHTO T 237, Paragraphs 5 and 6	To be established for each component		—

The silane coupler shall be an organosilane ester, gammamethacryloxy-propyltrimethoxysilane. The promoter shall be compatible with suitable methyl ethyl ketone peroxide (MEKP) and cumene hydroperoxide (CHP) initiators.

537.2.3 Aggregate

Aggregate for polyester concrete shall conform to the requirements of Section 509.2.4, "Aggregate," of the Standard Specifications, except the gradation shall meet the following:

Table 537.2.3:1
Polyester Concrete Aggregate Gradation

COMBINED AGGREGATE		
Sieve Size	Percentage Passing	
	3/8 inch Max.	No. 4 Max.
1/2 inch	100	100
3/8 inch	83 - 100	100
No. 4	65 - 82	62 - 85
No. 8	45 - 64	45 - 67
No. 16	27 - 48	29 - 50
No. 30	12 - 30	16 - 36
No. 50	6 - 17	5 - 20
No. 100	0 - 7	0 - 7
No. 200	0 - 3	0 - 3

Aggregate retained on the #8 sieve shall have a maximum of 45 percent crushed particles when tested in accordance with AASHTO Test Method T 27. Fine aggregate shall consist of natural sand only.

Aggregate absorption shall not exceed one (1) percent as determined by AASHTO Test Methods T 84 and T 85.

At the time of mixing with the resin, the moisture content of the aggregate, as determined by AASHTO Test Method T 255, shall not exceed one half of the aggregate absorption.

537.2.3 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.

Submit a list of at least three (3) previous Projects in which the polyester concrete system from the proposed Supplier has been used and satisfactory performance has been achieved. The previous Projects must have been completed within the last five (5) years and have been open to traffic for not less than one (1) year. Include in the submittal, location of Bridge (state, route, and Bridge identifier), name of polyester concrete system Supplier, approximate date of Project opening to traffic, owner, and contact person with phone number.

537.2.4 Confirmation Testing

The Supplier shall test the polyester resin binder and prime coat Materials the Contractor proposes to use, and will provide results to the Project Manager within 14 Days before use. The Project Manager will accept the Materials based on the certified Laboratory report.

537.3 CONSTRUCTION REQUIREMENTS

537.3.1 Equipment

537.3.1.1 Concrete Cleaning Equipment

Prepare the concrete to produce a surface relief equal to the International Concrete Repair Institute (ICRI) Surface Preparation CSP 5-7, or ASTM E 965 pavement macrotexture depth from 0.04 inch to 0.08 inch. Use of scabblers, milling machines, or sandblasting will be at the discretion of the Project Manager. Provide ICRI concrete surface profile chips to the Project Manager for inspection and Acceptance of prepared surface. ICRI concrete surface profile chips will become the property of the Department.

The use of air compressors and/or vacuum trucks is permitted. 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 the prime coat. Use vacuum trucks that are clean and do not drip engine fluids, or install drip pans to protect the clean concrete surfaces and overlay.

537.3.1.2 Placing and Finishing Equipment

A continuous mixer, employing an auger screw/chute device, will be approved for use by the Project Manager contingent on a demonstration that the device can consistently produce a satisfactory product. The continuous mixer shall 1) be equipped with a metering device that automatically measures and records the aggregate volumes and the corresponding resin volumes, and 2) have a readout gage, visible to the Project Manager at all times, that displays the volumes being recorded. The volumes shall be recorded at no greater than five (5) minute intervals along with the time and date of each recording. A printout of the recording shall be furnished to the Project Manager at the end of each Work shift.

Furnish slip-form finishing Equipment with an automatic grade control device to strike off the overlay to the established grade and cross section. Finishing machines shall be self-propelled and capable of forward and reverse movement under positive control. Finishing machines shall be operated normal to the longitudinal Bridge or Roadway centerline.

Equipment shall be fitted with suitable traps, filters, drip pans, or other devices as necessary to prevent oil or other Deleterious Material from being deposited onto the existing concrete surfaces.

537.3.2 Pre-construction

537.3.2.1 Material Suppliers

The polyester concrete overlay system Supplier shall make available a technical representative for a minimum of three (3) Days to make recommendations to facilitate overlay installation. This shall include, but not be limited to, trial batch preparation, trial overlay placement, surface preparation, overlay application and overlay cure.

The system Supplier shall also provide health and safety training for personnel who are to handle the Materials.

537.3.2.2 Trial Batches and Trial Overlay

Mix one (1) or more trial batches of polyester concrete for various percentages of resin binder according to manufacturer's recommendations. The approximate percentage of polyester resin binder to use will be determined from the trial batches.

The Materials, methods and Equipment used in the trial batches shall be the same as those intended for use in the trial overlay. If at any time different Materials, methods or Equipment are to be used, new trial batches will be required.

Place one (1) or more trial overlays on a previously constructed concrete base to demonstrate the effectiveness of the proposed mixing, placing, and finishing Equipment. Each trial overlay shall be 12 ft wide, at least six (6) ft long, and the same thickness as the overlay to be constructed. The trial overlay area shall be within the Project limits and at a location approved by the Project Manager.

Remove and dispose of all Materials used in the trial batches, including the concrete base.

537.3.2.3 Concrete Repairs

Complete concrete repairs for patches, delamination, and crack filling per Section 533, "Concrete Structure Repair" as specified in the Contract, before applying the overlay. Use polyester concrete as a patching material. Apply patch material at least one (1) hour before placing the overlay or place the patch material and overlay monolithically.

After repairs are complete, clean concrete surfaces by shotblasting.

537.3.2.4 Cleaning and Preparation

Before placing the overlay, clean the concrete 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 truck or air compressor to remove dust and other loose material. Do not use brooms.

Close and protect Bridge deck drains and areas of curb or railing above the proposed surface to ensure that the prime coat, polyester concrete and aggregate do not contaminate these areas.

Adequately isolate expansion joints and weakened plane joints before overlaying or saw them by approved methods within 4 hours after overlay placement.

Obtain Project Manager's approval of concrete cleaning and preparation before placing the prime coat.

537.3.3 Safety Provisions

Use personnel certified in the safe handling of Materials in accordance with the manufacturer's requirements. Provide a soap and water wash station for the workers at the

job site. Submit written documentation of material handlers' training to the Project Manager before applying the overlay.

537.3.4 Storage of Materials

Store Materials in accordance with the manufacturer's recommendations.

537.3.5 Usage Limitations

Do not overlay Bridges constructed with unventilated stay-in-place forms, unless forms are ventilated at a minimum rate of $\frac{1}{2}$ in² per square foot, or on Portland cement concrete that is less than 56 Days of age with polymer concrete overlay. Always follow manufacturer's recommendations concerning moisture content.

Submit proposed locations of the longitudinal and transverse joints for approval. Do not locate the longitudinal joints in wheel lines.

537.3.6 Application

Before applying the prime coat, the concrete area to receive the prime coat shall be dry when tested according to ASTM D 4263. The concrete surface temperature shall be between 50 degrees F and 100 degrees F during application of the prime coat. Follow the manufacturer's deck temperature recommendations. Do not use artificial methods to raise the deck temperature.

Follow the manufacturer's temperature requirements for polyester resin and aggregate components. The Contractor shall not apply polyester resin if either of the following conditions exists:

1. The air temperature is expected to drop below the manufacturer-required temperature within 8 h after application; or
2. The polyester resin gel time is less than ten (10) min.

The prime coat shall be uniformly applied to completely cover the surface to receive the polyester concrete. Apply the prime coat at an approximate rate of 0.09 to 0.11 gal/yd² prior to placement of polymer concrete. Flood concrete surfaces with the prime coat, allowing penetration into the concrete and filling of all cracks. Redistribute the applied prime coat in cracks by squeegees or brooms. The quantity of initiated, promoted resin shall be no more than what is needed to apply a prime coat. A noticeable increase in viscosity prior to placement will be cause for rejection. If the primed surface becomes contaminated, or if there is a failure of the material, clean the contaminated or failed area by abrasive blasting and re-prime.

Immediately after the prime coat has been applied, the polyester concrete overlay shall be placed, in accordance with manufacturer's guidelines.

Mix polyester concrete in mechanically operated mixers. Use a sufficient amount of initiator in the polyester concrete to produce set times between 30 and 120 minutes after placement. Accelerators or inhibitors may be required to achieve proper set times and shall be used as recommended by the resin Supplier.

Place and finish polyester concrete before gelling or within 15 minutes following addition of the initiator, whichever occurs first. Discard polyester concrete not placed within this time.

Use finishing Equipment that strikes off the polyester concrete to the established grade, cross section, and nominal depth. Fit finishing Equipment with vibrators or other means of consolidating the overlay material. Construct longitudinal joints parallel to the Roadway alignment at the approved locations. Construct vertical joints perpendicular to the deck surface.

The smoothness of the polyester concrete surface will be tested with a straightedge. The surface shall not vary by more than 0.02 feet from the lower edge of a 12 foot +/- 0.2 feet long straightedge placed in any direction. Any surface that fails to conform to the above tolerance shall be ground to meet this requirement.

Apply abrasive sand finish to polyester concrete surfaces. The sand shall be commercial quality blast sand, conforming to the absorption capacity and moisture content requirements of polymer concrete aggregate of this Specification. Provide sand such that 95% shall pass the No. 8 sieve and 95% shall be retained on the No. 20 sieve. Apply the sand finish by mechanical means immediately after overlay strike-off. Broadcast sand uniformly onto the surface before gelling occurs at a minimum rate of 1.5 lb/yd².

After application of the sand finish and before gelling occurs, texture the overlay by grooving with a steel-tined rake with tines 1/8 inch wide and spaced from 3/4 inch to 1 1/2 inch apart. Groove to a depth of 1/8 to 3/16 inch.

The surface texture of the overlay shall be uniform and shall have a coefficient of friction of not less than 0.35. If the coefficient of friction is less than 0.35, grind or groove, parallel to the centerline, those portions of surfaces until the coefficient of friction requirement is met.

537.3.7 Curing

Protect the finished overlay from moisture, Equipment, and public traffic until the overlay achieves an average Schmidt hammer reading of 24. The Schmidt hammer test shall consist of the average of ten (10) readings (strikes), all taken in an area approximately 18 inches in diameter. Perform one (1) such test per 500 sq ft of overlay. Traffic may be allowed on the overlay when the reading of 24 is achieved.

Do not contaminate concrete surfaces during clean-up of tools and Equipment. Do not dump or spill polyester concrete Materials or cleaning solvents in areas that will cause environmental or fire hazards.

537.3.9 Testing

Provide the necessary Equipment and supplies for conducting adhesion tests on the completed overlay. Perform adhesion tests according to ACI 503R - Appendix A of the ACI Manual of Concrete Practice. Adhesion tests shall obtain a 250 psi minimum pulloff or cohesive failure within existing concrete. Perform tests at a frequency of one (1) test per every 1600 sq ft of deck surface in a random location. Prime and patch test holes with polyester concrete immediately after testing.

537.3.10 Corrective Work

Correct surface variations that exceed ± 0.02 ft per 12 ft, unless otherwise directed by the Project Manager.

Repair damaged overlay areas by saw cutting in rectangular sections to the top of the concrete surface and replacing the material at no additional cost to the Department.

In the event that the testing performed under 537.3.9 does not meet minimum pulloff, the material shall be removed and replaced in the areas in which low adhesion is determined from additional testing. Any additional testing required shall be Incidental to the Work.

537.3.11 Warranty

In addition to the requirements of Section 106.10, "Guarantees and Warranties," provide a five (5)-year warranty for the overlay material and installation.

The Department will evaluate the Work and photographically document 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 due to material degradation.
2. **Scaling:** The concrete overlay surface has a visible, exposed, rough surface texture resulting from a loss of aggregate or resin.
3. **Delamination:** Visible or audible debonding of the polyester concrete Bridge deck overlay at the bond line with the existing concrete surface.
4. **Cracking:** Any visible crack not reflected from a crack in the existing concrete.

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 test in accordance with AASHTO T 242. For the warranty period, an average skid test number of 0.35 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.

537.4 METHOD OF MEASUREMENT

Polyester concrete will be measured by the cubic yard. The volume to be paid for will be determined from calculations based on the quantity of resin binder used, the percent by weight of resin binder in the polyester concrete, and a unit weight of 135 pcf. The Contractor shall furnish suitable measuring devices to assure correct proportioning of Materials and accurate measurement for calculating payment quantities. The payment quantity shall be the calculated quantity of polyester concrete used in the Work, exclusive of material used in trial overlay and any wasted or unused material. Payment quantity will include patches.

The Contract price paid per cubic yard for polyester concrete shall include full compensation for furnishing all labor, Materials, tools, Equipment, and Incidentals, and for doing all the Work involved in placing polyester concrete, including furnishing methacrylate resin prime coat and furnishing Materials for trail overlays, removal of unsound concrete and preparation of repair areas when polyester concrete is used as the patching material, and as shown on the Plans, as specified in the Standard Specifications and as directed by the Project Manager.

Removal of loose concrete and preparation of repair areas for patching material other than polyester concrete will be measured by the square yard in accordance with Section 533, "Concrete Structure Repair."

537.5 BASIS OF PAYMENT

The accepted quantities, measured as provided above, will be paid for at the Contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the Work described in this Section.

Pay Item	Pay Unit
<i>Polyester Concrete Bridge Deck Overlay</i>	Cubic Yard

537.5.1 Work Included in Payment

The following Work and items will be considered as included in the payment for polyester concrete and will not be measured or paid for separately:

- A. ICRI concrete surface profile chips, and
- B. Removal of unsound concrete and preparation of repair areas when polyester concrete is used as the patching material.

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, or ASTM A706, Grade 60, at the nominal dimensions in accordance with Table 540.2.1:1, "Nominal Dimensions of Reinforcement."

**Table 540.2.1:1
Nominal Dimensions of Reinforcement**

Bar size	Nominal Weight (lb/ft)	Diameter (inch)
No. 3	0.376	0.375
No. 4	0.668	0.500
No. 5	1.043	0.625
No. 6	1.502	0.750
No. 7	2.044	0.875
No. 8	2.670	1.000
No. 9	3.400	1.128
No. 10	4.303	1.270
No. 11	5.313	1.410
No. 14	7.650	1.693
No. 18	13.600	2.257

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 the AASHTO M 32.

540.2.4 Reinforcing Wire

Provide reinforcing wire in accordance with AASHTO M 32.

540.2.5 Corrosion-resistant and Coated Reinforcing Bars

The Contractor may use one (1) of the following corrosion-resistant or coated reinforcement systems for Bridge decks and other concrete components exposed to weather and Road salts:

1. Epoxy-coated reinforcement in accordance with AASHTO M 284 and M 317 and from plants certified by the Concrete Reinforcing Steel Institute (CRSI) for the coating and fabrication process;
2. Deformed stainless steel bars in accordance with ASTM A 955;
3. Stainless steel clad deformed steel bars in accordance with AASHTO MP 13;
4. Uncoated low-carbon, chromium, steel bars in accordance with AASHTO MP 18 (ASTM A 1035); or

5. Hot-dipped galvanized reinforcement in accordance with ASTM A 767.

540.2.6 Coating and Patching Materials

1. Provide a fusion-bonded powdered epoxy resin coating material that meets the requirements of AASHTO M 284.
2. Provide a liquid, two-part epoxy patching material formulated to be compatible with the fusion-bonded epoxy powder coating, to repair damaged or uncoated areas.
3. Provide zinc-rich paint with a minimum 65% zinc content in accordance with ASTM A 780 for patching damaged and uncoated areas of hot-dip galvanizing.

540.2.7 Accessories

Provide plastic-coated reinforcing tie wire for tying epoxy-coated reinforcing bars, for deformed stainless steel bars, for stainless steel clad deformed steel bars and for uncoated low-carbon, chromium, steel deformed bars. Provide galvanized, annealed wire ties for galvanized reinforcing bars. Provide one (1) 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 two (2) inches 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 the 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 the ground; or
7. Concrete blocks in place of sand chairs or other metal supports placed directly on the ground.

Use continuous chairs or supports with preformed metal forms.

Do not use uncoated black (ferrous) steel ties, chairs, supports or clips in direct contact with stainless or galvanized reinforcing.

540.2.8 Certificates of Compliance

Provide Certificates of Compliance to the Project Manager with each reinforcing steel shipment.

Show the Project number, the shipping invoice number, name of the manufacturer, pounds shipped, heat numbers, Laboratory test reports, and grade of steel on the Certificates of Compliance. This requirement is the same for each of the coating/cladding systems and the corrosion-resistant systems.

540.2.9 Epoxy-Coated Reinforcing Bar Certificates of Compliance

Provide the Department's Inspector three (3) copies of a Certificate of Compliance for each shipment of coated bars. State on the certificate that the samples of the 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 the Department for inclusion in final inspection reports.

540.2.10 Epoxy-Coated Reinforcing Coating

540.2.10.1 Epoxy Coating Thickness

The thickness of the epoxy coating after curing shall be between seven (7) mils and 12 mils. For Acceptance, at least 90 percent of all recorded film thickness measurements shall be in this range.

540.2.10.2 Continuity of Epoxy Coating

Ensure that the coating is free from 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 an average of one (1) holiday per linear foot of coated bar.

540.2.11 Hot-Dip Galvanized Reinforcing Bars

Provide hot-dip galvanized reinforcing bars in accordance with ASTM A 767. Galvanize bar after cutting and bending.

540.2.12 Galvanizing Material

Provide galvanizing zinc in accordance with ASTM B6.

540.3 CONSTRUCTION REQUIREMENTS

540.3.1 GENERAL

Measure dimensions from centerline of bar to centerline of bar.
Store all reinforcing bars above ground on platform skids or other supports. Reinforcing shall be kept free from dirt, grease, and other foreign matter. Reinforcing shall be kept free of corrosion as far as practicable.

540.3.1.1 Bar Lists and Bending Diagram

When the Contract documents do not include detail bar lists and bending diagrams, the Contractor shall provide such list and diagrams to the State Bridge Engineer for review and approval. The approval of bar lists and bending diagrams shall in no way relieve the Contractor of responsibility for correctness. The bar lists and bending diagrams shall meet the requirements of the current edition of the Concrete Reinforcing Steel Institute's (CSRI) publication Reinforcing Bar Detailing. The Contractor shall allow 30 Days for review of the submittal.

540.3.1.2 Bundling and Tagging

Tag and mark reinforcement bar shipments in accordance with CSRI's *Code of Standard Practice*.

540.3.1.3 Bar Bending

The Department will allow cold bending around a pin. Do not field bend Grade 60 bars, epoxy-coated bars or hot-dip galvanized bars.

Unless otherwise directed, ensure the bend diameter is in accordance with Table 540.3.1.3:1. That table specifies minimum pin diameters for uncoated and coated bars.

Table 540.3.1.3:1
Minimum Diameter of Bends

Type of reinforcement	Size	Minimum pin diameter (bar diameters)	
		Uncoated bars	Coated bars
Coated bars			
Stirrups and Ties	#3 - #5	4	7.5
Main Reinforcement	#3 - #5	6	9
All Types	#6 - #8	6	9
All Types	#9 - #11	8	12
All Types	#14 - #18	10	15

540.3.1.4 Splicing

Splice bars only in accordance with the Plans unless otherwise approved by the State Bridge Engineer.

Place and tie bars in lapped splices to maintain minimum reinforcing cover.

Splice spiral reinforcement by lapping. Ensure that laps are at least 48 bar or wire diameters, but not less than 1ft with 90° hooks around longitudinal bars at ends.

The Department will allow mechanical couplers for AASHTO M 31, Grade 60, and ASTM A706, Grade 60, deformed bar if the splice strength, verified by tests, is greater than or equal to 125% of the yield strength of the spliced reinforcing bars and develops the specified tensile strength of the bars. ACI 318 "Type 2" mechanical couplers meet the above splice strength requirements. Submit documentation to the State Bridge Engineer showing where mechanical couplers are proposed to be used, what type of coupler (manufacturer and model number) will be used, and certified test results from an approved testing service showing that the couplers meet these requirements. Show splice locations and coupler clearance dimensions in the request and submit before fabricating the reinforcing bars that will be coupled. Allow at least two (2) weeks for review and approval.

Unless otherwise specified, ensure that welded wire fabric and bar-mat reinforcement overlap is at least one (1) spacing of cross wires plus two (2) inches when measured between the outer-most cross wires of each sheet.

540.3.1.5 Field Cutting

Bars may be cut to length in the field by shearing or sawing. Flame cutting will not be permitted. The ends of coated or clad bars cut in the field shall be patched with suitable patching material.

540.3.1.5.1 Reinforcing Bar Placement

Place reinforcing bars as shown in the Contract drawings, securely tied in position with wire not smaller than 16 gauge. Carefully place, support and tie reinforcing, and place and consolidate concrete around reinforcing with care to avoid any displacement and damage to the coatings.

Tie all intersections where bar spacing is greater than or equal to one (1) ft in either direction. Tie alternate intersections where bar spacing is less than one (1) ft in either direction.

Use metal spacers, chairs, hangers, 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 ground, 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, plastic or epoxy-coated, tie wires for attachment of reinforcement.

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 ten (10) ft.

540.3.1.5.2 Reinforcing Bar Placement Tolerances

Ensure that the space between adjacent bars does not vary more than the greater of ½ inch or 1 /24 of the spacing dimension shown on the Plans.

Except for slabs cast on the ground, ensure that the clear cover of reinforcement shall not vary more than the greater of either 1/4 inch or 1/8 of the dimension shown on the Plans.

Ensure that the reinforcement clear cover in slabs cast on the ground does not vary more than minus 1/2 inch from the position shown on the Plans.

540.3.1.6 Cleaning Reinforcing Bars

Before placing concrete, clean the reinforcing bars of Materials that would reduce or destroy the bond.

540.3.1.7 Welding of Reinforcing Steel

Weld reinforcing steel only if the Contract requires it or if the State Bridge Engineer authorizes it in writing. Weld in accordance with AWS Specification D1.4, Reinforcing Steel Welding Code. Welding of bars other than ASTM A706 is allowed only upon approval of qualified welding procedures for those bars that comply with AWS D1.4. Submit a Welding Procedure Specification, stamped by an AWS certified welding Inspector for each procedure.

Welding to other added Contractor steel for stiffening, cage alignment, lifting, handling and other Contractor needs shall not be welded to reinforcing steel called for in the Plans.

540.3.1.8 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 540.3.1.8:1, "Concrete Cover Requirements."

**Table 540.3.1.8:1
Concrete Cover Requirements**

Location	Minimum cover (inch)
Concrete cast against and permanently exposed to the ground	3
Concrete exposed to the ground or weather	
Principal reinforcement	2
Stirrups, ties and spirals	1 1/2
Concrete Bridge slabs	
Top reinforcement	2
Bottom reinforcement	1
Concrete not exposed to weather or in contact with ground	
Principal reinforcement	1 ½

**Table 540.3.1.8:1
Concrete Cover Requirements**

Stirrups, ties and spirals	1
Bar bundles	2 ^a
^a Or equal to the diameter of a single bar of equivalent area, whichever is greater.	

540.3.1.9 Final Inspection

Do not place concrete until the Department inspects the reinforcing steel in place.

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

540.3.2.1 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. Use spreader beams and multiple pick points when hoisting bar bundles to prevent sagging. Do not store epoxy-coated reinforcing bars in sunlight for more than 30 Days. Use only non-metallic sleeved heads with immersion-type vibrators when placing concrete around epoxy-coated reinforcing.

540.3.2.2 Repair of Damaged Epoxy-Coating

Repair visible damage before shipping. Ensure the total surface area of patched coating Material is not more than one percent (1%) of the total coated area in any one (1) foot section. The Department will reject bars shipped to the Project that show more than one percent (1%) patched coating Material.

Patch sheared ends, cuts and exposed areas promptly 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 two percent (2%) of the coated area in any one (1) foot section. The Department will reject any installed bars with more than two percent (2%) patching.

Apply the patching material in strict compliance with the manufacturer's instructions. Allow adequate time for the patch to cure before placing concrete over the bars.

540.3.3 Requirements for Galvanized Reinforcing Bars

540.3.3.1 Galvanizing Bent Bars

Where galvanized bars are detailed to be bent or have other types of cold-forming, the bars must be bent before galvanizing.

540.3.3.2 Surface Preparations

Prepare bar surfaces 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.

540.3.3.3 Thickness of Galvanizing

Ensure that the galvanizing after drying with air, steam or wiping is from three (3) mils to 3.9 mils thick. Determine the thickness with a magnetic thickness gage.

540.3.3.4 Chromating

Treat the galvanized coating with chromate. This prevents a reaction between the bars and fresh Portland cement paste. The Department will allow proprietary chromating treatment solutions of equivalent strength instead of the generic chemical treatment in accordance with ASTM A 767, Section 5.3. Quenching of bent bars or bars to be bent is not allowed. Such bars must be chromated at ambient temperature.

540.3.3.5 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. A matte gray finish appearance is not, by itself, a cause for rejection.

Ensure that the coating cannot be removed through normal handling.

540.3.3.6 Installation of Galvanized Reinforcing Bars

Transport and store galvanized bars in a manner to prevent damage to the galvanized coating. All systems for handling galvanized coated bars shall have padded contact areas. All bundles of bars shall be lifted using spreader beams and multiple pick points or a platform Bridge to prevent bar-to-bar abrasion from sagging in the bar bundle. The bars and bundles shall not be dropped or dragged on the ground, platforms or other bars.

Galvanized reinforcing bars shall not be tied with black steel or left in contact with black steel. Galvanized reinforcing bars shall be left in contact only with galvanized, plastic-coated, or epoxy-coated surfaces.

540.3.3.7 Repair of Damaged Galvanizing

Patch sheared ends, cuts and exposed areas using a zinc-rich paint. Prepare the surface to be patched so that it is clean, dry and free of oil, grease and corrosion products. Blast-clean the surface to near-white metal, in accordance with SSPC-SP10. Spray or brush-apply the paint containing the zinc dust as recommended by the manufacturer in one (1) application of as many passes as required to achieve a dry film thickness of four (4) mils as determined using a magnetic or electromagnetic gage.

540.3.4 Repair of Stainless Steel Clad Deformed Steel Bars

The stainless steel clad deformed steel bars shall be shop bent as shown on the Contract documents. All ends of the bars where mild steel core is exposed shall be capped by one (1) of the following methods:

1. Heat shrink cap applied in accordance with the cap manufacturer's instructions.
2. Neoprene cap adhered with silicone or epoxy sealant.
3. Stainless steel cap epoxied in place.
4. Stainless steel seal weld.

No field cutting or bending of stainless steel clad deformed steel bars will be allowed.

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, galvanized, stainless steel, stainless steel clad, or low-carbon, chrome steel. The computed weights of reinforcing bars will be based on the nominal weights of the bars before application of the epoxy-coating, or galvanizing of the bars. When splice overlaps are unscheduled or are made for the convenience of the Contractor, and are approved by the State Bridge Engineer at locations not shown in the Contract, the extra steel required for splice overlaps will not be included in computing the weight of the bars for payment.

540.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Reinforcing Bars, Grade _____</i>	Pound
<i>Epoxy-Coated Reinforcing Bars, Grade _____</i>	Pound
<i>Galvanized Bars, Grade _____</i>	Pound
<i>Uncoated Corrosion Resistant Reinforcing Bars, Grade _____</i>	Pound
<i>Stainless Steel Reinforcing Bars, Grade _____</i>	Pound
<i>Stainless Steel Clad Reinforcing Bars, Grade _____</i>	Pound

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, and
- D. Mechanical reinforcing bar splices.

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 50, unless otherwise designated in the Contract. Provide steel for anchor bolts, sole plates, minor Bridge components, inlet grates, and cattle guards in accordance with ASTM A 36.

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–30 °F).

Conduct plate-frequency testing instead of hat-lot testing for plate Material thicker than 1 1/2 inch.

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 541.2.2:1
Tensile Properties of Shear Connector Studs

Property	Minimum requirement
Tensile strength	60,000 psi
Yield strength @ 0.2% offset	50,000 psi
Elongation in two (2) inch	20%
Reduction of area	50%

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 (2) threads are within the grip of the connected parts. Use bolts that will extend beyond the nut at least two (2) threads, but not more than 1/2 inch.

541.2.6 Structural Steel Coating

Provide coated Structural Steel in accordance with Table 541.2.6:1, "Coating of Structural Steel."

Table 541.2.6:1
Coating of Structural Steel

Item	Coating requirement
Structural Steel for steel Bridges	Section 544, "Protective Coating of New Structural Steel"
Structural Steel for concrete Bridges	Section 544, "Protective Coating of New Structural Steel" or Section 545, "Protective Coating of Miscellaneous Structural Steel"
Structural Steel for miscellaneous Structures	Section 545, "Protective Coating of Miscellaneous Structural Steel"
Metal Bridge railing	Section 545, "Protective Coating of Miscellaneous Structural Steel"
New exposed steel Bridge piling and similar applications	Section 545, "Protective Coating of Miscellaneous Structural Steel"
Recoating Bridges	Section 546, "Recoating Structures"

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 (6) copies of the following items for inclusion in the inspection report:

1. Structural Steel MTRs;
2. Certificates of Compliance and other documentation for the protective coating;
3. The manufacturers Certificate of Compliance for welding consumables;
4. Weld procedures;
5. QC inspection reports; and
6. 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 shop drawings for Acceptance 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 (2) additional complete sets.

541.3.3.1 Approval of Initial Submittal

The Department will review the preliminary drawings. The Department will return three (3) sets of drawings stamped "Accepted 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 (3) 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 (9) sets of corrected drawings; retain two (2) additional sets.

Do not fabricate Materials before receiving drawings stamped "Accepted" or "Accepted as Noted." Mark non-accepted drawings "VOID."

Allow at least 30 Days for review and Acceptance of final shop Plans and an additional 14 Days for 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 accepted set of shop drawings in a permanent file. Do not make any changes to accepted shop drawings. If changes are made, re-submit the drawings for Acceptance.

Before fabrication, submit a letter of intent to fabricate to the Project Manager containing the following information:

1. Names of the Fabricator;
2. Project number;
3. Drawing number;
4. Number of pieces to be fabricated;
5. 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 (1) copy of each standard drawing to the Project Manager and the State Bridge Engineer at least 10 Days before starting Work. Notify the State Bridge Engineer at least 10 Days before starting Work.

For steel items unique to a Project, prepare and submit shop drawings.

541.3.5 Rolled Girders and Plate Girders

Provide girders to the full length shown in the Plans. Bolted or welded girder splices will not be permitted unless noted otherwise in the Plans.

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 inch minimum from the corner in each direction to avoid such intersections.

Terminate welds attaching secondary components to main members 1/4 inch 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 $\pm 1/32$ inch.

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 two (2) inch diameter hole longitudinally through the center of pins with an eight (8) inch 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 inch. 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 inch or greater with six (6) 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. Welder must be qualified for the position the weld is performed in.

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 inch 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 inch between the ends of abutting members. Do not exceed 1/4 inch 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 S 10.1, *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 inch thick.

541.3.7.2.1 Anchor Bolt Holes

Core drill anchor boltholes in accordance with Table 541.3.7.2.1:1, "Required Nominal Anchor Bolt Hole Diameters."

Table 541.3.7.2.1:1
Required Nominal Anchor Bolt Hole Diameters

Bolt diameter (inch)	Hole diameter (inch)
3/4	1 1/2
1	1 3/4
1 1/4	2

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.

541.3.7.3 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 (1) pilot and one (1) driving nut for each size pin.

541.3.7.6 Removal of Lead-Paint Coated Steel Items

Dispose of lead paint debris in accordance with Section 547, "Safety and Environmental Requirements for Painting Operations."

541.3.7.7 Disposal of Steel Structures, Reinforcing Steel, Steel Debris or Steel Waste

Do not reuse salvaged steel items from existing Structures unless directed otherwise in the Plans. Salvaged steel shall be disposed of by Contractor as approved by the Project Manager.

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 541.4:1
Metal Unit Weights For Measurement

Material	Unit weight (lb/ft³)
Steel	490
Cast iron	445
Bronze	536

541.4.1 Bolts

The Department will pay the weight of fasteners as indicated on the Accepted Shop Drawings.

541.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Structural Steel for Concrete Bridges</i>	Pound
<i>Structural Steel for Steel Bridges</i>	Pound
<i>Structural Steel for Miscellaneous Structures</i>	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; and
- D. Weld material weight.

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 inch to one (1) inch is in accordance with Table 542.2.1:2, "Bolt Hardness Requirements."

**Figure 542.2.1:1
AASHTO M 164 (ASTM A 325) Bolts**

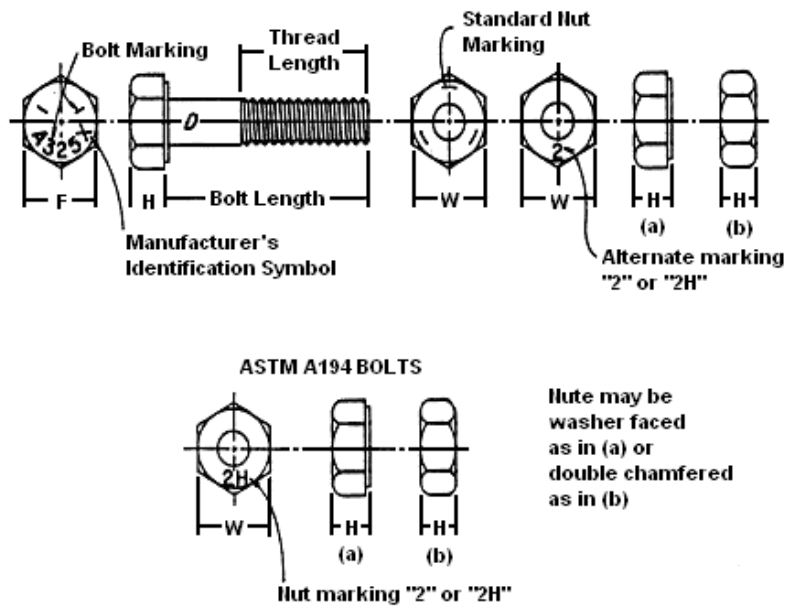


Table 542.2.1:1 Dimensions of High-Strength Bolts					
Nominal bolt size, D	Heavy hex structural bolts			Heavy hex nuts	
	Width across flats, F	Height, H	Thread length	Width across flats, W	Height, H
1/2	7/8	5/16	1	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 13/16	17/64
1 1/4	2	25/32	2	2	17/32
1 3/8	2 3/16	27/32	2 1/4	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 3/8	1 15/32
Note: All dimensions in inches					

Table 542.2.1:2 Bolt Hardness Requirements				
Bolt diameter	Hardness number			
	Brinnell		Rockwell C	
	Minimum	Maximum	Minimum	Maximum
1/2 inch–1 inch	248	311	24	33

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	
Bolt size	Length to be added to grip
1/2	1 1/16
5/8	1 3/16
3/4	1 3/8
7/8	1 9/16
1	1 3/4
1 1/8	1 7/8
1 1/4	2
1 3/8	2 1/8
1 1/2	2 ¼
Note: All dimensions in inches	

These values are based on using one (1) hardened flat washer and one (1) direct tension indicator.

When using beveled washers, subtract the thickness of a flat washer and add 5/16 inch for the beveled washer. Adjust the length in accordance with Table 542.2.1:3, “Bolt Lengths,” to the next longer 1/4 inch.

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.

542.2.3 Washers

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 (1) side no closer than $\frac{7}{8}$ of the bolt diameter from the center of the washer.

Table 542.2.3:1
Circular Washer Dimensions

Bolt size D	Nominal outside diameter	Nominal diameter of hole	Thickness	
			Maximum	Minimum
1/2	1 1/16	17/32	0.097	0.177
5/8	1 5/16	21/32	0.122	0.177
3/4	1 15/32	13/16	0.122	0.177
7/8	1 3/4	15/16	0.136	0.177
1	2	1 1/16	0.136	0.177
1 1/8	2 1/4	1 1/4	0.136	0.177
1 1/4	2 1/2	1 3/8	0.136	0.177
1 3/8	2 3/4	1 1/2	0.136	0.177
1 1/2	3	1 5/8	0.136	0.177
1 3/4	3 3/8	1 7/8	0.178 ^a	0.28 ^a
2	3 3/4	2 1/8	0.178 ^a	0.28 ^a
Over 2 to 4 incl.	2D-1/2	D+1/8	0.24 ^b	0.34 ^b

Note: All dimensions in inches.

^a 3/16 inch nominal.

^b 1/4 inch nominal.

Table 542.2.3:2
Square or Rectangular Beveled Washers for American Standard Beams and Channels

Bolt size (in)	Minimum side dimension (in)	Mean thickness (in)	Slope or taper in thickness
1/2	1 3/4	5/16	1:6
5/8	1 3/4	5/16	1:6
3/4	1 3/4	5/16	1:6
7/8	1 3/4	5/16	1:6

Table 542.2.3:2
Square or Rectangular Beveled Washers for American Standard Beams and Channels

Bolt size (in)	Minimum side dimension (in)	Mean thickness (in)	Slope or taper in thickness
1	1 3/4	5/16	1:6
1 1/8	2 1/4	5/16	1:6
1 1/4	2 1/4	5/16	1:6
1 3/8	2 1/4	5/16	1:6
1 1/2	2 1/4	5/16	1:6

Note: Hole tolerances are the same as for circular washers.

Table 542.2.3:3
Washer Tolerances

Dimension	≤1 1/2 inch nominal size, inclusive	>1 1/2 inch nominal size
Nominal diameter of hole	-0, +1/32	- 0, +1/16
Nominal outside dimensions	-1/32, +1/4	-1/32, +1/4
Flatness; maximum deviation from straightedge placed on "cut" side shall not exceed	0.01 inch	0.015 inch
Burr shall not project above immediately adjacent washer face more than	0.01 inch	0.015 inch

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

Bolt size (in)	Outside diameter (in)		No. of protrusions (equally spaced)	Thickness (in)		Inside diameter (in)	
	Min.	Max.		Without protrusions, minimum	With protrusions, maximum	Min.	Max.
1/2	1.167	1.187	4	0.104	0.180	0.523	0.527
5/8	1.355	1.375	4	0.126	0.220	0.654	0.658
3/4	1.605	1.625	5	0.126	0.230	0.786	0.790
7/8	1.855	1.875	5	0.142	0.240	0.917	0.921
1	1.980	2.000	6	0.158	0.270	1.048	1.052
1 1/8	2.230	2.250	6	0.158	0.270	1.179	1.183
1 1/4	2.480	2.500	7	0.158	0.270	1.311	1.315
1 3/8	2.730	2.750	7	0.158	0.270	1.442	1.446
1 1/2	2.980	3.000	8	0.158	0.270	1.573	1.577

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 the Project.

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 (2) 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 inch 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 (1) 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 (2) kips more than that value;

**Table 542.2.5.4.1:1
Snug Tight Tension**

Bolt diameter (in)	Installation tension, minimum (kip)
1/2	1
5/8	2
3/4	3
7/8	4
1	5
1 1/8	6
1 1/4	7
1 3/8	9
1 1/2	10

- 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 542.2.5.4.1:2
Installation Tension**

Bolt diameter (in)	Snug tension, minimum (kip)
1/2	12
5/8	19
3/4	28
7/8	39
1	51
1 1/8	56
1 1/4	71
1 3/8	85
1 1/2	103

- 4.6. Calculate the torque in accordance with the following equation:

$$V = \frac{T \times d}{4} \quad (1)$$

Where,

- 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
Required Rotation**

Bolt length (L) measured in step 1	Required rotation (turns)
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**Table 542.2.5.4.1:3
Required Rotation**

Bolt length (L) measured in step 1	Required rotation (turns)
$L \leq 4d$	2/3
$4d < L \leq 8d$	1
$L > 8d$	1 1/3

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
Minimum Tension Requirements**

Bolt diameter (in)	Tension, minimum (kip)
1/2	14
5/8	22
3/4	32
7/8	45
1	59
1 1/8	64
1 1/4	82
1 3/8	98
1 1/2	118

- 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 inch 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 (3) to five (5) 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 (1) 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 542.2.5.4.2:1
Initial Required Rotation

Bolt length (L) measured in Step 3.2	Required rotation (turns)
$L \leq 4d$	1/3
$4d < L \leq 8d$	1/2
$L > 8d$	2/3

Note: d = bolt diameter.

Assemblies that exceed the torque values listed in Table 542.2.5.4.2:2, "Torque Requirements," fail.

Table 542.2.5.4.2:2
Torque Requirements

Bolt diameter (in)	Torque foot-pounds, maximum
1/2	150
5/8	290
3/4	500
7/8	820
1	1,230
1 1/8	1,500
1 1/4	2,140
1 3/8	2,810
1 1/2	3,690

- 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 542.2.5.4.2:3
Final Rotation Requirements

Bolt length (L) measured in step 1	Required rotation (turns)
$L \leq 4d$	2/3
$4d < L \leq 8d$	1
$L > 8d$	1 1/3

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 (2) bolt, nut and hardened washer assemblies from each rotational capacity lot and at least three (3) 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 (1) 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.

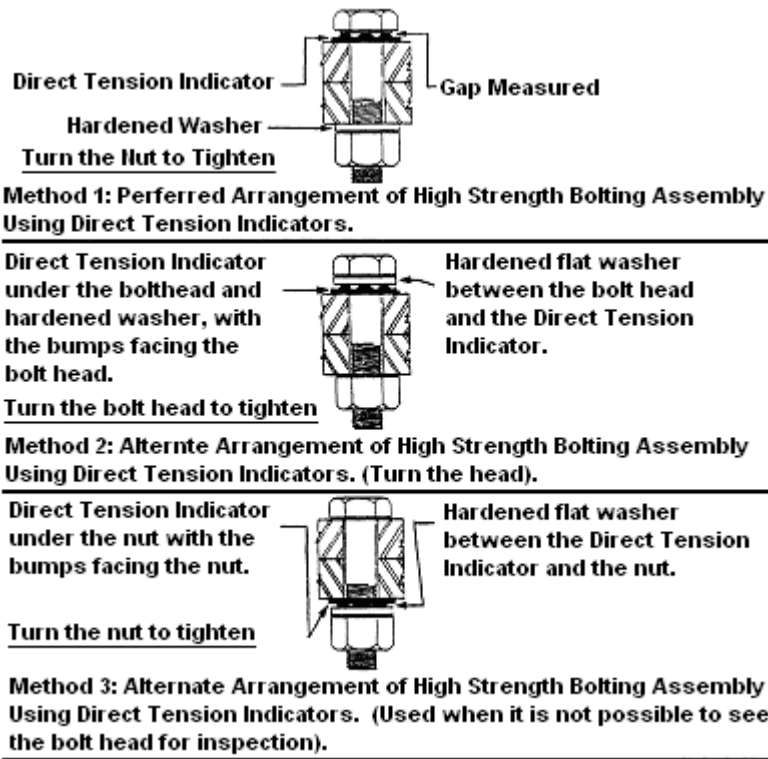
For oversized or slotted holes, place additional hardened washers between the bolted Material and the fastener.

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.

Figure 542.3.3:1
Installation Details



Ensure that galvanized bolt assembly direct tension indicator gap for all three (3) methods is less than or equal to 0.005 inch. Use Method 2 or Method 3 for galvanized bolt assemblies only after receiving Department approval.

542.3.4 Inspection

The Department will visually inspect every bolt for gaps. The Department will also check at least ten percent (10%) of the bolts, but not less than two (2) 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—Reserved

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 ASTM A 36 or AASHTO M 270, Grade 50.

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 164 (ASTM A 325), ASTM A 449, ASTM F 1555 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. Provide heavy hex nuts in accordance with ASTM A 563 Grade DH. Provide washers in accordance with ASTM F 436.

543.2.2.2 Connection Bolts

. Provide connection bolts in accordance with ASTM A 307, Grade A; connection nuts in accordance with ASTM A 563, Grade A; connection washers in accordance with ASTM F 844, unless otherwise noted on the Plans or Standard Drawings. 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. Ensure washer dimensions and tolerances are in accordance with Section 542.2.3.

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 inch within 20 horizontal feet.

For a Bridge on a curve, do not deviate more than 13/16 inch from the curve within 20 horizontal feet.

Ensure the rail posts are plumb within 1/4 inch over the full height.

543.3.2 Protective Coating

When the Contract specifies the railing to be colored, powder, 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 one percent (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

Pay Item	Pay Unit
<i>Metal Railing</i>	Foot

543.5.1 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;
- B. Additional weight of heavier sections provided solely for the Contractor's convenience; and
- C. All Incidentals necessary for the completion of the Work.

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 North East Protective Coating (NEPCOAT) Qualified Products List Provide a three (3) coat system for all new Structural Steel.

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 eight (8) inches by ten (10) inches for review and approval.

The Department may take random coating Materials samples during the Work for testing.

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 manufacturer's product data sheets. Submit two (2) 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 ASTM B 695, 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 excessively scar the metal.

Use blast-cleaning abrasives such as dry sand, steel shot, mineral grit, or manufactured grit. Ensure that the abrasives produce a uniform profile from 1 mil to 2 mil with an angular pattern as measured in accordance with ASTM D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers. Use of testex replica tape is common.

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 (3) 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 (1) 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 tooke 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**

Coating	Dry film thickness range (mils)
Primer	3 to 10
Topcoat	4 to 8
Urethane protective coat	3 to 10

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 tooke 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 (2) 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 (1) 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 10 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 four (4) inch high black letters on the inside of the fascia girders at two (2) 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"

544.4 METHOD OF MEASUREMENT—Reserved

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, drop inlet grates, cattle guards, field coating of new steel piling and other miscellaneous Structural Steel.

545.1.1 Coating Options

Apply the primer and topcoat in the shop. New metal Bridge railing and pedestrian railing shall be powder coated or galvanized.

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 (1) manufacturer. Select a coating system from the North East Protective Coating (NEPCOAT) Qualified Products List. . Provide a 2-coat system for all miscellaneous Structural Steel.

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 ASTM B 695, 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 (1) 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

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 eight (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 five (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.

Coat in accordance with SSPC-PA 1.

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 two (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 (1) 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. Clean off all rust on sole plates prior to installing and welding.

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 Film Thicknesses."

Table 545.3.5.3:1 Required Film Thicknesses	
Coating	Dry film thickness range (mils)
Primer	2–4
Topcoat	3–6

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 Department at least 10 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 (2) or more coats may be necessary to build up the required film thickness. Apply topcoat only to areas where the topcoat is damaged. Requirements of Section 545.3 apply to field repairs.

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—Reserved

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 North East Protective Coating (NEPCOAT) Qualified Products – List M which will become the Department's *Approved Products List* for Recoating Structures.

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 eight (8) inches by ten (10) inches 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 (1) notarized Certificate of Compliance to the Project Manager and one (1) 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 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 (2) notarized Certificates of Compliance to the Department.

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, *Power-Tool Cleaning to Bare Metal*.

The Project Manager will mark additional areas for cleaning in accordance with SSPC-SP 11. Clean at least two (2) inches 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 (1) standard for each Structure. More than one (1) standard may be necessary if the cleaned steel differs significantly from the photographic standards. For recoating Bridges, make the standard at least one (1) ft x one (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 Department.

When replacing a concrete Bridge deck, do not clean or coat the top surfaces of top flanges of beams and girders and shear connectors.

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 all surfaces. 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.

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 the NEPCOAT Qualified Products – List M for the required thicknesses of the coatings.

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

Pay Item	Pay Unit
<i>Recoating Structures</i>	Lump Sum
<i>SP 11 Power Tool Cleaning and Priming</i>	Square Foot
<i>SP 3 Power Tool Cleaning and Priming</i>	Square Foot

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. Spot 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 primer and 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—Reserved

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 20 NMAC 4.1 Hazardous Waste Management, 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
14. Protection of Workers from Lead (1926.62).

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 (2) 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 (2) 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 20 NMAC 4.1 Hazardous Waste Management and SSPC Guide 7, which is the primary reference document for waste disposal. If there is a conflict between 20 NMAC 4.1 Hazardous Waste Management and SSPC Guide 7, 20 NMAC 4.1 Hazardous Waste Management 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—Reserved

547.5 BASIS OF PAYMENT

Pay Item

Safety and Environmental Requirements

Pay Unit

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.

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**

Provide sawn lumber and timber in accordance with AASHTO M 168, and the National Forest Products Association's *National Design Specification for Wood Construction*.

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 550.2.3:1
Washer Dimensions**

Bolt diameter	Hole diameter	Washer diameter	Washer thickness
1/2	9/16	1 3/8	3/32
3/4	13/16	2	5/32
7/8	15/16	2 1/4	11/64

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 ASTM A36; 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 (3) sets of shop and erection drawings to the Department. The Department will return one (1) set with notations.

Provide up to eight (8) 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 (1) or two (2) 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 inch larger than the bolt diameter for bolted connections using more than two (2) bolts, and for bolt holes which are part of a shear plate or split-ring assembly.

Drill holes in connector plates 1/16 inch 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 inch to 1/16 inch greater than the diameter of the shank.

Make the hole depths approximately one (1) inch 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 (2) 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 AWP A U1 and T1.

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 five percent (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 inches 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 (2) liberal applications of a compatible preservative in accordance with AWP A 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 accordance with the Contract or approved modifications, to measure treated timber.

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

Pay Item

Treated Timber

Pay Unit

Thousand Board Feet

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 3/4 inch thick with laminates spaced no greater than 3/4 inch apart through the entire thickness. Provide shim thicknesses not less than 1/8 inch.

560.2.2 Certification

Furnish certified Laboratory test results on the elastomer properties of compound for both plain and laminated bearings. The required tests are per AASHTO M 251-06 Table 1. For Bridges north of I-40 and including I-40, the elastomer compound shall be Grade 3. For Bridges south of I-40, the elastomer compound shall be Grade 2. Test shall be done on an annual basis or when the material Supplier changes. Provide copies of certified mill test reports for laminated bearing steel and any required steel components.

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 following tests shall be performed on the actual bearing pads. One (1) bearing pad per lot shall be tested.

The bearing pad shall be tested per AASHTO M 251-06 Section 8.8.2. The average compressive load shall be 2,250 psi for laminated bearing pads and 1500 psi for plain bearing pads.

The bearing pad shall be tested per AASHTO M 251-06 Section 9.1. Where the bearing strain exceeds ten percent (10%), the lot shall be rejected. If the bearing pad design loads are not shown on the Contract Drawings, the test will not be required.

Testing is to be performed by the manufacturer Laboratory with the certified test results submitted to NMDOT.

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 inch.

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 560.2.6:1
Bearing Pad Tolerances**

Parameter description	Tolerance requirements
Overall Vertical thickness	
1 1/4 inch or less	0 inch to +1/8 inch
Over 1 1/4 inch	0 inch to +1/4 inch
Overall horizontal dimensions	
36 inch and less	0 inch to +1/4 inch
Over 36 inch	0 inch to +1/2 inch
Individual layer thickness ^a	± 20% of design value but no more than ± 1/8 inch
Variations from a plane parallel to the theoretical surface ^b	
Top ^c	0.005 radians
Sides	0.02 radians
Position of exposed connection members	1/8 inch
Embedded steel plates edge cover or connection members	0 in to +1/8 inch
Hole, slot, or insert sizes	+ 1/8 inch
Hole, slot, or insert positions	1/8 inch

^aElastomer-laminated bearing pads only.

^bAs determined by measurements at the bearing edges.

^cSlope relative to the bottom.

560.3 CONSTRUCTION REQUIREMENTS

560.3.1 General

Ensure bearing pads in the completed Structure exhibit a compressive strain of no more than ten percent (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 inch 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— Reserved

560.5 BASIS OF PAYMENT

The furnishing and installing of elastomeric bearing pads will be considered Incidental to the completion of the Work and no measurement or direct payment will be made therefore.

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 debris 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 (1) 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 seal. 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—Reserved

561.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Elastomeric Compression Joint Seal Replacement</i>	Foot

562.1 DESCRIPTION

This Work consists of providing, assembling, and installing Bridge joint strip seal assemblies per the Standard Drawings for Bridge Joint Strip Seals.

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. Unless noted on the Plans, Type A anchorage should be used.

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 562.2.2:1
Elastomer Physical Property Requirements**

Property	ASTM test	Requirement
Tensile strength, minimum	D 412	2,000 psi
Elongation at break, minimum	D 412	250%
Hardness, durometer, neoprene	D 2240	60 ± 5
Compression set, maximum ^a	D 395	40%
Brittleness @ -40 °F	D 746	Not brittle
Property deterioration ^b	D 573	
Tensile strength loss, maximum		20%
Elongation loss, maximum		20%
Hardness point change, Type A ^c	D 2240	0 to ±10
Ozone resistance ^d	D 1149	No cracks
Oil swell ^e	D 471	
Weight increase, maximum		+45%
Resistance to salt ^f	D 471	
Variation of volume		-5% to +10%

^aAfter 70 h at 212 °F using Method B, modified.

^bAfter 70 h at 212 °F.

^cDurometer A.

^dAt 20% elongation and 300 pphm in air at 104 °F.

^eUsing ASTM Oil #3, after 70 h at 212 °F.

^fAfter 70 h at 104 °F in calcium chloride solution.

562.2.3 Metal Components

Provide steel retaining bars in accordance with ASTM A 588. 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 (3) sets of complete shop drawings to the State Bridge Engineer for preliminary review; include two (2) 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 (1) set to the manufacturer or Supplier with notations. After making the required corrections, submit eight (8) 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 Technical Support Representative

Ensure an elastomeric concrete manufacturer's technical support 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 1/4 +/- 1/16 inch 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 inch 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—Reserved

562.5 BASIS OF PAYMENT

Pay Item

Bridge Joint Strip Seal

Pay Unit

Linear Foot

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. Leak Testing including water for leak test;
- D. Providing manufacturers' representatives and installation certification;
- E. Protective coating of steel components.

563.1 DESCRIPTION

This Work consists of providing and installing polymer Bridge joint seals consisting of a rapid-curing silicone or polyurethane sealing element.

563.2 MATERIALS**563.2.1 General**

Select sealing Material from the Department's *Approved Products List* for polymer Bridge joint seals.

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

Property	Requirement
Tack-free time, 77 °F	30–60 min
Nonvolatile content, minimum	93%
Tensile strength and 24 h extension test	—
Initial, 5-Day cure, 77 °F	4–29 psi
After water immersion	4–29 psi
After heat aging,	4–29 psi
After cycling, –20 °F, 50%, 3 cycles	4–29 psi
24 h extension (all specimens) ^a	Pass

^aAfter 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

Property	ASTM	Requirement
Bond @ -20 °F, 50% extension (1/2 inch)		
Non-immersed	D 5329	Pass 3 cycles
Water-immersed	D 5329	Pass 3 cycles
Tensile adhesion, minimum	D 412	800%
Penetration		
@ -13 °F	D 5329	5/16 inch

Table 563.2.3:1**Polyurethane Sealing Requirements**

Property	ASTM	Requirement
@ 0 °F	D 5329	1/16 inch
Flow 5 h @ 200 °F	D 5329	0

563.2.4 Backer Rods

Provide backer rods in accordance with the sealant manufacturer's recommendations.

563.2.5 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.

563.3 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 (10) 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 seven (7) Days before installing sealing Material. Clean Bridge joints in new or existing concrete with a sandblaster before placing the 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 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 sealant Material.

563.3.5 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.

563.3.6 Traffic

Do not allow traffic on newly installed silicone or polyurethane sealing elements without Project Manager approval. Silicone or polyurethane sealants are normally ready for traffic upon removal of the traffic control devices.

563.4 METHOD OF MEASUREMENT—Reserved

563.5 BASIS OF PAYMENT

Pay Item

Polymer Bridge Joint Seals,

Pay Unit

Foot

564.1 DESCRIPTION

This Work consists of providing and installing ultraviolet resistant Evazote or equivalent joint seal systems in accordance with the manufacture's recommendations and as approved by the Project manager.

564.2 MATERIALS**564.2.1 General**

Select sealing material and the nosing element from the Department's Approved Products List for Preformed Closed Cell Foam Bridge Joints. Provide sealing, bonding and nosing elements from the same manufacturer.

564.2.2 Closed Cell Foam Joint Seal

Use a joint seal that:

- a. is an impermeable, closed-cell, cross-linked, ethylene vinyl acetate, low density polyethylene copolymer, nitrogen blown foam material,
- b. has a minimum working range of 60% compression and 30% tension,
- c. meets or exceeds the requirements listed in Table 564.2.2:1 below,
- d. has 1/8 inch deep by 1/8 inch wide grooves spaced at 1/4 inch to 1/2 inch along both sides of the joint and running the entire length of the joint to increase bond surface area,
- e. is resistant to degradation due to ultraviolet radiation,
- f. is self extinguishing,
- g. is resistant to abrasion, oxidation, oils, gasoline, Road salts and other petroleum products that may be spilled on the surface.

Table 564.2.2:1
Minimum Requirements For Preformed Joint Sealer

Property	Requirement
Service Range	-94 – 160 degrees F
Tensile Strength	110 psi min
Elongation at break	235% min
Tear Resistance (ASTM D-624)	20 lb/inch min
Water Absorption (ASTM 3573, Suffix L)	0.035 psf max
Density	2.6 – 4.0 psf
Weathering (ASTM G-154)	3000 Hrs No Chalking, Flaking, Blistering, Checking, and Cracking
Recovery (ASTM D-545)	97% min
Compression / Deflection	
@25% Deflection of original width	10 psi
@ 59% Deflection of original width	20 psi

564.2.3 Bonder

Use a bonder that is a two (2) component, 100% solid epoxy adhesive designed to bond joint material to steel, cured concrete or wood, and is approved by the manufacturer.

564.2.4 Elastomeric Concrete

Use an elastomeric concrete that is mixed and applied according to the manufacturer's published recommendations and meets or exceeds the requirements listed in Table 564.2.4:1 below.

**Table 564.2.4:1
Minimum Requirements For Elastomeric Concrete**

Property	Reference	Requirement
Compressive Strength	ASTM D 695	2,600 psi
Tensile Strength	ASTM D 638	775 psi
Elongation at Break		150%
Hardness, Shore D	ASTM D 2240	59
Water Absorption	ASTM D 570	< one percent (1%)
Density		9.4 lb/gal
Slant Shear Bond Strength		
Concrete		250 psi min
Steel		250 psi min
Resilience @ 5% Deflection	ASTM D 695	90% min

564.2.5 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.

564.3 CONSTRUCTION REQUIREMENTS

564.3.1 General

Install the Joint sealant with a width 25% greater than the width of the joint opening at a near neutral condition (72 degrees F) according to the manufacturer's recommendations. Use the heat welding method for all directional changes in the joint sealant. Allow concrete to cure for 7 Days, before installing the sealing material. Have all joint systems pre approved by the Project Manager prior to placement. Use a Performance and Installation Enhancement (P.I.E.) bevel cut when the joint opening is greater than three (3) inches.

564.3.2 Technical Representative

Have the manufacturer's technical representative on site for the initial joint installation to assist and advise the construction personnel and ensure a satisfactory joint installation.

564.3.3 Manufacturer's Instructions

Provide a complete set of written joint installation instructions to the Project Manager at least 14 Calendar Days before installing the joints.

564.3.4 Priming

Prime all concrete or asphaltic surfaces prior to the placement of elastomeric concrete.

564.3.5 Existing or New Concrete To Concrete Joints

Clean surfaces of joint and remove debris. Sand blasting and/or mechanical abrasion of substrate may be required to remove debris. Place bonder and joint material against new or sound existing concrete.

564.3.6 Existing Concrete To Concrete or Concrete To Asphalt Joints

Remove unsound concrete or asphalt with a neat saw cut to a minimum size of two (2) inch depth and four (4) inches wide. Clean surfaces of joint and remove debris. Prime all surfaces with a primer acceptable to the manufacture and place elastomeric concrete. Place bonder and joint material against elastomeric nosing after it has cured to 80% of its final strength.

564.3.7 Protection of joints

Provide protection of the joint from construction traffic.

564.3.8 Warranty

In addition to the requirements of Section 106.11, "Guarantees and Warranties," provide a minimum five (5)-year warranty for the joint seals. Provide a warranty Surety bond on a Department-approved form for the total Bid Item amount for *Preformed Closed Cell Foam Bridge Joint Seals*. Use a Surety authorized to transact business in New Mexico and approved in the federal Circular 570 published by the United States Treasury Department. Provide all certifications required by the manufacturer necessary to sustain the manufacturer's warranty of the product to the Project Manager.

564.4 METHOD OF MEASUREMENT—RESERVED

564.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Preformed Closed Cell Foam Bridge Joint Seals</i>	Foot

564.5.1 Work Included in Payment

Evazote or equivalent joint systems; including material, labor, certifications, and all other costs associated with providing and installing of the joint systems; shall be included and no separate payment will be made therefor.

570.1 DESCRIPTION

This Work consists of supplying, constructing, and reconstructing pipe Culverts. Section 12 referred to below is from the AASHTO's *LRFD Bridge Design Specification*. Sections 26, 27 and 30 referred to below are from the AASHTO's *LRFD Bridge Construction Specification*.

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 ^a				
	Sub-drainage	Cross Drains	Turnouts	Storm Drains ^b	Siphons ^c
Metal (steel or aluminum or steel reinforced polyethylene)					
CMP	X	X	X	U	U
Spiral Pipe		X	X	X	U
Double Wall				X	U
Smooth FLO				X	U
Concrete Lined				X	U
Concrete					
Reinforced	X	X	X	X	U
Non-Reinforced ^d	X	X	X	X	U
Pressure					X
Cylinder					X
Cast in Place		X	X	X	U
Precast CBC ^h		X	X	X	U
Polypropylene					
Corrugated ^j	X	X	X	X	U
Triple wall ^k	X	X	X	X	U
Thermoplastic, high density polyethylene (HDPE)					
Pipe ASTM M252 ^d	X	U	U	U	U
Corrugated	X	X	X	X	U
Profile ^e	X	X	X	X	U
Solid	X			X	X
Thermoplastic, PVC					
Corrugated (in/out)	X	X	X	U	U
Profile ^f	X	X	X	X	U
Solid	X ^g			X	U
Pressure					X
Miscellaneous					
Ductile Iron					X

Table 570.2:1
Culvert Material Applications

Category/Material	Application ^a				
	Sub-drainage	Cross Drains	Turnouts	Storm Drains ^b	Siphons ^c
^a Primary Applications (Could be used in other applications as approved by the Project Manager)					
^b 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					
^c Must meet the pressure tight requirements of Section 570.2.2, "Joints"					
^d Must be approved by Project Manager					
^e Type S, Type D, or ASTM F 894					
^f ASTM F 794, F949, and ASTM F 1803					
^g Schedule 40					
^h For Precast box, refer to Special Provision 511 – F, if applicable					
ⁱ ASTM F2736 and MP-21-11					
^k ASTM F2764					
^x Normal Use					
^u Unacceptable					

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 (ANSI/AWWA)

Category/parameters	Material	Pipe	Design ^a	Installation ^a
Corrugated metal				
Galvanized	M 218	M 36	Section 12	Section 26
Aluminized, Type 2	M 274	M 36	Section 12	Section 26
Aluminum	M 196	M 196	Section 12	Section 26
Fiber-bonded	M 190, A	M 190, A	Section 12	Section 26
Polymeric	M 246	M 245	Section 12	Section 26
Coatings pavements and lining				
Asphalt coating	—	M 190, A	—	—
Concrete lined	—	M 36	—	—
Paved invert	—	—	M 190, B&C	—
Low n value	—	M 190, A	—	—
Reinforced concrete				
Round	—	M 170	Section 12	Section 27
Arch	—	M 206	Section 12	Section 27
Elliptically shaped	—	M 207	Section 12	Section 27
Reinforced D-load	—	M 242	Section 12	Section 27
Cylinder	—	C 303	AWWA M9	—
Pressure	—	C 302	AWWA M9	—
Non-reinforced concrete ^b				
<36 in	—	M 86	—	—
Cast-in-place concrete ^c	—	—	—	—
Polypropylene				

Table 570.2:2 Culvert Materials Specifications, AASHTO (ANSI/AWWA)				
Category/parameters	Material	Pipe	Design ^a	Installation ^a
Pipe 12 inch-- 30 inch	MP-21	MP-21	Section 12	Section 30
Pipe 36 inch – 60 inch	MP-21	MP-21	Section 12	Section 30
Thermoplastic, HDPE corrugated				
Pipe 3 inch–10 inch	—	M 252	—	—
Pipe 12 inch–60 inch	—	M 294	Section 12	Section 30
Thermoplastic, HDPE profile				
Profile 18 inch–120 inch	—	—	Section 12	Section 30
Thermoplastic, HDPE solid smooth				
Pipe 12 inch–60 inch	—	—	Section 12	Section 30
Thermoplastic, PVC profile				
Profile 4 inch–48 inch	—	M 304	Section 12	Section 30
Thermoplastic, PVC solid smooth				
Pipe 4 inch–15 inch	—	M 278	Section 12	Section 30
Pipe 18 inch–27 inch	—	—	Section 12	Section 30
Thermoplastic, PVC pressure				
Pipe 14 inch–36 inch	—	C 905	—	C 900 & M-23
Miscellaneous				

Ductile Iron Pipe

	ANSI/ AWWA C150/ A21.50	ANSI/ AWWA C150/ A21.50	C600
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Steel reinforced
Polyethylene Pipe
24 inch – 96 inch

D3350

^aInstall in accordance with Section 206, "Excavation and Backfill for Culverts and Minor Structures," Section 663, "Utility Items," for Pressure Pipe

^bMust be approved by Project Manager.

^cSee Section 572, "Cast-in-Place Concrete Pipe."

^dNMDOT approved thru 96 inch

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.

Table 570.2:3 Culvert Materials Specifications, ASTM (ACI)				
Category/parameter	Material	Pipe	Design	Installation ^a
Corrugated metal				
Galvanized	A 929	A 760	A 796	A 798

Table 570.2:3
Culvert Materials Specifications, ASTM (ACI)

Category/parameter	Material	Pipe	Design	Installation^a
Aluminized, Type 2	A 929	A 760	A 796	A 798
Aluminum	B 744	B 745	B 790	A 798
Fiber-bonded	A 885	A 760	A 796	A 798
Polymeric	A 742	A 762	A 796	A 798
Coatings, pavement, and lining				
Asphalt coating	—	A 849	—	—
Concrete lined	—	A 849	—	—
Paved invert	—	A 849	—	—
Low n value	—	A 849	—	—
Reinforced concrete				
Round	—	C76	—	C 1479
Arch	—	C506	—	—
Elliptically shaped	—	C507	—	—
Reinforced D-load	—	C655	—	C 1479
Cylinder	—	—	—	—
Pressure	—	C 361	C 361	—
Non-reinforced concrete^c				
<36 inch	—	C 14	—	C 1479
Cast-in-place Concrete ^d	—	ACI 346	—	—
Polypropylene				
Pipe 12 inch – 30 inch	F 2736	F 2736	—	D 2321
Pipe 36 inch – 60 inch	F 2881	F 2881	—	D 2321
Pipe 30 inch – 60 inch	F 2764	F 2764	—	D 2321
Thermoplastic, HDPE corrugated				
Pipe 3 inch–10 inch	D 3350, 335420C	—	—	D 2321
Pipe 12 inch–60 inch	D 3350, 324420C	—	—	D 2321
Thermoplastic, HDPE profile				
Profile 18 inch–120 inch	D 3350, 334433C	F 894 ^b	—	D 2321
Thermoplastic, HDPE solid smooth				
Pipe 12 inch–60 inch	D 3350, 335434C	F 714	—	D 2321
Thermoplastic, PVC profile				
Profile 4 inch–48 inch	D 1784, 12364C	F 794, F949, F 1803	—	D 2321
Thermoplastic, PVC solid smooth				
Pipe 4 inch–15 inch	D 1784, 12454	D 3034, F 679	—	D 2321
Pipe 18 inch–27 inch	D 1784, 12454	F 679	—	D 2321
Thermoplastic, PVC pressure				
Pipe 14 inch–36 inch	D 2241	—	D 3139	D 2321
Miscellaneous				
Ductile Iron Pipe	—	A716	A 746	—

**Table 570.2:3
Culvert Materials Specifications, ASTM (ACI)**

Category/parameter	Material	Pipe	Design	Installation ^a
Steel reinforced Polyethylene Pipe				
24 inch – 96 inch	D3350	F2562	---	D 2321

^aInstall in accordance with Section 206, "Excavation and Backfill for Culverts and Minor Structures," Section 663, "Utility Items," for Pressure Pipe.

^bUse R. S. C. = 100 and 160 only.

^cMust be approved by Project Manager.

^dSee Section 572, "Cast-in-Place Concrete Pipe."

570.2.1 Pipe

570.2.1.1 Metal Pipe

Provide helical corrugated pipe that have re-rolled ends with at least two (2) annular corrugations. If using stab joints, only one (1) end may have a factory attached coupling as 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 inch.

Use pipe with gasketed lock seams and re-rolled ends for watertight installations. Joints must meet the requirements per Section 570.2.2.1.2.

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 (2) 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 (2) 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 two percent (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 out of state RCP Suppliers shall arrange for witnessed plant tests at no additional cost to the Department. 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.

Provide test reports and certification for in plant joint tests required by Section 570.2.2.1.2.

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 or elliptical pipe equal to the nominal round pipe.

570.2.2 Joints

Select the appropriate joint in accordance with Table 570.2.2:1, "Joint Selection."

Table 570.2.2:1 Joint Selection				
Type of pipe Structure	Soil-tight	Water-tight	Pressure Tight	Restrained
Culverts under turnouts (not under Road)	X			
Cross drain Culverts	X			
Elbowed drop Culverts		X		X ^{a, c}
Storm drains		X ^b		
Rundowns or downdrains ^a		X		X ^{a, c}

**Table 570.2.2.1
Joint Selection**

Type of pipe Structure	Soil-tight	Water-tight	Pressure Tight	Restrained
Pond outlet pipes and risers		X		
Irrigation pipe (non-pressure)		X ^b		
Irrigation siphons and sag pipes (pressure)			X	

^aUse where pipe slopes are steep (>10%) and or velocities are high.

^bElliptical 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.

^cRCP 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 ten (10) min under testing conditions as outlined in the appropriate product ASTM specification.

When plant tested, the appropriate product joint shall meet the requirements of ASTM D 3212 (thermoplastic or steel reinforced **polyethylene**), ASTM C 443/C 497 (concrete) or ASTM-A760 (metal).

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 & 30, for standard joints in non-erodible soils.

**Table 570.2.2.1.3:1
Pressure-Tight Joint Materials**

Material	NMSSPWC Section
Polyvinyl chloride	121 (AWWA C 905)
Reinforced concrete	124 (ASTM C 361M)
Concrete cylinder	128 (AWWA C 303)
Ductile iron	129 (ANSI/AWWA C150/A21.50)
Ductile and cast iron fittings	130 (ANSI/AWWA C153/A21.53 & ANSI/AWWA C111/A21.11)
Solid wall HDPE	ASTM F 714

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

If the Contract specifies soil-tight joints, factory-attached metal or plastic stab joints with modified gaskets, hugger-type bands without gaskets or fully corrugated bands without gaskets can be supplied.

If the Contract specifies watertight joints, the requirements of Section 570.2.2.1.2, "Watertight Joints" must be met, which shall include the following: Factory-attached metal or plastic stab joints with modified gaskets, or hugger-type bands with lubed o-ring gaskets, is watertight when backfilled with flowable fill. With round pipe a minimum of 5C fully corrugated bands (13" wide) with a lubed, 12" wide, closed cell neoprene flat gasket is watertight without flowable fill. With pipe arch a minimum of 5C fully corrugated bands (13" wide) using rods and lugs with a lubed, 12" wide, closed cell neoprene flat gasket is watertight without flowable fill.

If the Contract specifies restrained joints all pipe affected will use rods and lugs.

570.2.2.2.2 RCP Joint Material

Provide flexible watertight sealing gaskets in accordance with ASTM C 443, ASTM C 877, or AASHTO M 198 for watertight applications.

Provide external sealing bands in accordance with ASTM C 877 for arch and elliptical pipe in watertight applications.

Provide closed-cell neoprene gaskets in accordance with ASTM D 1056 and AASHTO M 198, Type B when required on the Contract.

Provide butyl rubber mastic sealant in accordance with AASHTO M 198 for soil-tight applications for round, arch, and elliptical concrete pipe.

Grout watertight and pressure-tight joints as directed by the Project Manager.

570.2.2.2.3 Thermoplastic and Steel Reinforced Polyethylene 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.

570.2.2.2.4 Thermoplastic (Polypropylene) Joint Material

Provide bell and spigot joints in accordance with ASTM D3212 and ASTM F477. Spigot shall have two (2) gaskets installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. The bell shall be reinforced with a polymer composite band installed by the manufacturer.

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 570.2.3.1:1
Pipe Culvert Durability**

Type of pipe	Corrosion resistance number						
	CR1	CR2	CR3	CR4	CR5	CR6	CR7
Galvanized steel	Yes	No	No	No	No	No	No
Aluminized steel, Type 2 ^a	Yes	Yes	Yes	Yes	No	No	No
Aluminum alloy	Yes	Yes	Yes	Yes	Yes	No	No
RCP, Type II cement ^b	Yes	Yes	Yes	Yes	Yes	Yes	No
Polymeric coated steel	Yes	Yes	Yes	Yes	Yes	Yes	No
Aramid fiber bonded steel	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Thermoplastic ^c	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Steel reinforced and non-reinforced polyethylene pipe	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCP Type V cement ^b	Yes	Yes	Yes	Yes	Yes	Yes	Yes

^aThe 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.

^bCement type based on Section 510, "Portland Cement Concrete." If pH ≤ 5.0 , use a rapid chloride permeability $\leq 1,200$ coulombs.

^cCell 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.

570.2.3.3 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 inch 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*, Section 26 for metal pipe and steel reinforced polyethylene pipe; Section 27 for RCP; and Section 30 for thermoplastic pipe. Refer to NMDOT 206 Standard Drawings for additional pipe installation requirements.

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 inch.

Make watertight joints with the following:

1. Cement grout;
2. Flexible watertight gaskets;
3. External sealing bands; or
4. Any combination of these types.

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.

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.

Make water tight joints using a bell and spigot conforming to ASTM D3212 and F477. Push spigot into bell end so spigot reaches homing mark on bell end.

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 pipe is installed in full compliance with AASHTO's *LRFD Bridge Construction Specification*, Section 26 (metal and steel reinforced polyethylene pipe), Section 27 (RCP) or Section 30 (thermoplastic) requirements.

For thermoplastic pipe, provide the Department with the results of the deflection test detailed in Section 30 of AASHTO's *LRFD Bridge Construction Specification* 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—Reserved

570.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Culvert Pipe</i>	Foot
<i>Culvert Pipe End Section</i>	Each
<i>Culvert Pipe Arch</i>	Foot
<i>Culvert Pipe Arch End Section</i>	Each
<i>Storm Drain Culvert Pipe</i>	Foot
<i>Storm Drain Culvert Pipe End Section</i>	Each
<i>Storm Drain Culvert Pipe Arch</i>	Foot
<i>Storm Drain Culvert Pipe Arch End Section</i>	Each
<i>Siphon Culvert Pipe</i>	Foot
<i>Reinstalling Culvert Pipe</i>	Each

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 Culvert pipe cleaning in accordance with Section 613, "Cleaning of Culverts and Drainage Structures" when specified on the Plans.

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 571.1:1
Structural Plate Specifications: AASHTO

Category/parameter	Material	Design ^a	Installation ^b	Backfill
Structural plate				
Galvanized	M 167	Sect. 12	Sect. 26	M 145
Aluminum	M 219	Sect. 12	Sect. 26	M 145
Box Culvert				
Aluminum	M 219	Sect. 12	Sect. 26	M 145
Galvanized	M 167	Sect. 12	Sect. 26	M 145
Coatings, pavements, and linings				
Asphalt coating	—	—	M 243M	—
Paved invert	—	—	—	—

^aAASHTO LRFD Bridge Design Specifications

^bAASHTO LRFD Bridge Construction Specifications

Table 571.1:2
Structural Plate Specifications: ASTM

Category/parameter	Material	Design	Installation	Backfill
Structural plate				
Galvanized	A 761	—	A 807	—
Aluminum	B 746	B 790	B 789	—
Box Culvert				
Aluminum	B 864	—	B 789	—
Galvanized	A 964	—	A 807	—
Coatings, pavements, and linings				
Asphalt coating	—	—	A 849	—
Paved invert	—	—	A 849	—
Nuts and bolts				
Galvanized plate	A 449	—	—	—
Aluminum plate	A 307 or A 449 & A 153	—	—	—
Aluminum box Culvert	A 307 or A 449 & A 153	—	—	—

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 167.

Provide aluminum structural plates in accordance with AASHTO M 219.

571.2.3 Fasteners

Provide fasteners for steel structural plates in accordance with AASHTO M 167.

Provide fasteners for aluminum plate Structures in accordance with AASHTO M 219.

571.2.4 Asphalt Coating

If required, protect structural plate Structures with asphalt coating in accordance with AASHTO M 190. Provide field-applied coatings in accordance with AASHTO M 243.

Coat the fasteners extending outside of the pipe after installation. The Contractor may leave the portions of the fasteners extending inside the pipe uncoated.

571.2.5 Design and Certification Requirements

571.2.5.1 Design

The Contractor is responsible for the structural and foundation designs of metal box Culverts and other structural plate Structures. Geotechnical soils data and hydraulic scour depths will be provided by NMDOT. Design structural plate Structures in accordance with Section 10 and 12 of AASHTO's *LRFD Bridge Design Specification*.

At least 30 Days before beginning fabrication, submit to the State Bridge Engineer three (3) sets of the following Stamped by a New Mexico Professional Engineer:

1. Complete design calculations;
2. Shop drawings; and
3. Construction details and installation instructions for long-span structural plate Structures and metal box Culverts.

New Mexico Professional Engineer Stamp and foundation designs are not required for Structural plate Structures with structural inverts under 18 feet maximum. The State Bridge Engineer will return one (1) set, with notations, to the Contractor. Make the appropriate corrections and resubmit eight (8) 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 167 for Steel Structural Plates or Section 11 of AASHTO M 219 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 (3) plates come together at one (1) point.

Assemble structural plate Structures using bolts with a minimum 3/4 inch 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 two percent (2%) of the longest dimension (span or rise) or five (5) inches, whichever is less. However, only apply the two percent (2%) restriction for horizontal ellipse shapes having a ratio of top to side radii of three (3) or less. When the rise of arches with a ratio of top to side radii of three (3) or more, ensure that they do not vary from the specified dimension by more than one percent (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 manufacturer's 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 571.3.5:1
Electrochemical Criteria**

Type of Material	pH	Resistivity, ohm-cm	Soluble salts, SO₄, % by weight
Galvanized steel 2 oz. coating	5.8–8.0	>2,000	0.05
Galvanized steel 3 oz. coating	5.0–10.0	>2,000	0.05
Asphalt coating	^a	>2,000	0.075
Aluminum plate	4.0–9.0	>500	0.125

^aLower the pH range of the galvanized pipe by one (1).

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 (Modified Proctor), Method D (TTCP Modified).

To avoid damaging the Structure, compact the initial two (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 (2) 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 four (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 167 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—Reserved

571.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Structural Plate Pipe</i>	Foot
<i>Structural Plate Pipe Arch</i>	Foot
<i>Metal Box Culvert</i>	Foot

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. On site inspection by manufacturer's representative;

- F. Repair of protective coating; and
- G. Coating of the Structures.
- H. Shallow or deep foundation elements.

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, fly ash, 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 572.2:1
Slump Requirements

Pipe diameter (in)	Slump (in)
<42	2.5 ± 1.5
42–72	2.5 ± 1.0
>72	2.0 ± 0.5

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

Inside diameter, D	Outside diameter, D'	Width of pipe trench, B	Wall thickness, t
24	30	31	3
27	33	34	3
30	36	37	3
36	43	44	3.5
42	50	51	4
48	58	59	5
54	65	66	5.5
60	72	73	6
66	79	80	6.5
72	86	87	7
78	91	92	7.5
84	100	101	8
96	114	115	9
108	129	130	10.5
120	144	145	12

Note: All dimensions are in inches.

572.3.6 Tolerances and Geometry

Grade and alignment:

1. Departure from and return to established grade shall not exceed one (1) inch per ten (10) linear feet (25mm per 3 m). Maximum departure shall be limited 1 ½ inch (40 mm).
2. Departure from and return to established alignment shall not exceed two (2) inches per ten (10) linear feet (50 mm per 3 m). Maximum departure shall be limited to four (4) inches (100 mm).

572.3.7 Wall Thickness

Wall thickness shall be as shown in Table 572.3.5:1. Grade and alignment shall be controlled so that thicknesses of the pipe wall are symmetrical.

572.3.8 Pipe Diameter Tolerances

Internal diameter of pipe at any point shall not be less than 98% of the design diameter.

572.3.9 Excavation and Backfill

Excavate and backfill in accordance with Section 206, "Excavation and Backfill for Culverts and Minor Structures," except as modified in Section 572.3.9.1, "Trench Excavation."

572.3.9.1 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 95% of the maximum dry density if tested in accordance with ASTM D 698.

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 95% of the maximum dry density in accordance with ASTM D 698.

If boulders or rocks are in the bottom or sidewalls of the trench, remove them to at least six (6) inches 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 inch 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.

572.3.10 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 neither drawing moisture from the freshly placed concrete nor expanding upon additional wetting.

Place the concrete around the full circumference of the pipe monolithically in one (1) 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.

572.3.10.1 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 inch 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 inch.

Ensure that the flow line of the finished pipe does not vary more than 0.125 ft from the specified grade.

572.3.10.2 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 inches long into the ends of the pipe walls. Space the reinforcing bars at 12 inches on center for pipes with diameters 42 inches and smaller, and at 18 inches on center for pipes with diameters larger than 42 inches.

Within 30 minutes before pipe casting resumes, pipe end surface shall be thoroughly cleaned of foreign Materials, coatings, and loose or defective concrete, and thoroughly wetted. A tie-in cap shall be cast over joint across the top of pipe from trench wall to trench wall. The tie-in cap shall be 24 inches minimum in length and centered over the joint. Thickness shall be 1.5 times minimum wall thickness, shown in Table 572.3.5:1.

572.3.10.3 Collar

Joint for connections to another pipe or structure shall be made by squaring off the end of pipe. Excavation of the trench shall be made along the sides and bottom of the pipe to permit casting of concrete collar. Collar shall be 24 inches minimum in length and centered on joint. Thickness shall be 1.5 times the minimum wall thickness shown in Table 572.3.5:1.

572.3.10.4 Cover and Backfill

Ensure that the cover, measured from the top of the pipe to the bottom of the surfacing, is not less than 24 inches. Do not place backfill on pipes until the concrete has developed a compressive strength of at least 2,500 psi.

572.3.10.5 Temperature

Refer to Section 511.3.3, "Temperature and Weather Limitations."

572.3.10.6 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 three (3) inches 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 seven (7) Days after placement. However, do not exceed the maximum period of 24 h for removing forms and making repairs. Take measures to prevent air drafts from drying pipe. 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.

572.3.11 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 inch, for pipes with internal diameters of 42 inches or less;
2. Larger than 0.38 inch, for pipes with internal diameters from greater than 42 inches to less than 72 inches;
3. Larger than 1/2 inch, for pipes with internal diameters of 72 inches and greater.

Repair defects not extending through the pipe wall and less than two (2) ft², as directed by the Project Manager. Repair holes cut in the pipe, as directed by the Project Manager.

572.3.11.1 Crack Repairs

Perform interior crack repairs after backfilling.

Clean and fill transverse cracks with a width of 0.05 inch or more with an elastomeric compound approved by the Project Manager. Ensure that the elastomeric compound

penetrates into the crack at least 0.37 inch.

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 inch;
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 inch, 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 pressure grouting.

572.3.11.2 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 two (2) ft² (pipe may be rejected for one (1) foot 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.

572.3.11.3 Verification of Wall Thickness

If requested by the Project Manager, drill four (4) ¾ inch diameter holes at approximately 20-foot intervals, in the walls of the pipe to verify thickness. Drill one (1) hole in the top, one (1) hole in the bottom, and one (1) 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.

572.3.12 Field Quality Control

572.3.12.1 Load Tests

Load tests shall be performed when required by Contract documents. Test load applied to the top of pipe shall be at least 125% of the maximum earth load plus live load to which the pipe will be subjected. The pipe shall be inspected before and after load testing. Load tests shall be made without disturbing the earth supporting the lower 230 degrees of pipe. The test load shall be applied in accordance with 572.4.1.1 or 572.4.1.2.

572.3.12.2 Sandbox Test

Load shall be applied to a four (4) ft (1.2 m) length of pipe through a sandbox in such a manner that sand forms a bedding over 1/4 the circumference of the pipe, measured at the centerline of the crown. Sandbox shall be made of metal or dressed timber so heavy as to avoid appreciable bending by side pressure of sand. A strip of cloth or plastic film may be attached to the inside of the sandbox on each side, along the lower edge, to prevent the escape of sand between the sandbox and pipe. Depth of bedding above the pipe at the thinnest point shall be 1/4 the inside diameter of the pipe. Sandbox shall not contact pipe or sides of trench. Sandbox shall be filled with clean sand containing not less than five percent (5%) moisture and passing a 4.75 mm (No. 4) sieve. Upper surface of sand shall be struck off level with a straight edge and covered with a rigid top bearing plate. Lower surface of the

plate shall be a true plane made of heavy timbers or other rigid material capable of distributing the test load uniformly without appreciable bending. Test load shall be applied to the bearing plate by piling weights directly on the bearing plate or by moving heavy Equipment of predetermined weight onto the bearing plate. The bearing plate shall not be allowed to touch the sandbox.

572.3.12.3 Wheel Load Test

A wheel load equivalent to the test load shall be applied to pipe. Two (2) feet of compacted fill shall be maintained between pipe and wheel load.

572.3.12.4 Hydrostatic Test

When required by Contract documents, a hydrostatic test shall be made on completed pipe at any time after the concrete has reached design strength. Pipeline shall be filled with water to the design head above inside pipe crown and kept filled for a minimum of 48 h before the test. Line may be filled in one (1) length or between bulkheads or Structures. Water used shall have a temperature above 50 F. Test shall be for a period of four (4) h. Exfiltration rate shall not exceed 1000 gal per inch diameter per mi per 24 h (927 L per 10 mm of diameter per km per 24 h).

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

Pay Item	Pay Unit
<i>Cast-in-Place Concrete Pipe</i>	Foot

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—RESERVED

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 one (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.

601.3.5 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.

601.3.6 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.

601.4 METHOD OF MEASUREMENT—RESERVED

601.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Removal of Structures and Obstructions</i>	Lump Sum
<i>Removal of Surfacing</i>	Lump Sum or Square Yard
<i>Demolition</i>	Lump Sum

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**

CLASS	DESCRIPTION	Stone volume (ft ³)		Minimum dimension (in) ^a
		Minimum	Maximum	
A	Wire enclosed riprap	1/6	2/3	4
B ^b	Non-enclosed riprap	1	2	6
C ^b	Non-enclosed riprap	2	4	9
D	Derrick stone	14	27	12
E	Grouted riprap	1/3	1	3
F	Grouted riprap	1	2	6
G	Rock plating	—	—	4–8 ^c
N/A	Wrapped rockfacing	—	—	1
N/A	Gabions	—	—	4–8 ^c

^aMinimum size in the least dimension.

^bClass B and C stone — at least two (2) Fractured Faces.

^c70% to 80% of the stone — at least four (4) inches but not more than eight (8) inches in the smallest dimension. 30 to 20% of the stone — no larger than four (4) inches 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 foot.

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.

602.2.2.2.2 Mesh Openings

Ensure that mesh openings are uniform and hexagonal. Make mesh openings for riprap and double-twisted gabions approximately 3 1/4 inch × 4 3/4 inch, and for double-twisted revetment mattresses approximately 2 1/2 inch × 3 1/4 inch. Make mesh openings for welded wire mesh gabions approximately three (3) inch × three (3) inch, and for welded wire mesh revetment mattresses and wrapped rock faces approximately 1 1/2 inch × three (3) inch.

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 inch.

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 inch. Provide tie wire for double-twisted gabions and revetment mattresses with a diameter of at least 0.087 inch. Provide tie wire for riprap with a diameter of at least 0.120 inch. 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 inch. Unless otherwise approved, provide spiral binders with a maximum inside diameter of 2 1/2 inches and with a maximum pitch of three (3) inches.

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 602.2.2.5, "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.

Provide a description of the fastener, with drawings and photographs showing the number of fasteners required, details of the fasteners, and load capacities. In addition:

1. Lock and close each interlocking fastener. For gabions, use fasteners in every other opening. For revetment mattresses and wrapped rock faces, use fasteners in every opening; and
2. Close each overlapping ring fastener and overlap ends a minimum of one (1) inch. Provide one (1) ring for each opening.

The Department will allow this fastener for forming individual baskets, but not for interconnecting baskets.

602.2.2.2.9 PVC Coating

Provide PVC coating with an average thickness of 0.0216 inch and a minimum thickness of 0.0150 inch 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 (2) identical rectangular panels along a selvedge wire, each about 10 1/2 mesh-openings wide. Attach the two (2) panels along the two (2) selvedge wires using the proposed fastener system. If the Contractor uses alternative fasteners to join two (2) individual gabion baskets, the Contractor shall include two (2) additional selvedge wires (each mechanically wrapped with mesh wires) so that each fastener contains two (2) selvedges and

two (2) 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 (2) joined selvage wires exceeds two (2) inch. 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 four (4) inches. Use steel angles that are at least four (4) x four (4) x 3/8 inch.

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 one (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 (1) of the following mixes:

1. One (1) part cement to three (3) 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 (3) 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.

602.2.3.2 Portland Cement

Provide portland cement in accordance with Section 509, "Portland Cement Concrete Mix Designs."

602.2.3.3 Aggregate

Provide fine aggregate in accordance with Section 509, "Portland Cement Concrete Mix Designs."

602.2.3.4 Steel Anchorage

Provide steel staples in accordance with Section 540, "Steel Reinforcement." Use steel staples either epoxy coated in accordance with AASHTO M 284, or galvanized in accordance with ASTM A 153.

602.2.4 Concrete Block Revetment

Provide concrete block revetment products from the Department's *Approved Products List*. Provide concrete block units compatible with the geotextiles being used and with a minimum compressive strength of 3,000 psi, 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 inches. 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 three (3) inches from the specified slope; and derrick stone riprap varies no more than eight (8) inches from the specified slope.

Unless otherwise specified, place the riprap foundation course in a trench excavated to 24 inches 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 (4) 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 (1) part portland cement and three (3) parts fine aggregate (by volume). Mix with water to a workable consistency.

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 inches.

Space galvanized wire ties connecting top and bottom mesh layers approximately 24 inches 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 inches 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 (3) 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 \pm five percent (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. Selvages 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 (1) 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 six (6) in of the gabion foundation to at least 95% of maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified), 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 nine (9) inch to 12 inch. Minimize local deformations by not filling a gabion more than 12 inches higher than an adjacent gabion. Hand place stone at exposed surfaces.

Provide cross-connecting wires on gabions with cells 18 inches or higher. Place cross connecting wires directly above each layer of stone. Equally space and tightly tie two (2) connecting wires in each direction for each layer through two (2) 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 \pm 0.2 ft of the specified grade and slope.

Place the foundation course 18 inches 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 inches 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

Pay Item	Pay Unit
Riprap Class____	Cubic Yard
<i>Riprap Class G</i>	Square Yard
<i>Sacked Concrete Revetment</i>	Cubic Yard
<i>Concrete Block Revetment</i>	Square Yard
<i>Gabions</i>	Cubic Yard
<i>Revetment Mattresses</i>	Cubic Yard
<i>Wrapped Rockfacing</i>	Square Yard

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 preparing a Storm Water Pollution Prevention Plan (SWPPP), and constructing, inspecting, and maintaining erosion, sediment control, and storm water pollution prevention facilities for the discharge of storm water associated with construction activity. This Work includes construction phase activities through final stabilization.

603.1.1 Storm Water Pollution Prevention Plan

The Storm Water Pollution Prevention Plan (SWPPP) must satisfy the requirements of the current Construction General Permit and must contain the following sections, forms, and information sheet:

SWPPP REQUIRED SECTIONS

1. Storm Water Team;
2. Nature of Construction Activities;
3. Emergency Related Projects (if applicable);
4. Identification of Other Site Operators;
5. Sequence and Estimated Dates of Construction Activities;
6. Site Map;
7. Construction Site Pollutants;
8. Non-Storm Water Discharges;
9. Buffer Documentation;
10. Temporary Erosion and Sediment Control Plan and Description of Storm Water Control Measures (Construction Phase & Final Stabilization);
11. Pollution Prevention Procedures;
12. Procedures for Inspection, Maintenance, and Corrective Action;
13. Staff Training;
14. Documentation of Compliance and Other Federal Requirements;
15. SWPPP Certification; and
16. Post-Authorization Additions to the SWPPP.

SWPPP REQUIRED 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*.

An information sheet provided by the NMDOT provides the following:

1. A site description;
2. NOI inputs;

3. Drainage parameters;
4. Runoff, discharge, and volume calculations; and
5. 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 Construction General Permit, issued by the EPA, requires a SWPPP and submittal of the NOI for construction Projects with 1 acre or more of earth disturbance as defined in the NPDES Construction General Permit.

603.1.1.1 Temporary Erosion and Sediment Control Plan

The Final Stabilization Temporary Erosion and Sediment Control Plan (TESCP) prepared by the Department 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 sheets at final placement prior to seeding operations. For more details on the Final Stabilization TESCP, see Section 603.1.1.2, "Department Responsibilities."

The Construction Phase Temporary Erosion and Sediment Control Plan (TESCP) prepared by the Contractor depicts the location, type, and length of temporary erosion control measures, off-site flows, discharge locations, and flow paths within the Work area of the Right of Way on construction phasing plan sheets. For more details on the Construction Phasing TESCP, see Section 603.1.1.3, "Contractor Responsibilities."

603.1.1.2 Department Responsibilities

The Department will prepare and include in the Plans a Final Stabilization TESCP, a Re-vegetation/Erosion Control Plan, and a SWPPP information sheet. The Final Stabilization 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 outside of the Right of Way.

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. Total site area;
3. Total disturbed area;
4. Runoff coefficient for pre/post construction;
5. Receiving waters;
6. Latitude and longitude of the site;
7. Estimate of likelihood of discharge;
8. Endangered species or critical habitat;
9. Part 3 of the NPDES General Permit, Water Quality-Based Effluent Limitations;
10. Basic drainage and site information required for SWPPP development;
11. MS4 areas; and
12. 303d impaired list.

603.1.1.3 Contractor Responsibilities

Before disturbing any soil, the Contractor shall prepare and submit to the Project Manager a Contractor developed SWPPP based on the planned construction phasing and schedule. The Contractor shall prepare amendments to the SWPPP as Work progresses or as phasing or scheduling changes are made. Specifically, the Contractor shall prepare a Construction Phase TESC for each construction phase, complying with provisions of the NPDES Construction General Permit, and include at least the following items or activities:

1. Develop the SWPPP using a combination of structural, non-structural, and vegetative best management practices (BMPs) appropriate for the identified location to control erosion and sedimentation and manage storm water during construction activities.
2. 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.
3. Do not start earth—disturbing activities until the Contractor developed SWPPP has been submitted and the NOI is active.
4. 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.
5. 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.
6. Maintain the SWPPP in accordance with the NPDES Construction General Permit until final grading, erosion control, and seeding operation completion.

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 a copy of the electronic NOI (eNOI) 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 eNOIs to the EPA, designating the status of owner/operator. Do not begin earth-disturbing activities until the eNOIs are listed on the EPA website as “active.” The EPA will post eNOI approvals on their website. The Contractor shall submit a copy of the Contractor’s eNOI 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 the NMDOT. Provide a copy of the submittal to the Project Manager.

603.1.5 Off-Site Pollution Prevention Plan

Prepare and submit a SWPPP, eNOI, and NOT, if required, to appropriate agencies for Work performed outside the Project Right of Way. The Contractor is responsible for all associated NPDES requirements for the off-site locations. Comply with NPDES requirements for off-site locations. Provide a copy of each off-site 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 any of 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 (as required by the General Permit); or
3. Fails to document, in a Corrective Action Report (as required by the General Permit), field changes of erosion control measures as directed in writing by the Project Manager.

**Table 603.1.6:1
Schedule of Liquidated Damages**

Total Original Contract Amount (\$)	Charge (\$) per Day
≤2,000,000	500
>2,000,000–5,000,000	1,000
>5,000,000–10,000,000	1,500
>10,000,000	2,000

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, the Contractor shall reimburse the Department within ten (10) Days of the assessment. If the Contractor does not reimburse the Department within the ten (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, sediment control, and storm water pollution prevention 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 specified in the Contract and approved by the Project Manager.

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, "Revegetation" 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 one (1) inch and shall not exceed three (3) inches in diameter; shavings shall not be more than five percent (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 inch 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 nine (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 per the accepted Contractor developed SWPPP.

Install temporary erosion and sediment control features and maintain until final grading, erosion control, and seeding operations completion.

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 Contractor developed SWPPP for this review.

Coordinate the placement and maintenance of the temporary and permanent erosion and sediment control measures shown in the Contractor developed SWPPP.

The Department will assess liquidated damages, in accordance with Section 603.1.6, "Liquidated Damages," if the Contractor begins earth-disturbing Work before the following:

1. Submission of the eNOI and obtaining notification of permit coverage; or
2. Placing erosion control measures.

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.

The Contractor shall provide the necessary buffer protection for adjacent surface waters as required by the General Permit.

603.3.3 Temporary Soil Stabilant Application

Apply temporary soil stabilant to exposed areas not being worked. Begin stabilization within 1 Work Day after Work ceases, unless construction resumes within 14 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.

Reapply stabilant to areas of continued erosion and Contractor activity within four (4) 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 remaining vegetation, 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 two (2) inch by two (2) inch 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 sediment 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 SWPPP Inspection and Maintenance

Inspect and maintain the Project site for NPDES compliance during the Project. Inspect and maintain installations at the following frequencies, per the General Permit:

1. At least once every seven (7) Calendar Days; or
2. once every 14 Calendar Days and within 24 hours of a 0.25 inch or greater rainfall event; or
3. for Arid, Semi-Arid, or Drought-Stricken Areas. The Contractor may reduce the frequency of inspections to once per month and within 24 hours of the occurrence of a storm event of 0.25 inches or greater if your site is located in an arid, semi-arid, or drought-stricken area, as these terms are defined in Appendix A of the Construction General Permit, and construction is occurring during the seasonally dry period or during a period in which drought is predicted to occur. The Contractor must document that they are using this reduced schedule and the beginning and ending dates of the seasonally dry period in the SWPPP.

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 *SWPPP Inspection 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 (3) 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 and Maintenance

The Department will reimburse the cost to prepare the SWPPP, prepare and install all BMPs for the Construction Phase TESCP, and maintain the Construction Phase TESCP BMPs under pay item SWPPP Plan Preparation and Maintenance.

603.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Silt Fence</i>	Linear Foot
<i>Check Dam Type _____</i>	Linear Foot
<i>Earth Dike</i>	Linear Foot

<i>Pipe Slope Drain</i>	Linear Foot
<i>Sediment Trap</i>	Cubic Yard
<i>Soil Retention Blanket</i>	Square Yard
<i>Temporary Soil Stabilant</i>	Acre
<i>Culvert Protection</i>	Square Yard
<i>Drop Inlet Protection Type _____</i>	Each
<i>SWPPP Plan Preparation and Maintenance</i>	Lump Sum
<i>Mulch Socks</i>	Linear Foot
<i>Composted Mulch Socks</i>	Linear Foot

SWPPP Plan Preparation and Maintenance includes SWPPP preparation, BMPs, installation of BMPs, 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 temporary erosion and sediment control 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;
- G. Removal and replacement of the measure at the same location due to construction; and
- H. Relocation of BMPs during phasing and final placement.

603.5.2 Partial Payments

The Department will make an initial partial payment for *SWPPP Plan Preparation and Maintenance* upon receipt and Acceptance of the Contractor SWPPP based on the following equation:

$$P_1 = L \times 0.20 \quad (1)$$

Where,

P_1 is the initial partial payment upon receipt and approval of Contractor SWPPP.

The Department will make monthly partial payments for *SWPPP Plan Preparation and Maintenance* 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:

$$P_2 = [(A \times L)/B] - C \quad (2)$$

Where,

- P₂ is the partial payment during the progress of the Project
- L is the Total Bid Amount for *SWPPP Plan Preparation and Maintenance*
- 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.

604.1 DESCRIPTION

This Work consists of providing and installing geotextiles.

604.2 MATERIALS – RESERVED**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 604.2.1:1
Cross Reference of Old Classes to New Classes of Geotextiles

Geotextile	Old class	New class
Subsurface drainage	A or B	2 or 3
Sediment control	B	2
Erosion control	C or D	1 or 2
Separation	C or D	2 or 3
Stabilization	None	1

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 one (1) inch diameter or greater, or require a depth of trench greater than six (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 ten (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 three (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
Required Class of Separator Geotextile and Cover Thickness for R-values Greater Than or Equal to 20

Required minimum cover thickness, compacted	Required class of geotextile
6 inch.	2
12 inch.	3

Do not use aggregate larger than one (1) inch.

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 ten (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

Soil strength (CBR)	Corresponding R-value
1	10
2	15
3	20

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 six (6) inches of cover Material on the geotextile. Do not allow vehicles to turn on the cover Material until at least two (2) 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 six (6) inches to eight (8) inches deep (uncompacted) unless otherwise specified in the Contract. After placement, compact each lift to 95% of maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified). 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 (1) 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 (PI).

Compact the aggregate with vibratory Equipment to a minimum compaction of 95% of maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified). 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		
Soil strength R-value	Un-sewn seams overlap (inch)	Sewn seams overlap (inch)
<10	—	9
10–15	40	8
15–20	30	3
>20	24	—

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 (1) layer at geotextile overlaps.

604.5 BASIS OF PAYMENT

Pay Item	Pay Unit
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<i>Geotextile Class</i>	Square Yard
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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 one (1) inch 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 up grade. 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 inches 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 than six (6) inch layers of loose thickness. Compact each layer of impermeable Material to at least 95% of maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified).

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—RESERVED

605.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Underdrains</i>	Linear Foot
<i>Vertical Drains</i>	Linear Foot
<i>French Drains</i>	Linear Foot

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.

SECTION 606: METAL AND CONCRETE WALL BARRIER

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.

Use Materials for metal barrier installations in accordance with *A Guide to Standardized Highway Barrier Hardware*, 1995, AASHTO-AGC-ARTBA Report.

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 (4) 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 $\pm 1/4$ inch of specified dimensions. Only use one (1) combination of post and block for any one (1) continuous length of barrier.

Use straight posts, without defects, that do not vary more than one (1) inch 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 five percent (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 AWPAC14.

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, 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 the Contract and the Department's most recent "Approved Products List."

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 (1) continuous piece of Type VII reflective yellow sheeting with three (3) inch strips of black tape, spaced 2 3/4 inch 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 inches of the HMA grade. Fill, compact, and crown the remaining depth of the hole with asphalt Material or cold mix. Crown shall not exceed two (2) inches. 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
Required Guide Hole Diameter**

Type	Maximum diameter
Round wood	Diameter of post
Square wood	Dimension of side
Steel shape	Dimension of least side

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 (2) 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 inch. 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.

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 six (6) inch lifts and rod each lift to within two (2) inches 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 two (2) inches 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 four (4) inches 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.

Provide manufacturer certification at the Project Manager's request. Also, have the manufacturer's representative present for final approval of the metal barrier end treatment installation.

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 inches 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

Pay Item	Pay Unit
<i>Metal Barrier W-Beam</i>	Linear Foot
<i>Metal Barrier Thrie Beam</i>	Linear Foot
<i>Metal Barrier End Treatment</i>	Each
<i>Weathering Metal Barrier W-Beam</i>	Linear Foot
<i>Weathering Metal Barrier Thrie Beam</i>	Linear Foot
<i>Concrete Wall Barrier</i>	Linear Foot
<i>Temporary Concrete Wall Barrier</i>	Linear Foot
<i>Resetting of CWB</i>	Linear Foot
<i>State-Furnished CWB</i>	Linear Foot
<i>Temporary CWB Retained by the Contractor</i>	Linear Foot
<i>Concrete Wall Barrier (Modified)</i>	Linear Foot
<i>Concrete Wall Barrier (Half Section)</i>	Linear Foot

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 inch layer of bituminous material for the 1:10 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 (2) coated wires with diameters of 0.099 inch. Provide round barbs that have a coated diameter of 0.08 inch, with either two-point barbs spaced four (4) inches apart or four-point barbs spaced five (5) inches apart. Provide stays for barbed wire fences in accordance with ASTM A 116, with a coated diameter of at least 0.142 inch 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 inch and a length of at least 1 1/2 inch; 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 inch; 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 inch. The Contractor may use wire fasteners or metal clamps with thicknesses of 0.12 inch 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 top coating 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 inch, -1 inch.

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 line posts with corrugations, lugs, ribs, or notches spaced one (1) inch on centers to attach fence wire. The Department will not accept posts with punched tabs used for crimping around the wire.

Provide anchor plates with an area of at least 18 inch² 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, lodge pole 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 six (6) inches. Ensure the circumference of corner, brace, intermediate brace, and gate posts is at least 19 inches, measured six (6) inches below the top of the post.

The Contractor may provide line posts with a slight crook in one (1) direction, but the post may not vary more than 1 1/2 inch 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 three (3) inches. Ensure the circumference of line posts is at least nine (9) inches, measured six (6) inches below the top of the post.

Provide coast region douglas fir or New Mexico red spruce or fir braces for wood posts.

607.2.2.2.1 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 inch. 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 inch, with drop forged turnbuckles or other approved tension devices.

Provide pull cable and tension wires with a minimum zinc coating of 0.8 oz per square foot of uncoated individual wire surface, tested in accordance with ASTM A 90.

The Project Manager will determine the uniformity of the coating by visual inspection. The Project Manager may reject coating with excessive roughness, blisters, discoloration spots, bruises, and flaking. The Department may make other inspections and tests at the manufacture'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 inch. 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 chain link fabric full height. Provide galvanized, coated wire with a diameter of 0.148 inch. Provide two (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

Provide vinyl-coated chain link fences in accordance with Section 607.2.3, "Chain Link Fence," except as modified in this subsection.

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 Access Fence

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 Wood Posts

Provide wood posts from one (1) of the following species:

1. Northern White Cedar;

2. White Pine;
3. Jack Pine;
4. Red (Norway) Pine;
5. Southern Yellow Pine;
6. Ponderosa 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 four (4) inches -1/2 inch, +1 1/4 inch.

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 five percent (5%) of the butt area. Provide posts with sound tops, however, the Department will allow one (1) pipe rot not exceeding a diameter of 3/8 inch 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 (1) one-way sweep exceeding two (2) inches, 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 ten percent (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 inch x 1 1/2 inch wooden pickets spaced 3 1/2 inch on center and woven between five (5) cables. Each cable will consist of at least two (2) strands of galvanized steel wire with diameters of 0.099 in or larger.

Provide wooden pickets that are at least 48 inches 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 seven (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 of curves.

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 ten (10) feet 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 inch. 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 Access Fence

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 (2) coats of pentachlorophenol preservative to the cut surfaces.

607.3.4.2 Setting of Anchors, Cable, and Fittings for Post and Cable Access Fence

If a bolt projects more than one (1) inch from the nut, cut off 1/2 inch 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 three (3) inch wide reflective sheeting in accordance with Section 701.2.2.1, "Retroreflective Sheeting," 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 (3) 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 (2) 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 Project Manager.

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

Pay Item

Barbed Wire Fence ____ft

Game Fence ____ft

Section 607: Fence

Pay Unit

Linear Foot

Linear Foot

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<i>Woven Wire Fence</i> ____ft	Linear Foot
<i>Chain Link Fence</i> ____ft	Linear Foot
<i>Chain Link Security Fence</i> ____ft	Linear Foot
<i>Vinyl-Coated Chain Link Fence</i> ____ft	Linear Foot
<i>Snow Fence</i> ____ft	Linear Foot
<i>Pedestrian/Bicycle Railing</i> ____ft	Linear Foot
<i>Pedestrian Screening Fence Type</i> ____ft	Linear Foot
<i>Post and Cable Access Fence</i> ____ft	Linear Foot
<i>Remove and Rebuild (type) Fence</i>	Linear Foot
<i>Standard Gate</i> ____ft	Each
<i>Barbed Wire Gate,</i> ____ft	Each
<i>Chain Link Gate,</i> ____ft Span	<i>Each</i>
<i>Chain Link Gate,</i> ____ft Span by ____ft Rise	<i>Each</i>
<i>Pipe Gate</i> ____ft	Each
<i>Water Gap Gate</i>	Linear Foot
<i>Turnstile Gate</i> ____ft	Each
<i>Remove and Reset Gate</i>	Each
<i>Stile and Post Wire Trap</i>	<i>Each</i>

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 inch 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 inch x 12 inch 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 four (4) inches of bed course Material. Compact bed course Material to a density of at least 90% of maximum density as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified). Compact bed course Material for drive pads to a density of at least 96% of maximum density as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified). 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 inch 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 two (2) ft x two (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 inch 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 inch 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 inch (in any direction), if tested with a ten (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—Reserved

608.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Concrete Sidewalk ____inch	Square Yard
Drive Pad ____in.	Square Yard
Concrete Median Pavement ____inch	Square Yard
Concrete Median Pavement ____inch (Colored)	Square Yard
Concrete Median Pavement ____inch (Colored and Patterned)	Square Yard

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 inch 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 two (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.

609.3.2.2 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 inch 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 inch, 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 feet. Separate sections by open joints, 1/8 inch wide, except at expansion joints. Construct contraction joints at intervals of five (5) feet.

Form expansion joints at the intervals in accordance with the Contract, using the preformed expansion joint filler with a thickness of 3/4 inch.

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

Pay Item	Pay Unit
<i>Concrete Curb ____ inch</i>	Linear Foot
<i>Bituminous Curb</i>	Linear Foot
<i>Header Curb</i>	Linear Foot
<i>Concrete Sloped Curb and Gutter ____ inch x ____ inch</i>	Linear Foot
<i>Concrete Vertical Curb and Gutter Type ____ inch x ____ inch</i>	Linear Foot
<i>Standard Curb and Gutter</i>	Linear Foot
<i>Concrete Valley Gutter ____ inch x ____ inch</i>	Linear Foot
<i>Concrete Laydown Curb ____ inch</i>	Linear Foot

609.5.1 Work Included in Payment

The following 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 and reflectorized yellow paint for Median curb and gutter from radius point to radius point on the bull nose portion.

SECTION 610: CATTLE GUARDS

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 610.2.5:1
Aluminum Members Warning Devices Standards

Description	ASTM	Alloy	Temper
Tubing	B 429	6061	T-6
Fence angle	B 221	6061	T-6
Base plate	B 209	6061	T-6
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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 three (3) inches thick bedding of fine aggregate over the Subgrade and compact it to at least 95% of the maximum density in accordance with AASHTO T 180 (Modified Proctor), Method D (TTCP Modified). 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-bardiameter lap.

Chamfer exposed edges of concrete $\frac{3}{4}$ inch.

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 (2) 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—Reserved

610.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Cattle Guard (____ ft)	Each

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.

SECTION 613: CLEANING OF CULVERTS AND DRAINAGE STRUCTURES

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—RESERVED

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

Pay Item	Pay Unit
<i>Cleaning Culverts and Drainage Structures</i>	Lump Sum

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.

SECTION 614: PIPE CASING

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—RESERVED

614.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Pipe Casing</i>	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 – RESERVED**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 four (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 (3) 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 (1) 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 (1) 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 (2) 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:

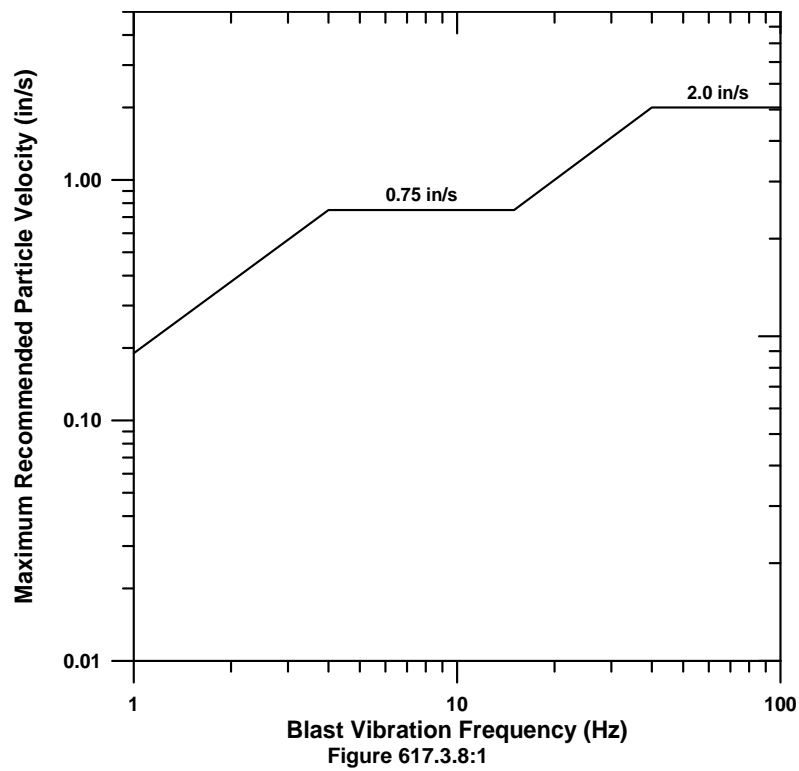
1. Copies of reports including analysis and conclusions for at least three (3) previous Projects similar in scope to this Project;
2. Resumes for all personnel involved in this Work.

617.3.8 Analysis of Vibration Monitoring

Submit to the Project Manager eight (8) 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 (1) of three (3) 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

Pay Item	Pay Unit
<i>Vibration Monitoring</i>	Lump Sum
<i>Vibration Risk Survey</i>	Lump Sum
<i>Video Taping</i>	Lump Sum

618.1 DESCRIPTION

This Work consists of providing traffic control management in accordance with the Contract and the *MUTCD, current edition*, 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 (1) traffic control supervisor (TCS) to provide traffic control management for the Project.

If assigning more than one (1) 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 (1) 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 (1) 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 (4) 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 inch x 18 inch 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 seven (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—Reserved

618.5 BASIS OF PAYMENT

Pay Item

Traffic Control Management

Traffic Control Management

Pay Unit

Lump Sum

Calendar Day

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:

$$P = \left(\frac{A \times L}{B} \right) - C \quad (1)$$

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.

SECTION 619: HEADGATES AND FLAPGATES FOR IRRIGATION DITCHES

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—Reserved

619.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Headgate Type____, ____ inch	Each
Flapgate ____ inch	Each

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.

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

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 valve for storing liquid herbicide temporarily while the Contractor services other sprayer parts.

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 NMDA 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

Pay Item	Pay Unit
<i>Selective/Non-Selective Herbicide Application</i>	Acre

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—Reserved

621.3 CONSTRUCTION REQUIREMENTS—Reserved

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 ten percent (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 five percent (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 five percent (5%) to less than ten percent (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 ten percent (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 ten percent (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 ten percent (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

Pay Item

Mobilization

Pay Unit

Lump Sum

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.

SECTION 622: FIELD LABORATORIES AND FIELD OFFICES

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 (1) 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 (1) 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 shutoff valve.

Drain, flush, and refill the water system every two (2) 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 (1) 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 six (6) inches 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 inch 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 feet x 14 feet x 8 inch. 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 (3) six (6) inch molds;
10. Extruder for specimen removal from mold;
11. Printer;
12. Printer cable;
13. Height standard block;
14. Serial cable;
15. Two (2) hundred and fifty specimen paper disks;
16. Operating service manual.

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 inch 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 (1) quick funnel insert;
20. Four (4) sample containers; and
21. One (1) 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 \pm R/ \pm RW & 48x/32x/48x CD \pm R/ \pm RW recorder;
5. Monitor: 19-inch color graphics monitor, VGA/DVI;
6. Printer: letter-quality color laser printer, eight (8) pages per minute minimum;
7. 11 inch x 17 inch 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
10. Microsoft Office Professional Plus 2007.

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 (1) 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 (2) scanning densities, with a minimum low scanning density of 98 lines per one (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 ten (10) locations;
 17. Has manual dialing and automatic redialing (two (2) 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 six (6) ft high. Make sure the fence has an access opening at least 16 ft wide and one (1) or more chainlink gates at least six (6) ft in height at an appropriate location to allow vehicles to pass.

Provide the fence and gates with at least two (2) 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 ft² of floor area.

Provide the field office with a minimum of 50 ft² of shelf space. Equip the field office with:

1. At least one (1) closet with at least ten (10) ft² of floor space, and with a 24 inches wide door (with lock); and
2. At least one (1) closet with at least 15 ft² of floor space and 20 ft² of shelf space.

Provide the field office with at least two (2) office spaces separate from the rest of the field office by full partition and door. Ensure that these office spaces have at least 144 ft² 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 inch, nine (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 (1) water cooler;
2. One (1) six (6) gal minimum capacity water heater;
3. A bathroom with lavatory and water closet;
4. One drafting table;
5. One (1) worktable measuring approximately 30 inches x 96 inches;
6. Two (2) 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—Reserved

622.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Field Laboratory Type I</i>	Each
<i>Field Laboratory Type II</i>	Each
<i>Supplemental Field Laboratory</i>	Each
<i>Supplemental Hot-Mix Asphalt Field Laboratory</i>	Each
<i>Supplemental Field Laboratory (Superpave)</i>	Each
<i>Field Office</i>	Each

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.

SECTION 623: DROP INLETS

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 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 six (6) inches 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 95% of maximum density as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified), 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

Pay Item

Median Drop Inlet, Type I, ___ to ___ ft

Median Drop Inlet, Type ___

Section 623: Drop Inlets

Pay Unit

Each

Each

<i>Modified Median Drop Inlet, Type</i> ___	Each
<i>Curb Drop Inlet Type</i> ___, ___ to ___ ft	Each
<i>Curb Drop Inlet Type</i> ___, over ___ ft	Each
<i>Drop Inlet Type</i> ___, ___ to ___ ft	Each
<i>Drop Inlet Type</i> ___, over ___ ft	Each
<i>Transverse Drop Inlet Type</i> ___, ___ to ___ ft	Each
<i>Transverse Drop Inlet Type</i> ___, over ___ ft	Each
<i>Junction Box</i>	Each

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 six (6) inches on extensions;
- H. Gravel for drain pocket and hardware cloth for the weep holes; and
- I. De-watering.

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 inch. 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 inch. 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 inch diameter cartridge in a one (1) inch diameter hole with a 3/4 inch 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 six (6) inches square or six (6) inches 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 (2) 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 inch;
3. Edging wire will be a galvanized wire core, with a diameter of at least 0.1338 inch (approximate U.S. gauge 10), coated with PVC, and having a minimum overall diameter of 0.1638 inch; and
4. Lacing wire will be a galvanized wire core, with a diameter of at least 0.0866 inch (approximate U.S. gauge 13.5), coated with PVC, and having a minimum overall diameter of 0.1166 inch.

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
PVC Coating Physical Property Requirements

Property	Required value	Test method
Initial Property Requirements	—	—
Specific Gravity, kg/Dm ³	1.30–1.35	ASTM D 792
Durometer Hardness	50–60	ASTM D 2240
Shore D	—	ISO 868
Volatile Loss, Maximum	—	ASTM D 1203
@ 105 °C for 24 h	two percent (2%)	ISO 176
@ 105 °C for 240 h	six percent (6%)	ASTM D 2287
Tensile Strength, kg/cm ² , Minimum	210	ASTM D 412
Elongation, %	200–280	ASTM D 412
Modulus of Elasticity, kg/cm ² , Minimum	—	—
100% of Elongation	190	ASTM D 412
Resistance to Abrasion, gm, Maximum	0.19	ASTM D 1242 – 95a
Brittleness Temperature, °C, Maximum	–30	BS 2782-104A
Cold bend temperature	+15	BS 2782-150B
Cold flex temperature	—	—
Creeping Corrosion, mm, Maximum ^a	25	—

^aPenetration of corrosion of the wire core from a square cut end when the specimen has been immersed 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 inch to 3/16 inch.

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/hooks anchors that are at least six (6) feet long. Ensure that the steel bolts extend at least one (1) foot into sound rock.

As construction progresses, the rock conditions encountered may require the lengths of the steel bolts/hooks 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 lb•ft, unless otherwise specified.

After installation, test a randomly selected set of ten percent (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 ten percent (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 six (6) inches and securely bind the perimeter edges of wire mesh so that the joints formed by tying the selvages 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 four (4) inches 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—Reserved

624.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Slope Protection Wire Mesh</i>	Square Yard
<i>Slope Protection Wire Mesh PVC-Coated</i>	Square Yard
<i>Resin-Grouted Steel Bolts</i>	Linear Foot
<i>Resin-Grouted Steel Anchors</i>	Linear Foot
<i>Earth Anchors</i>	Linear Foot
<i>Anchor Cable</i>	Linear Foot

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—Reserved

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—Reserved

626.5 BASIS OF PAYMENT

Pay Item*Scaling of Rock Slopes***Pay Unit**

Square Yard

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.

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.
4. The blade color shall be as approved by the Department.

630.3 CONSTRUCTION REQUIREMENTS

Place four (4) inch x 12 inch 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 ten (10) foot base-rail unit to the concrete wall barrier with at least three (3) 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—RESERVED

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
<i>Individual Glare Shield Blades</i>	Each
<i>Multiple Glare Shielding</i>	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 (1) 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 including breaks that are part of the rumble strip 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

Rumble Strips

Pay Unit

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.

632.1 DESCRIPTION

This Work consists of preparing the soil and seeding areas stripped of vegetation during construction operations and required to be revegetated as per the Clean Water Act.

632.2 MATERIALS

Provide certifications for all Materials to the Project Manager before Work commences.

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 12 months.

Provide to the Project Manager documentation of seed origin and pure live seed content from a certified testing Laboratory. Seed must arrive in the original sealed containers from the Certified Supplier and the Revegetation Contractor must provide all tags and certifications to the Project Manager. Certification must be provided that the seed has been stored in appropriate conditions in the 12 months before arriving at the Project. Any seed substitutions require letters from three (3) sources confirming that the originally specified seed is not available at the time of installation. Each seed bag shall have a unique identification number, and the certified seed Supplier shall maintain records of seed bag identification numbers for a period of three (3) years.

Calculate the pure live seed using the following equation:

$$PLS = \frac{P \times G}{100} \quad (1)$$

Where,

Section 632: Revegetation

PLS 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 Amendments

Provide amendments (specified type and formulation) and Supplier's certification in accordance with the Contract.

632.2.3 Wood Chip 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 one (1) inch and shall not exceed three (3) inches in diameter; shavings shall not be more than five percent (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) ten (10) inch 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.

All hay mulch is to be free of noxious weeds as certified by an industry recognized forage certification authority.

632.2.3.2 Straw Mulch

Do not use rotten or moldy straw. All straw mulch is to be free of noxious weeds as certified by an industry recognized forage certification authority.

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 Bonded Fiber Matrix (BFM)

Bonded Fiber Matrix (BFM) is a hydraulically applied blanket that controls soil erosion and accelerates seed germination. BFM is a three-dimensional composite of wood or paper fibers bonded by polymer tackifiers that provides high performance erosion prevention on slopes. A submittal shall be provided to the Project Manager providing core-drill photographs indicating the depth of completed BFM on the "A" soil horizon. The submittal shall reflect the tonnage of BFM required per acre on the Project. The Project Manager shall use this to confirm correct coverage of BFM on the Project.

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. The standard specified one (1) inch of compost mulch tilled into the top four (4) inches of soil for Class A Seeding equals 134 cubic yards of mulch per acre.

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
Material and Operations for Classes of Seeding

Material	Measure	Method	Criterion
All Composted Mulches	Moisture Content*	Evaporative loss at 105°C	No more than 60%
	Particle Size	Sieve	40% to 70% of material passes ¾ inch screen; 100% of pieces smaller than 4 inches in length and 2 inches in diameter
	Electrical Conductivity*	1:5 slurry (mass basis)	<10 mmho/cm
	pH*	1:5 slurry (mass basis)	pH 5.0 – pH 8.0
	Organic Matter*	Loss on ignition at 550°C	25% - 70% of dry weight
	Maturity	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.	
	Stability	Maximum core temperature of 110°F after 48 hours in 5 foot tall conical pile, with moisture adjusted to between 40% and 60%.	
	Debris	Less than one percent (1%) inorganic debris by volume, including, but not limited to, glass, plastic, stones and metal.	
Composted Mulches with Wastewater Biosolids	Trace Metals*	HNO ₃ digestion	Complies with Table 3 of 40CFR503.13
	Fecal Coliforms*	MPN with A-1 broth	<1000 MPN/dry gram

*Tests marked with asterisks must be performed by a suitable analytical Laboratory; other tests 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 may inspect and approve the composted mulch application during installation and upon completion of the Project.

Certification of compost weight shall be required. The weight shall account for moisture content at the time of sale. Certification must indicate date and time of sale, source of compost, and delivery location.

632.2.6 Rock Mulch

Rock mulch shall be ¾ inch to one (1) inch diameter Fractured Face material installed over hydroseeded areas to a depth of one (1) inch thick to aid in erosion control and water harvesting. The finished rock mulch surface must be smooth and uniform maintaining the original flow lines, slope gradients, and contours of the job. Certification of quantities must be provided to the Project Manager. A sample of the proposed rock mulch must be provided to the Project Manager and Landscape Architect for approval before application. A submittal shall be provided from a rock mulch Supplier confirming the tonnage required per acre for one (1) inch thickness of coverage depending on the chosen rock type size.

632.3 CONSTRUCTION REQUIREMENTS

632.3.1 Sampling

The Department may sample and test shipments of seed and fertilizer for compliance with the regulations and requirements of the NMDA. The Department may 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 632.3.2:1
Material and Operations for Classes of Seeding

Operation	Seeding class			
	A	C	D	SS
Seed bed preparation	X	—	X	X
Amendments	X	X	X	X
Seeding	X	X	X	X
Chain harrowing or hand raking	—	X	X	X
Compost Mulch	X	X	—	—
Hay or Straw anchoring, crimping	X ^a	—	—	—
Hay or Straw anchoring, tack	X ^a	—	—	X

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Soil Retention Blanket	—	—	X	—
BFM	—	X	—	X

^aAnchoring method is based on the specified mulch type.

Key:

X = required

— = not required

The Department defines the seeding classes as follows:

1. Class A = seeding with a drill (slopes flatter than 3:1)
2. Class C = seeding with hydroseeder; soil preparation, BFM (slopes flatter than 3:1)
3. Class D = seeding with soil retention blanket
4. Class SS = steep slope or inaccessible area seeding with a hydroseeder, BFM

632.3.3 Seedbed Preparation

Till the seedbed with a disc, harrow, or chiseling tools to at least four (4) inches 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.

Add any soil amendments as specified by disc, harrow, or chisel to a depth of four (4) inches.

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 Amendments

Apply the specified amendment uniformly to the prepared seedbed.

632.3.5 Seeding Season Limitations

There are no restrictions on time of seeding other than that the ground may not be frozen. Cool season grasses have been added to all seeding recommendations.

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 Drill Seeding

Plant seed approximately 1/2 inch deep, with a maximum depth of one (1) inch, unless otherwise specified in the Contract. Ensure that the distance between the drilled furrows is no more than eight (8) inches. If the furrow openers on the drill exceed eight (8) inches, 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.

632.3.6.2 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.

632.3.6.3 Contractors Warranty of Work

A 45 Day inspection of mulch following completion of application of mulch with mechanical crimping and tackifier must indicate a minimum of 90% of the original mulch still in place. Areas not meeting this criterion must be re-mulched and tackifier applied to meet the 90% standard. Allowance will be made for exceptional wind or water events which may have occurred during the 45 Day time period.

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 ten (10) inches 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 seeding with a mechanical mulch spreader. Anchor or tack the mulch with an approved tackifier. Use the Materials and rate of application recommended by the manufacturer. The tackifier shall be incidental to the seeding.

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 two (2) tons per acre of air-dry hay.

Anchor hay mulch using a crimper with flat serrated discs at least one (1) inch thick with dull edges, spaced no more than nine (9) inches 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 two (2) inches 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 (2) passes of the anchoring Equipment.

632.3.7.2 Straw Mulch

Ensure that the straw mulch rate of application is at least two (2) tons 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.

632.4 METHOD OF MEASUREMENT

The Department will measure parallel to slopes.

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.

Pay Item	Pay Unit
Class ____ Seeding	Acre
Steep Slope Seeding	Acre

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—RESERVED

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 inches wide, but in no case should they exceed 1.4 times the outside diameter of the pipe, plus 24 inches, 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 inches 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 six (6) inches 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 four (4) inches 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 six (6) inches 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 Sheet piling

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 inches above the top of pipe.

Do not remove sheet piling 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 one (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 four (4) ft of pipe and utility appurtenances, under the Roadway Prism, to 95% of maximum dry density as determined by AASHTO T 180 (Modified Proctor), Method D (TTCP Modified).

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 seven (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—RESERVED

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.

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 Mix 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 four percent (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:

1. Mastic in accordance with Federal Specification SS-S-210.
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 (1) 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 sits 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 (2) 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 inch 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 five (5) foot x five (5) foot 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 Project Manager the proposed procedure in writing. Do not use the proposed procedure until Project Manager approval.

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 NMSSPWC.

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

Pay Item	Pay Unit
Manhole Type __, __ft diameter __ft to __ft Depth	Each
Manhole Type __, __ft diameter over __ft to __ft Depth	Each
Manhole Type __	Each
Special Manhole Type __	Each
Manhole, __ft diameter	Each
Sewer Manhole, __inch diameter	Each
Drop Manhole, __inch diameter	Each
__ inch x __inch Reducing Cone	Each
Additional Depth for Manhole	Vertical Foot
Additional Depth for __ft diameter Manholes	Vertical Foot
Manhole Adjustment	Each
Manhole Extension	Each
Tie to Existing Manhole	Each
Manhole Frame and Cover	Each

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;"
4. Section 800, "Water Transmission Collector and Distribution Lines;"
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;"
16. Section 108, "Brick;"
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.

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 seven (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 seven (7) Days in advance. Provide two (2) 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 (1) 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 (1) 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

Pay Item	Pay Unit
<i>Trees, Shrubs, and Ground Cover (___)</i>	Each
<i>Sodding (___)</i>	Square Yard

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 (1) mailbox and one (1) mailbox support.

A double mailbox installation consists of two (2) mailboxes and one (1) mailbox support. Multiple mailbox installations consist of from three (3) to 16 mailboxes and one (1) mailbox support. A picnic table unit consists of one (1) picnic table and two (2) benches.

667.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Timber Parking Barriers	Each
Charcoal Grills	Each

Park Benches	Each
Picnic Shelters	Each
Picnic Table Pads	Each
Picnic Tables and Benches	Each
Litter Receptacles	Each
Historical Markers	Each
Skylights	Each
Mirrors	Each
Storage Buildings	Each
Air Systems	Each
Water Closets	Each
Lavatories	Each
Urinals	Each
Mailbox Installation (Single)	Each
Mailbox Installation (Double)	Each
Mailbox Installation (Multiple)	Each
Rest Room Buildings	Lump Sum
Sanitary Sewer System Improvements	Lump Sum
Picnic Shelter Renovation	Lump Sum
Corrals	Lump Sum
Post and Cable Barriers	Linear Foot
Glazed Wall Tiles	Square Yard
Glazed Roofing	Square Yard

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, current edition*.

701.2 MATERIALS**701.2.1 Concrete**

Use Class G concrete for overhead sign structure foundations in accordance with Section 502, "Drilled Shafts."

Use Class A concrete for extruded panel sign foundations in accordance with Section 510, "Portland Cement Concrete."

701.2.2 Steel Reinforcement

Use steel reinforcement in accordance with Section 540, "Steel Reinforcement."

701.2.3 General

Provide Materials manufactured in accordance with the requirements of ASTM D 4956, current version.

701.2.3.1 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 (3) 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.

701.2.3.2 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.

701.2.3.3 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.

701.2.3.4 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 dye stamped in 3/8 inch letters and numerals, or 1/2 inch 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.

701.2.3.5 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.

701.2.4 Sign Components

701.2.4.1 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.

701.2.4.1.1 Colors

Provide the diffuse Day color of the retroreflective sheeting in accordance with ASTM D 4956, current version, Table 13.

701.2.4.1.2 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 701.2.4.1.2:1, "Type IV Sheeting—Unmetallized Microprismatic Element," Table 701.2.4.1.2:2, "Type VIII F Sheeting—Fluorescent Microprismatic Lens," Table 701.2.4.1.2:3, "Type IX Sheeting—Microprismatic Lens," Table 701.2.4.1.2:4, "Type IX F Sheeting—Fluorescent Microprismatic Element," and Table 701.2.4.1.2:5, "Type XI Retroreflective Sheeting." Conduct testing methods in accordance with ASTM E 810.

Table 701.2.4.1.2:1
Type IV Sheeting—Unmetallized Microprismatic Element

OA	EA	White	Yellow	Orange	Red	Green	Blue	Brown
0.2	-4	360	270	145	65	50	30	18
0.2	+30	170	135	68	30	25	14	8.5
0.5	-4	150	110	60	27	21	13	7.5
0.5	+30	72	54	28	13	10	6	3.5

Table 701.2.4.1.2:2
Type VIII F Sheeting—Fluorescent Microprismatic Lens

Minimum reflectivity for fluorescent sheeting (average candle power per foot candle per square foot)		
OA	EA	Orange
0.1	-4	300
0.1	+30	135
0.2	-4	210
0.2	+30	95
0.5	-4	75
0.5	+30	35

Table 701.2.4.1.2:3
Type IX Sheeting—Microprismatic Lens

Minimum reflectivity (average candlepower per foot candle per square foot)							
OA	EA	White	Orange	Yellow	Red	Green	Blue
0.2	-4	380	145	285	76	38	17
0.2	+30	215	82	162	43	22	10
0.5	-4	240	90	180	48	24	11
0.5	+30	135	50	100	27	14	6.0

Table 701.2.4.1.2:3
Type IX Sheeting—Microprismatic Lens

OA	EA	Minimum reflectivity (average candlepower per foot candle per square foot)					
		White	Orange	Yellow	Red	Green	Blue
1.0	-4	80	30	60	16	8.0	3.6
1.0	+30	45	17	34	9.0	4.5	2.0

Table 701.2.4.1.2:4
Type IX F Sheeting—Fluorescent Microprismatic Element

OA	EA	Minimum reflectivity (average candle power per foot candle per square foot)	
		Yellow	Yellow/Green
0.2	-4	230	300
0.2	+30	130	170
0.5	-4	145	190
0.5	+30	81	110
1.0	-4	48	64
1.0	+30	27	36

Table 701.2.4.1.2:5
Type XI Retroreflective Sheeting

Minimum reflectivity (average candle power per foot candle per square foot)											
OA	EA	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
0.1	-4	830	620	290	83	125	37	25	660	500	250
0.1	+30	325	245	115	33	50	15	10	260	200	100
0.2	-4	580	435	200	58	87	26	17	460	350	175
0.2	+30	220	165	77	22	33	10	7.0	180	130	66
0.5	-4	420	315	150	42	63	19	13	340	250	125
0.5	+30	150	110	53	15	23	7.0	5.0	120	90	45
1.0	-4	120	90	42	12	18	5.0	4.0	96	72	36
1.0	+30	45	34	16	5.0	7.0	2.0	1.0	36	27	14

701.2.4.1.3 Retroreflective Sheeting Backing

Provide backing for sheeting Types IV through XI in accordance with ASTM D 4956, current version.

701.2.4.1.4 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 protective overcoating in accordance with manufacturer's recommendations.

Apply retroreflective sheeting to a treated substrate, as recommended by the manufacturer. 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.

701.2.4.1.5 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.

701.2.4.1.6 Multiple Pieces of Sign Sheeting

Ensure that sign faces from two (2) 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 inches tall with one (1) unspliced sheet of retroreflective sheeting. The Department will allow a horizontal splice, only if the substrate panel is 48 inches or taller. Ensure sheet colors match.

Sheeting shall be butt spliced when more than one (1) piece of sheeting is used on one (1) piece of substrate per manufacturer's recommendations. The sheeting pieces should not touch each other.

701.2.4.1.7 Screening Inks

The Department will allow use of screening inks, or acrylic 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 701.2.3.1, "Sign Manufacturer's Quality Control."

Use ultraviolet (UV) resistant inks requiring no additional clear coating or UV protection. Use inks that are one (1) part non-isocyanate Material, easily removed from sign screens with citrus-based environmentally friendly screen cleaning solvents.

701.2.4.1.7.1 Outdoor Weatherability

Use screening inks, or acrylic film overlays with weather-resistant properties equal to retroreflective sheeting.

701.2.4.1.7.2 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 (1) quick motion; no ink, paste, or film overlay should come off. Use 3/4 inch wide Cellophane Tape for this test.

701.2.4.1.7.3 Solvent Resistance

After curing, ensure sign faces resist manufacturer recommended cleaning solvents.

701.2.4.1.7.4 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.

701.2.4.1.7.5 Color

Use a sign face color in accordance with ASTM D 4956, current version.

701.2.4.1.7.6 Retroreflective Intensity (Transparent Colors)

Process and apply transparent colored inks or transparent colored acrylic 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 701.2.4.1.2:1, "Type IV Sheeting—Unmetallized Microprismatic Element," Table 701.2.4.1.2:2, "Type VIII F Sheeting—Fluorescent Microprismatic Lens," Table 701.2.4.1.2:3, "Type IX Sheeting—Microprismatic Lens," Table 701.2.4.1.2:4, "Type IX F Sheeting—Fluorescent Microprismatic Element," and Table 701.2.4.1.2:5, "Type XI Retroreflective Sheeting," for each color at 0.2° OA and -4° EA (or 0.1° and/or 1.0° Observation Angles if, specified in the Contract).

701.2.4.1.7.7 Process Colors on Sheeting

Ensure the retroreflective intensity values are 70% of the retroreflective values specified in Section 701.2.4.1.2. Corresponding values at 0.2° OA and -4° EA are included in Table 701.2.4.1.7.8:1, "Retroreflective Intensity per Process Color."

701.2.4.1.7.8 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 701.2.4.1.7.8:1
Retroreflective Intensity per Process Color**

Type of sheeting	Intensity Value (average candelas per foot candle per square foot)		
	Red	Blue	Green
Type IV Unmetallized Microprismatic Element	24.5	14.0	24.5
Type IX Microprismatic Element	53.2	11.9	26.6
Type XI Retroreflective Sheeting	60.9	18.2	40.6

701.2.4.2 Sign Legends and Sheeting

A sign legend shall contain such letters, numerals, symbols, arrows, borders, and other accessories that convey the sign's message.

Sign legend and background shall be of the same type in accordance with Section 701.2.4.1, "Retroreflective Sheeting."

Provide legends in accordance with *MUTCD, current edition*. The legend may be:

1. 0.005 in minimum thickness integral, semi-rigid;
2. Self-adhering, machine cut sheeting; or
3. Reverse screened using weatherproof screen process inks compatible with the background that provides the designated sign colors and retroreflectorization; or a reverse film overlaid with an approved acrylic film overlay.

Provide extruded panel signs with borders as follows:

1. 1 1/8 inch wide with six (6) inch corner radii for signs under six (6) feet tall;
2. Two (2) inch wide with nine (9) inch corner radii for signs from six (6) feet to 7.5 feet tall; or
3. Three (3) inch wide with 12 inch corner radii for signs over 7.5 feet tall.

701.2.4.3 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.

701.2.4.4 Aluminum Panel Signs

Use 0.08 inch minimum thickness 6061-T6 or 5052-H38 aluminum alloy for signs 24 inch wide or less. Use 1/8 inch minimum thickness 6061-T6 or 5052-H38 aluminum alloy for signs wider than 24 inch.

Provide aluminum alloys in accordance with ASTM B 209. Supply as flat stock Material. Provide aluminum panel signs with smooth edges and corners.

701.2.4.4.1 Corners

Cut corner radii in accordance with the FHWA Standard Highway Signs manual.

701.2.4.4.2 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 701.2.3.1, "Sign Manufacturer's Quality Control."

Punch or drill a hole in the aluminum sign panel to receive tamper proof hardware.

701.2.4.5 Extruded Panel Signs

Use extrusion-type signs, if mounted on steel I-Beam posts or on overhead sign Structures.

701.2.4.5.1 Aluminum Extrusions

Use 6063-T6 aluminum alloy in accordance with ASTM B 221, provided in 12 inch or six (6) inch sections in accordance with the Contract.

701.2.4.5.2 Sign Fabrication for Extruded Panel Signs

Sign legend and background for Extruded Panel Signs shall be fabricated on a metal facing panel unless a digital printing process is used.

701.2.4.5.3 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 inch per foot of length and 0.004 inch per inch of width.

For metal facing panels, use panel units two (2) feet to four (4) feet wide, installed vertically. Do not horizontally splice metal facing sign panels eight (8) ft tall or less.

For horizontal splices on signs taller than eight (8) feet, offset the metal facing splices from the corresponding extrusion joint by 1/2 inch to one (1) inch.

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 inch.

701.2.4.5.4 Digitally Printed Signs

Signs manufactured using digital printing process with a protective overlay film to produce all or part of the image shall conform to all other requirements of Section 701 with the exception that signs may be comprised of extruded panels only or by using metal panel fabrication over the extruded panel.

For extruded panel signs without metal panels, all or part of the image shall be printed on the required sheeting which then shall be laminated to the aluminum extrusion. After lamination of the sheeting to the extrusions, the extrusions may be assembled and bolted together to finish the sign.

For metal panel signs, all or part of the image may be printed before or after the sheeting is laminated to the metal panel.

701.2.4.5.4.1 Outdoor Weathering of Digitally Printed Signs

Inks applied using digital printing processes with a protective overlay film shall produce standard traffic colors (green, yellow, red, blue, brown, black) and have outdoor weathering properties equal to that of the base reflective sheeting.

701.2.4.5.4.2 Standard Traffic Colors Digitally Printed

Standard traffic colors (green, yellow, red, blue, brown, and black) printed with digital printing technology with a protective overlay film must provide the diffuse daytime color of the retroreflective sheeting in accordance with ASTM D4956-09, current version, Table 11.

701.2.4.5.4.3 Retroreflective Intensity of Digitally Printed Standard Traffic Colors

The coefficient of retro reflection of the standard traffic colors (green, yellow, red, blue, brown, and black) digitally produced on white sheeting shall provide an initial minimum retroreflective intensity as specified in Section 701.2.4.1.7.6.

701.2.4.5.5 Extrusion Hardware

Use 2025-T4 aluminum alloy extrusions for hardware with an aluminite or alodine finish, in accordance with ASTM B 221.

701.2.4.6 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 inch x 12 inch 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.

701.2.4.7 Packaging and Shipping

Package and protect signs and hardware for shipment and storage.

701.2.5 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 IX minimum sheeting backgrounds applied; or
2. Type IX minimum sheeting with an integral, semi-rigid, aluminum alloy backing, a minimum of 0.005 in thick. Use Type IX minimum for legends.

Install retroreflective sheeting field overlays in accordance with Section 701.2.4.2, "Sign Legends and Sheeting." Remove and repair the existing legend, as directed by the Project Manager.

701.2.6 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 (1) 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 one (1) mil thick.

701.2.6.1 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).

701.2.6.2 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 inch to 0.005 inch thick.

701.2.6.3 I-Beam Posts

Fabricate I-beam posts for extruded panel signs from standard Structural Steel shapes in accordance with ASTM A 36. Use one (1) 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.

701.2.6.4 Overhead Sign Structures

Fabricate overhead sign Structures as specified in the Contract.

701.2.6.5 Breakaway Base Systems

Use Type I Breakaway base systems that include slip-type connection, hardware, and stub post as specified in the Contract.

701.2.6.6 Fabrication

701.2.6.6.1 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.

701.2.6.6.2 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 inch thick or less. Saw or mill Material over 1/2 inch 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 eight (8) fasteners per facing panel. Do not field assemble these items.

The Contractor may deliver assembled signs more than eight (8) ft high in two (2) parts.

701.2.6.6.3 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

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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 701.2.3.4, "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 180 (Modified Proctor), Method D (TTCP Modified).

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 701.2.6.3, "I-Beam Posts," and Section 701.2.6.5, "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 (2) 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

Pay Item	Pay Unit
<i>Extruded Panel Signs</i>	Square Foot
<i>Panel Signs</i>	Square Foot
<i>Overhead Sign Structure, _____ Type, _____ Size</i>	Each
<i>Steel I-Beam Posts</i>	Foot
<i>Breakaway Base System for Steel I Beam Post</i>	Each
<i>Steel Posts & Base Posts for Aluminum Panel Signs</i>	Foot
<i>Multi-Directional Slip Base Posts for Aluminum Panel Signs</i>	Each
<i>Retroreflective Sheeting Field Overlay Panels</i>	Foot
<i>Remove and Reset Traffic Sign</i>	Each
<i>Remove and Reset Panel Sign</i>	Each
<i>Remove and Reset Extruded Panel Sign</i>	Each

The Department will pay for overhead sign structure foundation installations in accordance with Section 502, "Drilled Shafts."

The Department will pay for steel reinforcement used for overhead sign structure foundations in accordance with Section 540, "Steel Reinforcement."

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 for extruded panel sign foundations;
- D. Class A Concrete for extruded panel sign foundations and multi-directional slip base posts;
- E. Hauling of removals; and
- F. Protective coatings.

Any other items installed by the Contractor for the installation of items covered by this specification shall be considered Incidental to the items listed in Section 701.5 BASIS OF PAYMENT and 701.5.1 WORK INCLUDED IN PAYMENT.

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 701.2.4.1, "Retroreflective Sheeting," Section 701.2.4.2, "Sign Legends and Sheeting," and Section 701.2.4.3, "Sign Backgrounds."

Provide Type VIII or greater intensity retroreflective sheeting for legends and sign backgrounds, unless otherwise specified in the Contract.

Use black letters on a reflective fluorescent orange background for construction signing, unless otherwise specified in the Contract.

Provide Type IV or greater intensity retroreflective sheeting for background of regulatory signs.

702.2.1.1 Steel Posts and Base Posts for Construction Signing

Provide steel post and base post Material in accordance with Section 701.2.6, "Sign Structures and Hardware."

702.2.1.2 Portable Sign Supports

Provide portable sign supports in accordance with the *MUTCD, current edition* 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, current edition* and Table 701.2.4.1.2:1, "Type IV Sheeting—Unmetallized Microprismatic Element," and Table 701.2.4.1.2:2, "Type VIII F Sheeting—

Fluorescent Microprismatic Lens.”

702.2.2.2 Vertical Panels

Use reflectorized vertical panels with orange and white retroreflective sheeting or tape in accordance with the *MUTCD, current edition* and Table 701.2.4.1.2:1, “Type IV Sheeting—Unmetallized Microprismatic Element,” and Table 701.2.4.1.2:2, “Type VIII F Sheeting—Fluorescent Microprismatic Lens.”

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, current edition* and as approved by the Project Manager. Use only one (1) size drum on the Project.

Use reflectorized drums with fluorescent orange and white high-performance retroreflective sheeting or tape. Use horizontal, circumferential, fluorescent orange and white reflectorized stripes from four (4) inches to six (6) inches wide for drum marking. Ensure the number of alternating fluorescent orange and white reflectorized stripes and the amount of non-reflective drum surface space is in accordance with the *MUTCD, current edition*.

Provide drums that are a minimum 36 inches high and 18 inches 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, current edition*.

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 VIII 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 inch mandrel in one (1) 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 701.2.4.1, “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 five (5) min without peeling away more than one (1) inch 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 701.2.4.1.2:1, "Type IV Sheeting – Unmetallized Microprismatic Element," and Table 701.2.4.1.2:2, "Type VIII F Sheeting—Fluorescent Microprismatic Lens."

702.2.2.5 Traffic Cones

Provide traffic cones in accordance with the MUTCD, current edition 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 inches tall weighing at least ten (10) lb with a base alone weighing seven (7) lb, with a distribution of cone weight effectively holding the traffic cones upright under traffic conditions.

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.

702.2.3 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, current edition* 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, current edition* Specifications for advance warning arrow display):

1. Pass Left—Three (3) chevrons of five (5) lamps each sequencing right-to-left;
2. Pass Right—Three (3) chevrons of five (5) lamps each sequencing left-to-right;
3. Pass Either Side—Two (2) 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 (4) lamps, one (1) 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 (8) matrices capable of producing at least eight (8) 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 inches high and nine (9) inches wide.

Ensure a clearly displayed message on the sign panel that is legible from a distance of 800 ft during daytime and nighttime operation at angles in accordance with the *MUTCD*,

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 (1) person without use of heavy Equipment. Ensure a clearance of at least seven (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 (4) non-removable leveling jacks, one (1) 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 inches inside diameter towing eye from one (1) inch round, solid steel. Size the ball receptacle to accept a standard two (2) inch ball;
3. Two (2) safety chains with 1/4 inch diameter links. Install one (1) chain on each side of the draw bar and extend 24 inches beyond the towing eye. Install a safety hook on the outer end of each chain;
4. Two (2) 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 inches 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, current edition* 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.

Use Traffic Cones only during daylight hours.

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."

Keep construction traffic control devices clean so that the intended visibility is not diminished. The condition of construction traffic control devices is subject to Department approval.

The Department will assess liquidated damages at a rate of \$500 a Day for each Day or portion of a Day that a portable changeable message sign does not function.

702.4 METHOD OF MEASUREMENT—Reserved

702.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Construction Signing</i>	Square Foot
<i>Steel Posts and Base Posts for Construction Signing</i>	Foot
<i>Barricade, Type_____</i>	Each
<i>Vertical Panel, Type_____</i>	Each
<i>Construction Traffic Marker</i>	Each
<i>Portable Sign Support</i>	Each
<i>Channelization Device, Type_____</i>	Each
<i>Sequential Arrow Display</i>	Each
<i>Portable Changeable Message Sign</i>	Each
<i>Traffic Cone</i>	Each
<i>Temporary Signal Span</i>	Lump Sum

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 (1) 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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 702.5 BASIS OF PAYMENT and 702.5.1 Work Included in Payment.

703.1 DESCRIPTION

This Work consists of providing and installing traffic markers and appurtenances in accordance with the MUTCD, current edition 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 inch diameter holes and, unless otherwise specified, ensure a total length of seven (7) ft \pm 1/2 inch.

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 one (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 Department 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 inch thickness with a center mounting hole. Expand a metal or plastic grommet with a 3/16 inch 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 three (3) inch diameter and rectangular reflective panels at least six (6) inches \times 12 inches.

Table 703.2.2:1
Specific Intensity Values — Round Reflectors

OA	EA	Minimum reflective intensity (candlepower per foot-candle)	
		Crystal	Amber
0.1	0.0	119.0	71
0.1	20.0	47.0	28

Table 703.2.2:1 Specific Intensity Values — Round Reflectors			
OA	EA	Minimum reflective intensity (candlepower per foot-candle)	
		Crystal	Amber
0.33	0.0	26.0	16
0.33	20.0	13.0	8

Table 703.2.2:2 Specific Intensity Values — Rectangular Reflectors				
OA	EA	Minimum reflective intensity (candlepower per foot-candle)		
		Crystal	Amber	Red
0.2	20 ^a	40.0	30.0	10.0
0.2	10 ^a	105.0	75.0	27.0
0.2	0	125.0	90.0	35.0
0.2	5 ^b	125.0	90.0	30.0
0.2	10 ^b	105.0	75.0	30.0
0.2	20 ^b	85.0	60.0	25.0
0.2	30 ^b	30.0	30.0	7.0
0.2	40 ^b	15.0	15.0	4.0

^aIndicates 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 burrs, 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 inches to 48 inches.

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 five (5) impacts at any angle at a speed of 55 mph and ten (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 703.2.3.1:1 Dimension Requirements for Tubular Traffic Markers	
Description	Dimensions (inch)
Outside diameter	2.23–4
Wall thickness, minimum	1/8

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 inches 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 inch to two (2) inch and an outside diameter of from seven (7) inch to 12 inch.

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 Work begins.

703.2.3.4 Flexible Traffic Marker Retroreflective Sheeting

Provide flexible traffic markers with two (2) three (3) inches high pre-applied retroreflective sheeting bands. Begin the bands no more than two (2) inches from the top, with no more than six (6) inches 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 701.2.4.1.2:1, "Type IV Sheeting – Unmetallized Microprismatic Element," and Table 701.2.4.1.2:2, "Type VIII F Sheeting – Fluorescent Microprismatic Lens," 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 (1) 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 703.2.4.2:1 Requirements for Reflective Barrier Delineator Configuration	
Description	Requirement
Slope of reflecting face (degrees)	0–11
Area of reflecting face, minimum (square inches)	6 1/2

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 inch thick pad of pressure sensitive adhesive and a minimum overall height of 2.46 inches 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 703.2.4.3:1 Specific Intensity Values Reflective Barrier Delineator		
Minimum reflective intensity (candlepower per foot-candle)		
OA	EA	Crystal
0.1	0	55.0

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, current edition. 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 interfere 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—Reserved

703.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Object Marker Type_____</i>	Each
<i>Road Delineator Type_____</i>	Each
<i>Flexible Traffic Marker</i>	Each
<i>Tubular Flexible Traffic Market</i>	Each
<i>Reflective Barrier Delineator</i>	Each
<i>¹/₁₀-Mile Delineator</i>	Each

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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 703.5 BASIS OF PAYMENT and 703.5.1 Work Included in Payment.

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 *High Solids Waterbase Acrylic Hi-Build (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 704.2.2:1 Bead Retained (Percentage)		
U.S. Mesh	Microns	% Retained
18	1000	5 - 15
30	600	20 - 35
50	300	55 - 75
100	150	0 - 5

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 beads with moisture resistant coating.

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 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 (2) 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 704.2.3:1 Temporary Marking Tape			
Minimum Retroreflectivity (millicandelas per foot-candle per square foot)			
OA	EA	White	Yellow
0.2	86	1,770	1,310
0.5	86	1,270	820

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 four (4) inches or six (6) inches 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 diamond 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 ten (10) mil thick and four (4) inches or six (6) inches 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, current edition*.

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 Hot Thermoplastic Pavement Markings

The thermoplastic reflectorized material shall consist of a solid mixture of heat-stable resins, white or yellow pigment, inter-mixed glass beads, filler, and other Materials in granular or block form specifically compounded for reflectorized pavement markings to be applied to the pavement in a molten state. The characteristics of the liquefied material shall be such that complete and even coverage of specified areas to the required thicknesses is provided by the required application method and rate. Upon cooling to normal pavement temperature, this material shall produce an adherent reflectorized marking capable of resisting deformation and wear in the Roadway.

704.2.5.1 Acceptance of Hot Thermoplastic

Contractor shall supply a letter of certification from the manufacturer with each batch certifying the material meets the requirements of the NMDOT's, "HOT THERMOPLASTIC PAVEMENT MARKINGS, SECTION 704.2.5".

Test Methods – All tests shall be performed according to ASTM, AASHTO, Federal Test Method Standard Number 141 or methods designated by the State.

The Department will reduce payment for or reject hot thermoplastic pavement markings used before submitting the proper documentation, if the test results do not meet the Specifications.

704.2.5.1.1 General Requirements

The thermoplastic material shall not exude fumes which are toxic, injurious, or require specialized breathing apparatus when heated to the temperature range specified by the manufacturer for application. The material shall remain stable when held for four (4) hours at this temperature, or when subjected to four (4) re-heatings, not exceeding a total of four (4) hours, after cooling to ambient temperature. The temperature viscosity characteristics of the plastic material shall remain constant throughout the re-heatings and shall show like characteristics from batch to batch. There shall be no obvious change in color of the thermoplastic material as a result of reheating, and the color of the material shall not vary from batch to batch.

704.2.5.1.2 Color

The thermoplastic material, after heating for four (4) hours \pm five (5) minutes at $425 \pm$ three (3) degrees F and cooled to $77 \pm$ three (3) degrees F, shall meet the following:

White: Daylight reflectance at 45 degrees - 0 degrees shall be 75 percent minimum.

Color shall match Federal Test Standard Number 595, color chip no. 17925.

Yellow: Daylight reflectance at 45 degrees - 0 degrees shall be 45 percent minimum.

Color shall match Federal Test Standard Number 595, color chip no. 13538.

704.2.5.1.3 Retroreflectance

The white and yellow thermoplastic Materials shall meet the minimum retroreflectance values in accordance with Table 704.2.5.1.3:1 as measured by a portable retroreflectometer device within 30 Days after application to the Roadway surface.

Table 704.2.5.1.3:1 Hot Thermoplastic Pavement Markings			
		Minimum Retroreflectance (millicandelas)	
OA	EA	White	Yellow
1.5	86.5	250	175

704.2.5.1.4 Softening Point

After heating the thermoplastic material for four (4) hours \pm five (5) minutes at $425 \pm$ three (3) degrees F and testing in accordance with ASTM D 36, the thermoplastic Materials shall have a softening point of 215 ± 15 degrees F.

704.2.5.1.5 Water Absorption and Specific Gravity

The thermoplastic material shall not exceed 0.5 percent by weight of retained water when tested in accordance with the requirements of ASTM D 570.

The specific gravity of the material, as determined by Section 16 of AASHTO T 250, shall be between 1.85 and 2.15.

704.2.5.1.6 Impact Resistance

After heating the thermoplastic material for four (4) hours \pm five (5) minutes at $425 \pm$ three (3) degrees F and forming test specimens, the impact resistance shall be not less than ten (10) inch-pounds when tested in accordance with Section 9 of AASHTO T 250.

704.2.5.1.7 Bond Strength

After heating the thermoplastic material for four (4) hours \pm five (5) minutes at $425 \pm$ three (3) degrees F, the bond strength to Portland cement concrete shall be not less than 180 pounds per square inch. The bond strength shall be determined in accordance with the procedures specified in Section 7 of AASHTO T 250.

704.2.5.1.8 Abrasion Resistance

The abrasion resistance of the thermoplastic material shall be determined by forming a representative lot of the material at a thickness of 0.125 inches on a four-inch square monel panel (thickness 0.050 ± 0.001 inches), on which a suitable primer has been previously applied, and subjecting it to 200 revolutions on a Taber Abraser at 25°C , using H-22 calibrated wheels weighted to 250 grams. The wearing surface shall be kept wet with distilled water throughout the test. The maximum loss of thermoplastic material shall be 0.5 grams.

704.2.5.1.9 Cracking Resistance at Low Temperature

After heating the thermoplastic material for four (4) hours \pm five (5) minutes at $425 \pm$ three (3) degrees F, applying to concrete blocks, and cooling to $15 \pm$ three (3) degrees, the material shall show no cracks when observed from a distance exceeding 12 inches. Testing for low temperature crack resistance shall be in accordance with the procedures specified in Section 8 of AASHTO T 250.

704.2.5.1.10 Flowability

After heating the thermoplastic material for four (4) hours \pm five (5) minutes at $425 \pm$ three (3) degrees F, and testing for flowability in accordance with Section 6 of AASHTO T 250, the white thermoplastic shall have a maximum percent residue of 18, and the yellow thermoplastic shall have maximum percent residue of 21.

704.2.5.1.11 Yellowness Index

The white thermoplastic material shall not exceed a yellowness index of 0.12 when tested

704.2.5.1.12 Flowability (Extended Heating)

After heating the thermoplastic material for eight (8) \pm 1/2 hours at 425 \pm three (3) degrees, with stirring the last six (6) hours, and testing for flowability in accordance with Section 12 of AASHTO T 250, the thermoplastic shall have a maximum percent residue of 28.

704.2.5.1.13 Flash Point

The thermoplastic material shall have a flash point not less than 475 degrees F when tested in accordance with the requirements of ASTM D 92.

704.2.5.1.14 Storage Life

The Materials shall meet the requirements of this specification for a period of one (1) year from the date of manufacture. The month and year of manufacture shall be clearly marked on all packages of thermoplastic material. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for this one (1) year period. Any material which does not meet the above requirements, or which is no longer within this one (1) year period at the time of application, shall not be used. The Contractor shall replace any outdated material with material meeting the above performance and time requirements at no additional cost to the Department.

704.2.5.1.15 Primer-Sealer

Primer-sealers shall be used on Portland cement concrete surfaces and existing aged asphalt with exposed aggregate. Primer-sealer should not be used on new asphalt surfaces. The primer sealer shall be applied as recommended by the thermoplastic material manufacturer. The primer-sealer shall be compounded specifically for use with the specified thermoplastic material.

704.2.5.1.16 Color Stability

Using accelerated weathering per ASTM G155 cycle 1, white color stability shall be measured for no color change after 500 hours of exposure, and for yellow color shall be measured for no color change after 1000 hours of exposure.

704.2.5.1 Composition

The thermoplastic composition shall conform to the following requirements:

Table 704.2.5.1:1

	Percent by Weight	
	White	Yellow
Binder	20% (minimum)	20% (minimum)
Titanium dioxide (for white)	10% (minimum)	-
Yellow Lead Free Pigment (for yellow)	-	1.5% (minimum)
Reflective Glass Inter-mix beads	30 – 45%	30 – 45%
Calcium carbonate or equivalent filler	20 – 42%	20 – 42%

The ingredients of the thermoplastic composition shall be thoroughly mixed and in a solid or sectionalized block, or free-flowing granular form. When heated in a melting apparatus, the material shall readily liquefy into a uniform solution. This solution shall be free from all skins, dirt, foreign objects or any other ingredient which would cause bleeding, staining, blotting, or discoloration when applied to the bituminous or concrete pavement surfaces.

The thermoplastic shall be based on the following binder composition:

Alkyd: Shall consist of a mixture of synthetic resins, at least one (1) of which is solid at room temperature, and of high-boiling-point plasticizers. At least one third of the

binder composition and no less than eight percent (8%) by weight of the entire material formulation shall be solid maleic-modified glycerol ester resin or maleic modified pentaerythritol ester resin. The alkyd binder shall not contain any petroleum-based hydrocarbon resins.

An alkyd thermoplastic formulation may be used for symbols, legends, and transverse lines, including stop bars and crosswalks.

An alkyd thermoplastic formulation may be used for longitudinal lines, including lane lines and edge lines, unless otherwise shown on the Project Plans or specified herein. Extrusion or spray formulations shall be used in accordance with requirements of the application Equipment used to install the markings.

704.2.5.2 Reflective Glass Beads

The inter-mix glass beads shall conform to AASHTO M 247 Type I, and may be coated or uncoated as recommended by the manufacturer. If uncoated beads are used, the thermoplastic formulation shall be configured to minimize settling of the inter mix beads when the material is heated and applied.

In addition to incorporating glass beads in the thermoplastic mix, glass beads shall be applied to the surface of the molten material immediately after application. The drop-on beads shall be in accordance with New Mexico State Department of Transportation Standards and Specifications for Highway and Bridge Construction section 704.2.2 and shall be applied at a minimum rate of 10 pounds of glass beads per 100 square feet of line (ex. 300 linear feet of four (4) inch stripe and 200 linear feet of six (6) inch stripe).

704.2.5.3 Filler

The filler shall be a white calcium carbonate or equivalent filler with a compressive strength of at least 5,000 pounds per square inch.

704.2.5.4 Titanium Dioxide

Titanium Dioxide shall conform to the requirements of ASTM D 476 for Type II (92 percent).

704.2.5.5 Yellow Pigment

The yellow pigment shall be heat resistant and be lead and heavy metal free. The type of yellow pigment shall be at the option of the manufacturer provided that the material conforms to all color requirements in a stable and durable fashion as specified herein.

704.2.6 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, flinits, 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	
Test	Requirement Specific Intensity (millicandelas per lux)
Directional reflectance—Type A markers only	
Glazed surface (minimum)	≥75
Body of marker (minimum)	≥65
Yellow index—Type AY markers only	
Glazed surface (maximum)	≤0.07
Body of marker (maximum)	≤0.12
Color—Type AY markers only	
Purity	76–96%
Dominant wave length	579–585 μm
Total luminous reflectance (Y value, minimum)	≥0.41
Autoclave resistance	Glaze shall not spall, craze, or peel
Strength (minimum)	≥1.5 kip
Water absorption (maximum)	≤2.0 %

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 (1) or two (2) 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**

Test reflectance	Requirement Specific Intensity (millicandelas per lux)		
	White	Yellow	Red
0° Incidence Angle, minimum	278	139	70
20° Incidence Angle, minimum Strength 2.0 kip	111	56	28

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 (1) or two (2) 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 inch².

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**

Test reflectance	Requirement Specific Intensity (millicandelas per lux)		
	White	Yellow	Red
0° Incidence angle, minimum	93	46	—
20° Incidence angle, minimum 2.0 kip	37	19	—

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.

The Contractor shall use M-TPC-WBACR or M-TPC-WBACRHB for temporary striping and only use M-TPC-WBACRHB for permanent striping.

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 four (4) inch lines.

Use a machine equipped with a mechanical device capable of placing a broken reflectorized centerline with a ten (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 (1) 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 (1) 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 destination Project Manager a "Letter of Transfer for Paint" and a copy of the certificates of compliance for paint and glass beads. The origin Project Manager shall include the following in the letter:

1. The amount left in the tanks upon completion of the origin Project;
2. The origin Project, including, Termini, Project number, and control number;
3. The destination Project;
4. The date; and,
5. 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, current edition*, 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 (3) 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 four (4) inch, six (6) inch, eight (8) inch, or 12 inch wide painted lines is $\pm 1/8$ inch.

704.3.5.2 Paint Application Rate

Apply paint at a minimum rate of 19.75 gal per mile of paint for a solid four (4) inch line and 4.94 gal per mile for a broken four (4) inch line, based on a ten (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 six (6) inches for a 40 ft cycle.

704.3.5.4 Transverse Gap Dimension

Provide the following transverse gap dimensions between centerline stripes for two (2) and three (3) 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 two (2) inch gap between the broken and no passing zone stripes;

2. Ensure an eight (8) inch 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 six (6) lb to each gallon of paint.

704.3.6 Hot Thermoplastic Pavement Markings

The thermoplastic material shall be delivered in cardboard containers or plastic bags of sufficient strength to permit normal handling during shipment and handling on the job without loss of material. The net weight of each container shall be approximately 50 – 55 pounds. When supplied in bags the construction of the bag shall be such that it can be placed into the melter with the thermoplastic striping material to become part of the finished product.

Each container shall be clearly marked to indicate the color of the material, the process batch number, the manufacturer's product number, the manufacturer's name and address and the date of manufacture.

704.3.6.1 Moisture

All surfaces shall be inspected for moisture content prior to application of thermoplastic. Approximately two (2) square feet of a clear plastic of tarpaper shall be laid on the Road surface and held in place for 15 to 20 minutes. The underside of the plastic or tarpaper shall then be inspected for a build up of condensed moisture from the Road surface. If the amount of condensed moisture is of a sufficient amount to result in water dripping from the plastic or tarpaper when held in a vertical position, thermoplastic shall not be applied. This moisture test shall be repeated until the moisture in the Road surface has been allowed to evaporate to a level whereby there is not excessive build up of condensed moisture on the underside of the plastic or tarpaper.

704.3.6.2 Cleaning

All surfaces shall be clean and dry before thermoplastic can be applied. Loose dirt and debris shall be removed by blowing compressed air over the area to be striped. If the thermoplastic is to be applied over existing paint lines that are determined to have poorly adhered painted markings, the paint markings shall be swept with a mechanical sweeper or wire brush to remove any such areas that would interfere with the proper bonding of the thermoplastic. Curing compound and loosely adhered surface film shall be removed from all new Portland cement concrete surfaces by loose grain abrasive pressure blasting, mechanical abrasion, wire brushing or high pressure water blasting. When primer sealer is required insure that all dust and diamond grinding debris is removed completely prior to applying the primer sealer. Open graded Roadways may require sweeping to ensure cleanliness.

704.3.6.3 Layout

The pavement markings shall be placed in proper alignment with guidelines established on the Roadway. Deviation from the alignment established shall not exceed two (2) inches per 200 feet of Roadway nor shall any deviation be abrupt. Longitudinal markings shall be offset at least two (2) inches from construction joints of Portland cement concrete surfaces and joints and Shoulder breaks of asphalt surfaces.

If interim or temporary striping is required on final mat and water borne traffic paint is utilized, seven (7)-15 wet mils with beads reduced accordingly can be used or as per manufactures recommendation. This interim or temporary striping shall be paid for as specified in the Contract.

704.3.6.4 Primer Application

The primer shall be applied to the Road surface in a continuous film at a thickness as

recommended per manufacturer's product data sheet. Before the Thermoplastic is applied, the primer shall be allowed to dry to a tacky state. The Thermoplastic shall be applied within and not exceed 5 hours after the primer application.

704.3.6.5 Ambient Conditions

The ambient air and Road surface shall be 60 degrees F and rising before application of thermoplastic can begin.

704.3.6.6 Material Requirements

The pavement marking material shall be installed in a molten state by the conventional extrusion or ribbon extrusion method at a minimum temperature of 400°F and a maximum temperature of 450° F. Scorching or discoloration of material shall be cause for rejection by the Engineer. The machinery shall be constructed so that all mixing and conveying parts, up to and including the extrusion die or spray head, maintain the material in the molten state, at the required application temperature.

704.3.6.7 Application Film Thickness

The pavement marking material shall be applied at a thickness of not less than 90 mils for long line markings on all Roads and not less than 120 mils for cross walks, stop bars, legends & symbols.

Inlay of markings should be taken into consideration in snow plow areas or areas where aggressive traffic shear is a concern. If inlay of markings is required, payment for inlay shall be paid for separately.

704.3.7 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 (3) 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 diamond 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

No payment will be made for the number of skips (spaces) in long line pavement marking applications.

The Department will measure *Retroreflectorized Painted Markings* for four (4) inch, six (6) inch, eight (8) inch, 12 inch, and 24 inch widths using multiples of the standard four (4) inch width to calculate a total length.

The Department will measure *Hot Thermoplastic Pavement Markings* for four (4) inch, six (6) inch, eight (8) inch, 12 inch, and 24 inch widths using multiples of the standard four (4) inch 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

Pay Item	Pay Unit
<i>Retroreflectorized Painted Markings</i> ____inch	Foot
<i>Temporary Striping</i>	Foot
<i>Removable Marking Tape</i>	Foot
<i>Nonremovable Marking Tape</i>	Foot
<i>Retroreflectorized Plastic Pavement Stripe</i> ____inch	Foot
<i>Retroreflectorized Plastic</i> ____ (type) Arrow	Each
<i>Retroreflectorized Word</i> (____)	Each
<i>Retroreflectorized Plastic</i> ____ (type) Symbol	Each
<i>Retroreflectorized Plastic Railroad Crossing</i>	Each
<i>Retroreflectorized Painted Railroad Crossing</i>	Each
<i>Hot Thermoplastic Pavement Stripe</i> ____inch	Foot
<i>Hot Thermoplastic</i> ____ (type) Arrow	Each
<i>Hot Thermoplastic Word</i> (____)	Each
<i>Hot Thermoplastic</i> ____ (type) Symbol	Each
<i>Hot Thermoplastic Railroad Crossing</i>	Each
<i>Reflective Raised Pavement Marker, Type</i> ____	Each
<i>Nonreflective Raised Pavement Marker, Type</i> ____	Each
<i>Temporary Reflective Raised Pavement Marker, Type</i> ____	Each
<i>Plowable Reflective Raised Pavement Marker, Type</i> ____	Each

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, "Reflectorized 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

Paint	
(gallons per mile)	Percent reduction
>19.75 to >17.77	0
17.77 to >14.81	10
14.81 to >9.87	25
≤9.87 ^a	50
Glass Beads (pounds per gallon)	

Table 704.5.1:1
Reflectorized Painted Markings Payment Price Reduction Schedule Based on
Actual Placement Quantities

Paint (gallons per mile)	Percent reduction
>6 to >5	0
5 to >4	17
4 to >3	33
≤3 ^a	50

^aSubject 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;
- D. Surface preparation; and
- E. Maintaining and protecting the pavement markings from traffic during the marking operations.

Any other items installed by the Contractor for the installation of items covered by this specification shall be considered Incidental to the items listed in section 704.5 BASIS OF PAYMENT and 704.5.2 Work Included in Payment.

SECTION 705: GENERAL REQUIREMENTS FOR TRAFFIC SIGNAL AND LIGHTING SYSTEMS

705.1 Description

This Work consists of providing and installing complete and functioning Traffic Signal and 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 four (4) inches, 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, 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 two (2) inches of fine-grained Material that passes a 3/8 inch 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 two (2) inches 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 and Traffic Services Engineer.

Schedule shutdowns in accordance with the construction traffic control plan. Notify the Project Manager and the Maintaining Agency in writing at least five (5) 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 five (5) Working Days before any interruptions. Allow the Maintaining Agency to inspect the Work before and after re-energizing.

705.3.3.3 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 Department may require the Contractor to record/video tape Equipment prior to disassemble and packing. This Work will be considered Incidental to construction.

The Contractor shall coordinate with the local power company to remove salvaged lighting material. If specified in the Contract, remove and deliver the material to the required location.

705.3.3.4 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 per Section 705.5. Submit an appropriate billing verification to the Project Manager.

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 ten (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 Lighting System and/or Traffic Signal are 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

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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—Reserved

705.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Signal/Lighting System Start-up Costs</i>	Allowance

Furnishing and installing of Traffic Signal and lighting systems will be measured and paid for, as provided in the applicable sections of these Specifications, for the Work specified in the Contract.

705.5.1 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:

- Allowed costs required for energy and communication service for the 30 Day operating test period, energy/communication permit fees, and energy/communication permit transfer fees.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 705.5 BASIS OF PAYMENT and 705.5.1 Work Included in Payment.

706.1 DESCRIPTION

This Work consists of bringing electricity to the Project (Power Service Installation), 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 hot dipped galvanized steel, 1/8" aluminum, or 304D stainless steel;
2. Fully welded construction with welding material specifically designed for material used;
3. All fasteners, latches, and hardware are made of stainless steel and all hinges are continuous interior or piano style;
4. No exposed nuts, bolts, screws, rivets or other fasteners on the exterior;
5. Fully framed side hinged cabinet doors equipped with neoprene flange compressed gaskets and 2,000lb stress rated hasps;
6. Enclosure shall be factory wired and conform to required NEMA and UL 508A Standards;
7. Provide a meter socket with a minimum rating of 100 A or 200 A as required in the Contract or the demand of the system;
8. Main breakers shall be 1, 2, or 3 poles;
9. Provide separate metered main, lighting main & disconnects as required;
10. Cable in/cable out circuit breakers Standard;
11. Circuit breakers installed in a vertical position handle up for on, handle down for off;
12. Circuit breakers are industrial grade, full rated;
13. All bussing is UL approved copper cable bussing, fully rated;
14. Distribution panel with deadfront panel and ¼ turn latch;
15. Wiring will be NEMA IIB Standards showing connections to external Equipment;
16. Control wiring is 19 strand #12 or #14 AWG MTW;
17. Functions of circuit breakers, switches and other components as required shall be clearly identified by engraved nameplates;
18. As-built factory drawings enclosed.

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.
5. Enclosure shall be factory wired and conform to required NEMA and UL 508A Standards.

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 $1.5 \text{ fc} \pm 0.5 \text{ fc}$ 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 Luminaires, 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 arrestor 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 Contractor shall pay the local power company for Power Service Installation. The Contractor shall obtain a detailed estimate from the local power company.

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 705.3.4, "Responsibility for Utility and Maintenance."

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 two (2) inches to ten (10) inches 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 ten (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 grout or caulking to provide a weather-resistant, dust-tight installation.

706.4 METHOD OF MEASUREMENT

Power Service Installation will be paid for complete in place.

706.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Service Pole</i> ____(type)	Each
<i>Service Riser</i> ____(type)	Each
<i>Meter Pedestal</i> ____(type)	Each
<i>Lighting Control Cabinet</i>	Each
<i>Power Service Installation</i>	Allowance

For Power Service Installation the Contractor shall be paid the actual amount charged by the local power company for the Work.

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 and Power Service Installation coordination will be considered as included in the cost of the main items and will not be measured or paid for separately.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 706.5 BASIS OF PAYMENT and 706.5.1 Work Included in Payment.

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 in accordance with NMDOT Standard Serials and designed in accordance with the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* (current edition).

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 and collar assembly with set screws and ground lug. Provide an aluminum base approximately 15 inches high with a covered hand hole at least eight (8) inches x 18 inches.

Fabricate the pole from four (4) inches nominal diameter spun aluminum pipe, as per the Standard Drawings.

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 four (4) ft high or less for a projected area of five (5) ft². Design a Type I Standard ten (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 steel. 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 12 ft² each and a design weight of 150 lb each.

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 0.3125-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 a design for octagonal cross sections with a taper rate of 0.14inch/ft.

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 steel. For the shaft, provide steel members with a minimum thickness of 0.3125 inch.

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 inch. Galvanize the steel transformer base after fabrication in accordance with ASTM A 123.

Provide bases with a height of at least 20 inches and, in one (1) side, a hand hole with cover at least eight (8) inch x 12 inch.

Provide transformer bases designed to allow the shaft to rotate a full 90° 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 449, galvanized in accordance with ASTM F 2329. 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 eight (8) inches and hot-dip galvanize the full thread plus six (6) inches.

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 39 lb and a projected area of 1.1 ft².

Provide shaft extensions in accordance with Section 707.2.2.2, "Shaft," except that steel shaft extensions may have a minimum thickness of 0.3125 inch.

707.2.4 Reserved

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 707.2.5.1:1 Type V Standard Pole Straightness Tolerances	
Total mounting height (ft)	Straightness (inch)
20	3/4
30	1
35	1 1/4
40	1 1/2
50	1 3/4

Limit dead load deflection in accordance with AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* (current edition), 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 inch for mounting heights of equal to or less than 33 ft;
2. Wall thickness of at least 3/16 inch for mounting heights of from greater than 33 ft to 40 ft;
3. Wall thickness of at least 0.219 inch for mounting heights greater than 40 ft; and
4. No longitudinal welds and only two (2) 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 (4) 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 inch. 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 inch. Provide a round cross section shaft, tapered at a constant rate. Ensure the shaft is a one-piece section, attached by two (2) 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 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.

707.2.5.2.3 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 inch. 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 nine (9) inches and galvanize for a minimum of 12 inches. Provide each anchor bolt for Type V Standards with nuts and washers, as required for a Breakaway base, or one (1) 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 (current edition)*. 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 aluminum Standards.

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 (current edition)*.

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 inch 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 1.14 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 each. Base the design on the number of Luminaire positions specified in the Contract, assuming one (1) Luminaire in each position. Submit eight (8) 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 1.5 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 three (3) inches.

707.2.6.1.2 Hand Hole

Provide a minimum 11 inch x 30 inch 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. Ensure that longitudinal welds, other than in the slip joint area, have 75% minimum weld surface penetration.

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 AASHTO M-111-94. 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

Integrally weld the base plate to the pole shaft with a backing ring using an AWS prequalified 100% penetration weld. Provide a hole with at least a 16-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 anchor bolts for each Type VI Standard according to ASTM F 1554; Grade 55 steel, or AASHTO M-314. Provide one (1) leveling nut, one (1) hold-down nut, and washers for each anchor bolt, top and bottom. 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.

Provide design of frame and lowering device to the State Bridge Engineer for approval.

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 (2) 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. Provide design of the head frame to the State Bridge Engineer for approval.

707.2.6.2.2 Luminaire Ring

Construct the Luminaire ring of six (6) inches, 8.2-pound single-piece channel with the appropriate number of two (2) inch 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 three percent (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 (3) 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. Provide design of the luminaire ring to the State Bridge Engineer for approval.

707.2.6.2.3 Hoisting Cable

Support the Luminaire ring with three (3) (3/16-inch diameter) stainless steel 19 x 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. Provide design of the hoisting cable to the State Bridge Engineer for approval.

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 (2) 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. Provide design of the latching device to the State Bridge Engineer for approval.

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 x 7 strand, 1/4-inch diameter, aircraft cable (Military Spec.: MIL-W-83420). Provide manufacturing details, load ratings, anticipated winch loadings and winch Specifications to the State Bridge Engineer for approval.

Ensure that the winch has an ultimate strength of five (5) 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 (4) 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 weathertight 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. Provide design of the electrical system to the State Traffic Engineer for approval.

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. Provide Hardware design to the State Bridge Engineer for approval.

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 (1) 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. Provide design of the Power unit to the State Traffic Engineer for approval.

707.2.7 Anchor Bolts

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 ASTM F-1554.

Provide one (1) leveling nut and one (1) 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 (1) 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—Reserved

707.5 BASIS OF PAYMENT

Pay Item	Pay Unit
Type____ Standard, ____ ft	Each
Type____ Standard, ____ ft Arm	Each
Remove and Reset High Mast Standard and Luminaire	Each
Remove and Reset Lighting Standard and Luminaire	Each
Remove and Reset Traffic Signal and Mast Arm	Each
Install State-Furnished Standards, Mast Arms, and Roadway Luminaires	Each
High Mast Lowering Device	Each

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 V, and type VI Standards; and training and technical services for type VI Standards.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 707.5 BASIS OF PAYMENT and 707.5.1 Work Included in Payment.

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 for Traffic Signal Standards (Type I) and control cabinet foundations in accordance with Section 510, "Portland Cement Concrete."

Use Class G concrete for Traffic Signal Standards (Type II and III) and luminaire Standards foundations in accordance with Section 502, "Drilled Shafts."

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 one (1) inch 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 (1) 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 four (4) inches above finished grade or existing ground, 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 and behind control cabinet foundations. Construct the concrete pad in accordance with the Contract.

708.4 METHOD OF MEASUREMENT—Reserved

708.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Structural Concrete, Class A</i>	Cubic Yard

The Department will pay for Traffic Signal Standards (Type II and III) and luminaire

Standards foundations installations in accordance with Section 502, "Drilled Shafts."

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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 708.5 BASIS OF PAYMENT and 708.5.1 Work Included in Payment.

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.

Where wire is not installed, a tracer wire must be installed for line locating.

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 inches 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 inch to 30 inch 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 inch 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 two (2) inches to four (4) inches vertically above the bases.

Terminate conduit that enters a pull box from one (1) inch to three (3) inch inside the box wall and from two (2) inch to three (3) inch 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 (6) 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 (1) 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 two (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 six (6) inches 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 embedded in concrete for abutments, piers, or Bridge decks. Securely attach conduit to the reinforcing steel (by approved methods) at intervals not to exceed four (4) ft.

Use galvanized malleable iron clamps (or other approved methods) to secure conduit runs on Structure surfaces spaced no more than five (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 inch to one (1) inch.

709.3.4.1.2 Liquid-Tight 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

Pay Item	Pay Unit
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<i>Rigid Electrical Conduit ____ inch Dia.</i>	Foot
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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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 709.5 BASIS OF PAYMENT and 709.5.1 Work Included in Payment.

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. For use in non-deliberate traffic areas, pull boxes and covers shall comply with all test provisions of ANSI/SCTE 77 2010 "Specification for Underground Enclosure Integrity".

Provide metal pull boxes:

1. For use in Bridge decks, railing, and other areas subject to deliberate vehicular traffic, provide enclosed watertight metal pull boxes that support, in place, an AASHTO H 20 loading (32,000 lb single axle over a 10 in x 20 in area), unless otherwise specified in the Contract.

710.2.2 Non-Deliberate Traffic Rated Polymer Concrete Pull Box

Non-deliberate traffic areas pull boxes shall be made of polymer coated concrete with fiberglass reinforcement. The box shall have continuous fiberglass cloth reinforcement on the inside and outside perimeter. The covers shall have a minimum of two (2) layers of fiberglass cloth reinforcement. Pull boxes shall comply with all test provisions of ANSI/SCTE 77 2010, "Specification for Underground Enclosure Integrity". All non-deliberate traffic pull boxes shall be tested and certified by UL 66WF (Underwriters Laboratories) or a nationally recognized third party independent test lab and re-verified every year to meet all test provisions of the ANSI/SCTE 77 2010 "Specifications for Underground Enclosure Integrity".

710.2.3 Deliberate Traffic Rated 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 deliberate vehicular traffic (AASHTO H 20 loading); and
3. Fabricated from cast iron with a hot-dipped galvanized finish.

710.2.4 General Pull Box Cover Requirements

All pull box covers shall be designed for the required loadings and shall meet or exceed the rated loading of their corresponding pull box.

Pull box covers shall be sealed with a neoprene gasket providing a NEMA 4 water tight enclosure.

All non-deliberate traffic pull box covers shall comply with all test provisions of ANSI/SCTE 77 2010 "Specification for Underground Enclosure Integrity" and shall meet Tier 15 application. Markings showing the Tier 15 rating shall be embossed on the top surface of the cover.

All non-deliberate traffic pull boxes shall comply with all test provisions of ANSI/SCTE 77 2010 "Specification for Underground Enclosure Integrity" and shall meet the Tier 22 application. Markings showing the Tier 22 rating shall be labeled or stenciled on the inside and outside of the box.

All non-deliberate traffic pull boxes and covers shall be made of polymer coated concrete

with fiberglass reinforcement. The box shall have continuous fiberglass cloth reinforcement on the inside and outside perimeter. The covers must have a minimum of two (2) layers of fiberglass cloth reinforcement.

All deliberate traffic rated pull boxes and covers must be made from matched metal tooling to ensure product uniformity.

All Covers must be secured to pull box using ½-13UNC S.S. penta head bolts.

Fasteners must be capable of withstanding a torque of 56 ft-lbs and a pull out strength of 750 lbs. The pull out test must be performed with the cover in place and fasteners torqued to 56 ft-lbs. Fasteners, inserts, and cover must not be damaged by the performance of this test.

Covers must have a non-skid surface with recessed lock-down locations for penta head bolts and pry bar slots.

The nominal dimensions of the opening in which the cover sits must be the same as the cover dimensions except the length and width dimensions must be 1/8" or greater.

Provide cast iron covers for concrete pull boxes where concrete pull boxes are specified in the Contract.

Fabricate No. 4 bare copper ground clamps to attach grounds to cast iron or steel covers where used on pull boxes without grounding provisions, unless otherwise specified in the Contract.

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. Glue in logos shall not be permitted. On deliberate traffic rated 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 entrainment, 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 three (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. Pull boxes should not be installed within the ADA ramp area.

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 Deliberate Traffic Rated 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 two (2) inch maximum size rock fill, surrounded by drainage geotextile.

With the exception of metal pull boxes installed in concrete, provide an 18 inch deep sump below pull boxes. If using pull box extensions with pull boxes to provide extra depth, make sumps 30 inches deep.

Excavate holes to allow a minimum six (6) inch 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—Reserved

710.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Electrical Pull Box (Standard)</i>	Each
<i>Electrical Pull Box (Large)</i>	Each
<i>Electrical Pull Box Extension</i>	Each
<i>Metal Pull Box</i>	Each
<i>Splice Cabinet</i>	Each
<i>Traffic Signal Manholes</i>	Each

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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 710.5 BASIS OF PAYMENT and 710.5.1 Work Included in Payment.

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 per NEC®.

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.

The Contractor may use cable pulling lubricant for inserting conductors into conduit. Install bushings on metallic conduit ends before pulling wire.

For each conductor or cable, leave a minimum of four (4) ft of slack at each signal or lighting Standard and a minimum of two (2) ft of slack at each pull box.

Wire nut 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 (2) 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 (2) 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 using spades 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 (1) 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 inch.

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 (1) or two (2) 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 (2) compartments. Fit one (1) 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 midjet 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 as 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 inch 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 (3) layers of pipe insulation tape, 0.01 inch minimum thickness, or place through a one (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 (1) lock nut inside and one (1) lock nut outside of each box when the box is not threaded.

711.4 METHOD OF MEASUREMENT—Reserved

711.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Multi-Conductor Cable</i> ____(number)	Foot
<i>Single Conductor</i> ____(AWG number)	Foot
<i>Communication Cable</i> ____(number) Pair	Foot

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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 711.5 BASIS OF PAYMENT and 711.5.1 Work Included in Payment.

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 inch 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 inch 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 inch. 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. Mount the optical system so that its parts are readily accessible or removable. 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 inch supporting pipe frame.

Hinge each door and secure to the body of the housing with two (2) 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 inch. 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 (2) 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 inch nominal length tunnel visor of 3003-H16 corrosion-resistant aluminum alloy sheet a minimum of 0.04 inch thick in accordance with ASTM B 209. Encircle the lens with tunnel visors for 300° with a four (4) inch open slot on the bottom. Provide the visor with four (4) twist-on attaching ears for installation to the signal door by four (4) corrosion-resistant screws. Provide the vertical outer face of the door with four (4) 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 inch 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 (2) 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 inch.
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 inch signal visors;
2. Retrofit into existing 12 inch 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.

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 (2) 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 (1) 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 one (1) inch² 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 inch (nominal) thick, black polycarbonate plastic with a flat finish on both sides. Enclose the screen in a 0.04 inch minimum thickness polycarbonate plastic frame, 1 1/2 inch deep containing mounting holes for insertion in the doorframe;

2. Eggcrate-type screen, 0.02 inch minimum thickness aluminum made of 0.036 inch nominal thickness polycarbonate, and 1 1/2 inch deep. Mount the assembly on a polycarbonate frame of 0.04 inch minimum thickness;

Provide spacing between horizontal members of 1/2 inch, 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 inch from the closest extremity of the lamp. Provide ANSI A 21 Traffic Signal lamps, 67 W.

Provide 1/4 inch minimum thickness polycarbonate plastic lens material with pattern texture on the outside, or 1/8 inch 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 inch 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 (2) 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 ten percent (10%). Ensure that the hand or walking man symbols are at least (HxW) ten (10) inch x 6.5 inch. 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 ten percent (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 five (5) inch 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 inch 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 inch; 150 W – 3 inch).

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 (6) 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

Pay Item	Pay Unit
____(number) Section Traffic Signal Assembly	Each
____(number) Section Optically Programmed Signal Assembly	Each
Pedestrian Signal: Neon	Each
Pedestrian Signal: Incandescent	Each
____(number) Section Back plate	Each
Directional Louver	Each
Pedestrian Sound Unit	Each
____(number) Section Traffic Signal Assembly (LED)	Each
Pedestrian Signal (LED)	Each

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.

713.1 Description**713.1.1 Vehicle Detection System**

This Work shall consist of furnishing and installing a Vehicle Detection System that detects vehicles on a Roadway via processing of images and/or objects 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) as specified in the Contract;
 - 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, as specified by the manufacturer, consisting of components necessary to maintain the quality of video signal;
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 (4) synchronous video sources, including CCTV video cameras and video 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 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 (3) 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 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 or Ethernet port. Make provision for downloading data via a modem and dial-up telephone lines, DSL, Ethernet, 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.

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 when preferred or recommended by the manufacturer. 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 20 feet or higher above the Roadway, or as recommended by the manufacturer, 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 as specified by the Traffic Services Engineer. Provide a system that allows a single camera, placed at the proper mounting location with the proper lens, to monitor from six (6) to eight (8) 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; 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 current micro processing technology. 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 the following input power levels:

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 National Transmission Standards Committee (NTSC) (color) composite video inputs, so signals from four (4) cameras or other synchronous, or non-synchronous, video sources process in real-time. 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 manufacturer shall contact the Departments 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 inch to ½ inch, 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 NTSC, or CCIR video signals;
3. Each camera shall be house, as a minimum, in NEMA 4 water-resistant, dustproof and/or gas filled enclosure;
4. Uses a single industry 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 per the Contract. 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 a digital, 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, 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 (1) 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 Radar Presence Detector (RPD)

The Radar Presence Detector (RPD) is an FMCW (Frequency Modulated Continuous Wave) radar device that provides accurate vehicle detection at the stop bar, and has the following features:

1. Reports real-time presence of both moving and stopped vehicles;
2. Operating Frequency of 24.0 – 24.25 GHz (K-Band). K-Band provides the widest allowable bandwidth. This larger bandwidth provides a higher resolution signature with greater accuracy;
3. Real Time Presence Data in 10 Lanes;
4. The Availability of 12 zones and 16 channels with user selectable zone to channel mapping Zones can be linked together using OR and AND logic;
5. Fail-Safe Mode to put the intersection into recall in communication to the RPD is lost; and
6. No Cleaning or Adjustment necessary to maintain performance.

713.2.2.1 Mounting and Positioning

1. Each RPD sensor shall be mounted on the backside of the opposing approaches mast-arm unless a special circumstance exists that prevents this mounting placement.
2. Each RPD sensor will be mounted at a height of 20 ft +/- 5 ft. The mounting height will be no more than 35 ft and no less than 15 ft.
3. Each RPD sensor shall be capable of being mounted at a minimum of a 0 ft offset from the nearest lane of interest.
4. Each RPD sensor shall be aligned so that the area of detection begins five (5) ft. downstream of the stop-bar and continues upstream for 100 ft.
5. Each RPD Sensor will be mounted on a six (6) inch two (2)-axis heavy duty sensor mount that will be attached to the mast-arm by at least two (2) Band-it straps.
6. A 12 AWG stranded wire will be tapped to the pole and connected to the RPD's grounding lug.

713.2.2.2 Connections and Cabling

1. A cable with a brass Mil-Spec connector will be connected to the sensor and run down the pole into a junction box mounted to the backside of the signal pole or

- located per Signal Lab direction.
- 2. Silicon Dielectric Compound will be applied to the connection point between the sensor and the connector on the cable.
- 3. Bulk Cable will be terminated into the supplied junction box. The junction box will be located in the mast arm through the hand hole on the mast arm upright or outside the pole at a minimum of 10'. The bulk cable will be run from the junction box in the mast arm pole, thru conduit to the Traffic Signal cabinet.
- 4. Bulk Cable will be terminated into terminal blocks on a pre-assembled back plate located in the Traffic Signal Cabinet.

713.2.2.3 Traffic Cabinet Components

- 1. Each RPD system will have a pre-assembled backplate installed into the traffic cabinet, which will include: AC/DC power conversion, Surge Protection, Terminal Blocks for cable landing, and Communication Connection points.
- 2. The RPD shall use contact closure input file cards with 2 or 4 channel capabilities. The contact closure input file cards for the RPD shall be compatible with industry standard detector racks.

713.2.2.4 Number of RPD's Per Intersection

- 1. There shall be one (1) RPD for each approach of the intersection requiring stop-bar detection.

713.2.2.5 Electrical

- 1. The RPD shall consume less than 10W.
- 2. The RPD shall operate with a DC input between 9 VDC and 28 VDC.
- 3. The RPD shall have onboard surge protection.

713.2.2.6 Communication Ports

- 1. The RPD shall have two (2) communication ports, and both ports shall communicate independently and simultaneously.
- 2. The two (2) communication ports will allow remote communications without interrupting the operation of the RPD and its interface to the contact closure cards and Traffic Signal controller.

713.2.2.7 Configuration

- 1. The RPD shall have a method for automatically defining Traffic Lanes, stop bars and zones without requiring user intervention. This auto-configuration process shall execute on a processor internal to the RPD and shall not require an external PC or other processor.
- 2. The auto-configuration method shall not prohibit the ability of the user to manually adjust the RPD configuration.
- 3. The RPD shall support the configuring of lanes, stop bars and detection zones in one (1) ft (0.3-m) increments.
- 4. The RPD shall include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic representation.

713.2.3 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.

713.2.3.1 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 14.035 Hz or 9.639 Hz, depending on the emitter control switch used.

713.2.3.2 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.

713.2.3.3 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 (3) 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 (-).

713.2.3.4 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 (3) optical detectors per channel.

Ensure the assembly provides suitable sensitivity to the optical detector signal via adjustable range settings.

Provide a plug-in, two (2) 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 \pm 0.119 Hz as Frequency I.
2. 14.035 Hz \pm 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, 0 to +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.

713.2.3.5 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.

713.2.4 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. 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, NEMA TS2,

713.2.4.1 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.

713.2.4.2 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.

713.2.4.3 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 $\frac{1}{2}$ 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.

713.2.4.4 Ducted Loop Wire

Use ducted loop wire loosely encased in $\frac{1}{4}$ 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.

713.2.4.5 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, or as specified by the user agency.

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 713.2.4.5:1, "Hot-Applied Loop Sealant Property Requirements," after curing.

Table 713.2.4.5:1
Hot-Applied Loop Sealant Property Requirements

Test	Procedure	Specification
Penetration @ 77 °F, 3.53 oz., 5 s	ASTM D 5329	35, maximum

Table 713.2.4.5:1
Hot-Applied Loop Sealant Property Requirements

Test	Procedure	Specification
Softening Point	ASTM D 36	180 °F, minimum
Ductility, 77 °F	ASTM D 113	6 inch, minimum
Mandrel Bend 180 °F, 5s, 1.07 in diameter	—	Pass
Pour temperature	—	380 °F, Minimum
Safe heating temperature	—	380 °F–420 °F

713.2.4.6 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 713.2.4.6:1, "Cold Applied Loop Sealant Property Requirements," after curing.

Table 713.2.4.6:1
Cold-Applied Loop Sealant Property Requirements

Test	Procedure	Specification
Hardness	ASTM D 2240	65–85
Tensile strength	ASTM D 412	500 psi, minimum
Elongation	ASTM D 412	400%, minimum
Adhesion (peel strength) (Canvas to conc.)	ASTM D 903	15 lb, minimum
Arc resistance	ASTM D 49	71 s, minimum
Dielectric strength @ 50 Hz	ASTM D 150	6.35, minimum

713.2.4.7 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 μ H to 1,000 μ H 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 \pm five percent (5%), after initial adjustment. Optically couple detector outputs. Provide a fail-safe (closed) output in case of power loss.

713.2.4.8 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."

713.2.5 Operation

Provide digital switches on the front panel or software for making operational selections or adjustments. Provide a minimum selection of three (3) frequency ranges and three (3) 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.

713.2.6 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.

713.2.7 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.

713.2.8 Pedestrian Detectors

713.2.8.1 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 inch minimum thickness. Make the signs nine (9) inch x 12 inch.

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 (2) coats of powder coat or best quality infrared oven baked paint as follows:

1. First Coat: Baked epon primer, zinc chromate, or equal.
2. Second Coat: Flat black or when specified Federal yellow alkyd urea baked enamel matching Federal Standard 595 A Color Chip 33538.

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 Radar Presence Detector (RPD)

RPD's shall be mounted on the specified supports as called for and detailed in the Special Provisions for RPD's.

713.3.2.1 Physical Properties

1. Provide an RPD unit consisting of an enclosure of that conforms to the NEMA 250 Standard for type 4X enclosures.
2. Obtain the operating voltage (115 V AC) for the pre-assembled backplate directly from the Traffic Signal Cabinet.
3. All external components of the RPD shall be ultraviolet-resistant, corrosion-resistant, and protected from fungus growth and moisture deterioration.
4. The RPD shall be able to withstand a fall of five (5) ft without compromising its functional and structural integrity.
5. The RPD shall include a connector that meets the MIL-C-26482 specification. The Mil-C-26482 connector shall provide contacts for all data and power connections.

713.3.2.2 Radar Design

1. The RPD shall be designed with a matrix of radars.
2. The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

3. The RPD antennas shall be designed on printed circuit boards.
4. The RPD shall transmit a signal with a bandwidth of at least 245 MHz. This bandwidth provides the greatest accuracy for distinguishing closely spaced vehicles and gives the highest possible resolution.
5. The RPD shall provide at least 8 RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.
6. The RPD shall have a self-test that is used to verify correct hardware functionality.

713.3.2.3 Operating Conditions

1. The RPD shall maintain accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk.
2. The RPD shall be capable of continuous operation over an ambient temperature range of -40°F to 165.2°F (-40°C to 74°C).
3. The RPD shall be capable of continuous operation over a relative humidity range of five percent (5%) to 95% (non-condensing).

713.3.2.4 Warranty, Maintenance, and Support

1. The Contractor shall obtain and assign to the Department all manufacturers guarantees or warranties which are normally provided as customary trade practice for items and Materials incorporated into the Work. In the absence of a manufacturer's guarantee, the Contractor shall warrant that mechanical and electrical Equipment and material incorporated into the Work are free from any defects or imperfections in workmanship and material for a period of one (1) year after final Acceptance of the Project. The Contractor shall be responsible for repairing any malfunction or defect in any such Equipment or material, which develops during the one (1) year period.
2. The Contractor shall supply two (2) sets of installation guides and user manuals for the Equipment incorporated in the Project, one (1) of which shall be submitted to the Department with submittal of manufacturers shop drawings.

713.3.3 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.

713.3.3.1 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.

713.3.4 Loop Detectors

Install loop detector consisting of two (2) 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.

713.3.4.1 Loop Detectors Installation Requirements and Procedures

713.3.4.1.1 Saw Cuts

Make saw cuts using an abrasive cutting wheel concrete saw. Make saw cuts from 2¼ inch to 2½ inch deep and approximately 0.275 inch wide. Use a ⅝ inch 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 inch 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 two (2) inches 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 two (2) inch 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 (1) 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 six (6) inches. 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.

713.3.4.1.2 Rigid Electrical Conduit Entrance

Provide a separate one (1) inch 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.

713.3.4.1.3 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 (4) 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 two (2) inches 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 one (1) inch radius.

713.3.4.1.4 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 ¼ inch of the top. Do not allow spillover onto the pavement surface; immediately strike off excess material.

713.3.4.1.5 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.

713.3.5 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 ¼ inch to ½ inch 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 one (1) inch and in layers equal to or greater than 1½ 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 four (4) inches.

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.

713.3.6 Integrity Test Check

After completing loop installation in the Roadway, check each loop with a megger, if required, 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."

713.3.7 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—Reserved

713.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>CVP</i>	Each
<i>Video Cable</i>	Foot
<i>Video Camera</i>	Each
<i>Video Hardware System</i>	Each
<i>Radar Presence Detector (RPD)</i>	Each
<i>Optical Detector Cable</i>	Foot
<i>Optical Emitter</i>	Each
<i>Loop Detector Wire</i>	Foot
<i>Ducted Loop Detector Wire</i>	Foot
<i>Loop Lead-in Cable</i>	Foot
<i>Detector Saw Cut</i>	Foot

Phase Selector Rack, ____ Channel

Each

Phase Selector Module

Each

The Department will pay for conduit for detector installations in accordance with Section 709, "Rigid Electrical Conduit."

713.5.1 Work Included in Payment

The following Work and items will be considered as included in the payment for Radar Presence Detector (RPD) and will not be measured or paid for separately:

- A. RPD Sensor, Sensor Mount, Sensor Cable, splice box, preassembled back plate and two (2) channel detector card for interface to Traffic Signal controller.
- B. When the number of approaches has been established to create one (1) detection unit, no additional payment shall be made for integration.

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/Type 2 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 microprocessors.

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 or super cap backup in the same module for power-down clock operation and battery or super cap-backed random-access memory (RAM) for non-programmed data such as message logs for a minimum of 72 hours.

Provide controller ports with the following capabilities:

1. Direct interface with a personal computer for uploading and downloading program data; and
2. Direct interface with a dial-up modem or Ethernet 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) or touch screen 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 (2) 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.

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 (6) independent preemption programs. Make it possible to prioritize preemption; Delay before preemption, cycle during preemption and 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 preempt data is printable. Provide railroad preemption in accordance with the *Manual on Uniform Traffic Control Devices, current edition*, 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 $\pm 0.005\%$.

Provide battery or super cap backup capable of maintaining real time and memory for at least 72 hours. Provide a time clock that keeps track of time of Day in seconds, Day of week, and date and programmable automatic daylight savings time changes. If a power disruption occurs, ensure that the coordinator will automatically restart itself once line voltage returns. Provide a coordinator capable of 100 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 (4) cycles, four (4) splits per cycle, three (3) offsets per cycle, three (3) permissive periods per split, one (1) pedestrian permissive period per split, and three (3) 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 add only, or smooth 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,

date, 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 surface mount technology that meet NEMA requirements for Traffic Signal controllers. Cover current-carrying traces with a solder mask material. Coat boards containing 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 (5) 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 (2) 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 \pm 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 current NEMA Standards TS2, 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 714.2.1.5.1:1
Timing Intervals and Minimum Range of Adjustment

Interval	Timing range (s)	Maximum resolution (second increments)
Initial or minimum	0–99	1
Extension (gap)	0–9.9	0.1
Yellow change	0–9.9	0.1
Red clearance	0–9.9	0.1
Maximum (Max 1)	0–99	1
Maximum (Max 2)	0–99	1
Walk	0–99	1
Pedestrian clearance	0–99	1
Red revert	2–7	1

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 (2) 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 (8) 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 (4) 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 per NEMA.

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

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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 (3) 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, including follow up timing adjustments and/or fine tuning as required by the Department.

714.2.2.2.1 System Training

Hire a traffic engineering consultant to train Department personnel for two (2) 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 (2) 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 aluminum that is at least 1/8 inch thick. Fabricate pedestal cabinets of aluminum at least 1/8 inch 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 (1) door in the front and one (1) 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 inch x 20 inch. 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 (2) 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 714.2.3.1.4:1 Control Cabinet Dimensions Requirements		
Type of cabinet	Outside dimensions H x W x D (inch)	Use
G	33 x 20 x 14	If specified on Plans
M	48 x 30 x 16	If specified on Plans
MS	54 x 38 x 24	4-phase single-ring operation
P	54 x 38 x 24	8-phase dual-ring operation
R	72 x 38 x 24	If specified on Plans

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

1. Cabinet finish per user agency; or
2. For powder coating, use the following two (2) coat finish:
 - a. A four (4) stage iron phosphate coating, and
 - b. A triglycidyl isocyanurate polyester powder coat paint matching Federal Standard 595A Color Chip 27886, with a minimum thickness of two (2) mm.

714.2.3.2 Cabinet Wiring, Terminals and Facilities

Provide wiring, terminals, and facilities within the cabinet in accordance with NEMA TS2, or the latest NEMA Standards.

Perform all field flash sequence programming at the field terminals using only a screwdriver or flash color plug. Do not debus the field terminal blocks for flash programming.

Provide field terminal blocks wired with four (4) 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 714.2.3.2:1
Back Panel Wiring Requirements

Description	Wire color	Gauge
Green/Walk load switch output	Brown	14
Yellow load switch output	Yellow	14
Red/Don't Walk load switch output	Red	14
CMU (other than AC power)	Violet	22
Controller I/O	Blue	22
AC + (power panel to main panel)	Black	8
AC + (main panel)	Black	10
AC - (power panel to main panel)	White	8
AC - (main panel)	White	10
Chassis ground (power panel)	Green	8
DC ground	Grey	22
Flash programming	Orange	14

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 inch 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 and power bus 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 inch quick-connect tab type, 300 V and 20 A rated. Mechanically strip the wire ¼ inch, 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 714.2.3.2.1:1
Load Switch/Flasher Unit Positions

Type of cabinet	Load switch positions	Flash relay positions	NEMA flasher
Phase single ring	8	2	1
8-phase dual-ring	16	4	1

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

Type of cabinet	Detector rack positions	Detector terminal blocks
4-phase single-ring	16	16
8-phase dual-ring	16	16
8-phase dual-ring	Up to 32	Up to 32

Table 714.2.3.2.3:2
4-Phase Single-Ring Operation 16-Channel Detector Rack Order of Positioning

PH1	PH2	PH4	PH2EC	PH1	SD1	SD2	SD4
PH3	PH2	PH4	PH4EC	PH3	SD3	SD2	SD4

714.2.3.2.3:3
8-Phase Dual-Ring Operation 16-Channel Detector Rack Order of Positioning

PH1	PH2	PH6	PH2EC	PH3	PH4	PH8	PH4EC
PH5	PH2	PH6	PH6EC	PH7	PH4	PH8	PH8EC

Table 714.2.3.2.3:4**8-Phase Dual-Ring Operation Additional Detector Rack^a**

Dual lefts				System detectors and preemption			
PH1	PH3	SD1	SD2	SD6	SD3	SD4	SD8
PH5	PH7	SD5	SD2	SD6	SD7	SD4	SD8

^aProvide only additional channels required on Plans

Provide connector/pin assignments (2 x 22 pin edge card connector with 0.156 in contact centers, key slots located between B and C, and M and N) in accordance with Table 714.2.3.2.3:5, "Connector/Pin Assignments."

Table 714.2.3.2.3:5
Connector/Pin Assignments

Connector/pin	Assignment
A	DC (-) common
1	Call Delay inhibit (Channel 1)
B	DC (+) power
2	Call Delay inhibit (Channel 2)
C	Reset
4 and D	Loop # 1
5 and E	Loop # 1
F	Output # 1A Opto-coupler (Collector)
H	Output # 1A Opto-coupler (Emitter)
8 and J	Loop # 2
9 and K	Loop # 2
L	Chassis ground
S	Output 1B AccuCount FET (Drain)
w	Output # 2A Opto-coupler (Collector)
x	Output # 2A Opto-coupler (Emitter)
y	Output # 2B AccuCount FET (Drain)
z	Output # 1C Fail FET (Drain)
19	Output # 2C Fail FET (Drain)

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 (2) 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 to support and protect communications required.

Provide the telemetry interface panel with a socket-mounted, communication line transient protection device wired in series with the telemetry communication circuit where copper is used. Match the communication line impedance with the transmitter output impedance to minimize line noise.

714.2.3.2.7 Wiring Diagrams

Provide four (4) sets of wiring diagrams for each cabinet. Provide a plastic envelope in the cabinet to house two (2) 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.

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 20 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 20 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 $\frac{7}{16}$ inch;
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 (1) quad outlet for test Equipment, tools, and lighting mounted on the upper left hand side of the cabinet. A second duplex GFCI convenience outlet mounted on the upper right hand side of the cabinet. 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 20 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. LED Light Door Switch. Include a door switch for each cabinet that turns the cabinet LED lights 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 inch mesh screen to prevent the operator from contacting the fan blades. Provide a filter for the cabinet intake fan vent;
2. LED Light. Mount a LED fixture in the cabinet over the door; position to minimize damage when sliding Equipment off shelves. Mount a LED fixture on the bottom of the cabinet, position to minimize damage. Secure LED lights separately when transporting to avoid breakage. Provide a door switch for the LED lights;
3. Door Stops. Provide a stop for each controller cabinet door of 22 inch or greater width, or 6 ft² 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 (3) 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 (5) 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 (3) 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 two (2) 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 (1) RC network in parallel with each group of three (3) 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-16E, or MMU-16LE Smart Monitor with Ethernet port where required) units shall be the self-contained, shelf mounted type with the appropriate NMEA MS, Port 1 SDLC, RS232 and ethernet 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 inches x 4.5 inches x 11 inches (H x W x D).
 - a. The enclosure shall be constructed of sheet aluminum with a minimum thickness of 0.062 inches, 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 an 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 -34°C to +74°C;
 - 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:

<u>PIN</u>	<u>FUNCTIONS</u>
1	DCD*
2	TX DATA
3	RX DATA
4	DTR (Data Terminal Ready)
5	SIGNAL GROUND
6	DSR*
7	DSR*
8	CTS*
9	NC

*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."

714.3.2 Testing

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 will begin testing of the Controller Cabinet(s) for a minimum 15 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 15 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 and Signal Lab Technician will final accept of all controllers and cabinets in accordance with Section 705.3.5.2, "Operation Tests."

714.3.3 Turn-On

Do not turn-on controllers and auxiliary Equipment after installation, until the Signal Lab Technician 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 (5) 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.

714.3.4 Modifications

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—Reserved

714.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Traffic-Actuated Controller</i>	Each
<i>System Master</i>	Each
<i>_____ (type) Controller Cabinet</i>	Each
<i>Closed Loop Traffic Control System</i>	Lump Sum

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<i>Remove and Reset Signal Controller</i>	Each
<i>Remove and Reset Controller Cabinet</i>	Each
<i>Controller Interconnect System</i>	Each

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 714.5 BASIS OF PAYMENT.

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 inch 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 three (3) gauge wall thickness (approximately 1/4 inch 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 inch, are five (5) ft long with minimum tensile strength of 85,000 psi, unless otherwise specified in the Plans. Provide two (2) 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 (5-banana jack, female base) type or (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 (2) police keys with each cabinet. Provide a cabinet at least 12 inch wide x ten (10) inch high x six (6) inch 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 inch galvanized rigid conduit, unless otherwise specified in the Plans.

All cabinets (inside and outside surfaces) shall be finished as follows:

1. Cabinet finish per user agency;
2. For powder coating, use the following two (2) coat finish:
 - a. A four (4) stage iron phosphate coating;
 - b. A triglycidyl isocyanurate polyester powder coat paint matching Federal Standard 595A Color Chip 27886, with a minimum thickness of 2mm.

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 (1) 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 (8) 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.

715.2.3.4 Time Clock

Provide a time clock with an automatic Daylight Savings Time correction. Ensure the time switch allows the flashing field indications to be turned on or off manually or on a time of Day basis. Mount the time clock unit on the backside of the door.

715.3 CONSTRUCTION REQUIREMENTS

Mount beacons and flasher controllers 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 inches 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—Reserved

715.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Beacon Assembly</i>	Each
<i>Flasher Controller</i>	Each
<i>Flasher Controller with Time Clock</i>	Each
<i>Span Wire Installation</i>	Lump Sum

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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 715.5 BASIS OF PAYMENT.

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 two (2) inch 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 refractor 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 refractor 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 one (1) inch or two (2) inch pipe brackets without removing the clamping device. Also, provide the slip fitter capable of leveling of the Luminaire horizontally $\pm 3^\circ$.

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 type, lamp wattage, and line voltage are in accordance with the Contract.

Ensure the slip fitter accepts a two (2) inch 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 an optical assembly that allows 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 one (1) inch pipe slip fitter. Provide a one (1) inch Schedule 40 steel pipe support bracket securely welded to a 1/2 inch 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 (3) or four (4) 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 one (1) ft² of sign face to any adjacent one (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 (3) 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 reflector, 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 luminaires capable of illuminating an area equal to one (1) mounting height on either side of the fixture, and two (2) 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 Table 716.2.7.1, "High-Intensity Discharge Lamp/Ballast Requirements.")

716.2.6.1 Metal Halide Lamp Ballast

Provide constant-wattage, auto-regulated ballasts for metal halide lamps with a voltage input range of \pm ten percent (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 \pm ten percent (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 \pm ten percent (10%), and ballast loss of no more than ten percent (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 \pm ten percent (10%), and a ballast wattage loss of no greater than ten percent (10%).

716.2.7 Lamps

Provide HID lamps for Luminaires in conformance with the requirements shown in Table 716.2.7:1, "High-Intensity Discharge Lamp Requirements."

Table 716.2.7.1
High-Intensity Discharge Lamp/Ballast Requirements

Description watts (ANSI)	Minimum initial lumens^a	Minimum rated life (h)	Use
Metal Halide:			
175 Coated (M57)	15,000 (h)	7,500	Sign Lighting
400 Clear (M59)	32,000 (h)	20,000	Roadway
1000 Clear (M47)	115,000 (V)	12,000	High Mast
Sodium:			
70 Clear (S62)	6,300	24,000	Underpass, Rest Area
100 Clear (S54)	9,500	24,000	Rest Area
150 Clear (S55)	16,000	24,000	Underpass, Rest Area
200 Clear (S66)	22,000	24,000	Roadway, Rest Area
250 Clear (S50)	27,500	24,000	Roadway, Rest Area
400 Clear (S51)	50,000	24,000	Roadway, Rest Area
1000 Clear (S52)	140,000	24,000	High Mast

^aVertical 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 (2) 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 Luminaires.

Place ornamental poles and Luminaires in accordance with the Contract requirements and the manufacturer's recommendations, as approved by the Project Manager.

716.4 METHOD OF MEASUREMENT—Reserved

716.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Roadway Luminaire Type_____</i>	Each
<i>Area Luminaire Type_____</i>	Each
<i>Underpass Luminaire</i>	Each
<i>High Mast Luminaire Type_____</i>	Each
<i>Ornamental Pole and Luminaire</i>	Each

The Department will specify the Luminaire 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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 716.5 Basis Of Payment and 716.5.1 Work included in payment.

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 three percent (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 four (4) inches 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 four (4) inches 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 (1) 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 (2) 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—Reserved

720.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Permanent Vehicular Impact Attenuator Unit</i>	Each
<i>Vehicular Impact Attenuator Unit Work Zones</i>	Each
<i>Sand Barrel Vehicular Impact Attenuator Unit</i>	Each
<i>Remove and Reset</i>	Each

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.

Any other items installed by the Contractor for the installation of items covered by this

Section 720: Vehicular Impact Attenuator Units Page 767

specification shall be consider Incidental to the items listed in section 720.5 Basis Of Payment and 720.5.1 Work included in payment.

SECTION 721: PAVEMENT MARKING REMOVAL

721.1 DESCRIPTION

This Work consists of removing existing pavement stripes and markings.

721.2 MATERIALS—Reserved

721.3 CONSTRUCTION REQUIREMENTS

Use Equipment that is capable of completely removing pavement stripes 1/4 inch \pm 1/8 inch 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—Reserved

721.5 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Removal of Pavement Stripe</i>	Foot
<i>Removal of Pavement Marking</i>	Each

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.

Any other items installed by the Contractor for the installation of items covered by this specification shall be consider Incidental to the items listed in section 721.5 BASIS OF PAYMENT and 721.5.1 Work Included in Payment.

DIVISION 800 – CONSTRUCTION STAKING AND POST CONSTRUCTION PLANS

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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
6. Lines and grades.

The Department will supply the data as printout sheets, field books, electronic files (when available, and at the discretion of the Department), 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. Per NMSA 61-23-26, Public Work, a New Mexico licensed professional surveyor is required to be in responsible charge of construction staking surveys for engineering and architectural public Works projects with a construction cost of \$100,000.00 or greater.

Locate and establish control points with the data given in the Plans.

Verify Department-provided survey data, and submit changes or adjustments (including recorded data) to the Project Manager for approval at no cost to the Department.

801.2 CONSTRUCTION REQUIREMENTS

801.2.1 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 61-23-28 NMSA, Reference marks; removal or obliteration; replacement, and

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 prismatic 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."

Contractor will make every effort to preserve and reference the provided survey control points in such a manner, that their location can be reestablished by the contractor in cases of weather related disturbances or vandalism.

Contractor will perform necessary transformation/calibration utilizing the referenced control points provided by the Department so that all survey Work is in the coordinate system provided by the DOT.

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 construction centerline. Establish necessary Right of Way centerline Project stationing and reference stakes for use in determining the location of the Right of Way for construction staking purposes, and re-establishing the Right of Way 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 routine slope stake changes as needed to blend slopes into the existing terrain as approved by the Project Manager.

Perform slope stake changes required to blend slopes into the existing terrain as approved by the Project Manager for additional Work as defined 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 one (1) inch x five (5) inch x 14 inch black on white with three (3) inch stenciled numbers. Mount the markers on the fence or on an appropriate shop-made post four (4) feet 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

Pay Item	Pay Unit
<i>Construction Staking by the Contractor</i>	Lump Sum
<p>The Department will make partial payments in accordance with the approved construction-staking schedule of values. The Department considers slope stake changes and other staking changes as Incidental to the completion of the Work and will not measure or pay for it separately.</p>	

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 but not limited to alterations in the grade or alignment of the Road, structures, or both. Post Construction Plans shall be kept current and readily available at all times for the Project Manager to review.

The Post Construction Plans, including any revised plan sheets, shall be neat, legible and of the size let. All revisions to the original Plans shall be delineated in black ink, located properly on the drawing, legible and true to scale. Every Post Construction Plan, Profile, and Cross Section Sheet shall be designated as such by note or stamp "As-Built" in the upper right area in black.

802.1.1.1 Contractor-Supplied Documents and Services

Provide qualified personnel to perform Post Construction Plan updates and 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 both electronic & paper copy. If there is no electronic data submitted for survey, the Post Construction Plans will be paper copy submittals. All paper copy submittals shall be 24" x 36" in size unless otherwise specified by the Project Manager.

802.2 CONSTRUCTION REQUIREMENTS**802.2.1 General**

The Post Construction Plan submittal shall include but not be limited to the following:

1. Changes to the length of Project in miles;
2. Changes to the B.O.P. and E.O.P. in stationing and milepost location;
3. Changes to the station equations; all equations shall be listed;
4. All Structures, as built, and changes to Major Structures with Structure Number and span length, shall be shown on the plan and profile sheets and Structure sheets;
5. Typical section changes and station to station locations, including subexcavation limits, cut and fill limits, with the in place depth of each type of surfacing (subexcavation, Subbase, Base Course, HMA, etc.) on each plan and profile sheet;
6. Final quantities in appropriate columns on the plan set;
7. Changes to widths and locations of turnouts and Median openings, with radii indicated and changes to Structures, on Plan and Profile sheets;
8. All line, grade, and super elevation rate 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 casings, offsets, depths, or elevations. Service lines to private property are not required;
11. 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;
12. All build notes shall be edited identifying changes made. Build notes not requiring edit shall be check marked;
13. Verify all Change Order information, excluding Gross Receipt Tax Change Orders,

has been transferred to the Post Construction Plans and the proper sheets have been inserted and indexed and refer to the Change Order number;

14. Post Construction Plans should not use destructive binding & should be bound in a manner acceptable by the Project Manager; and
15. General Notes/Call Out sheets shall be edited changing the tense of each item to indicate what was done; strike-through of items not required or completed on the Project shall be done retaining legibility.

802.3 BASIS OF PAYMENT

Pay Item	Pay Unit
<i>Post Construction Plans</i>	Lump Sum

DIVISION 900 – QUALITY CRITERIA

Division Contents

901: Quality Control/Quality Assurance (QC/QA)	779
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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. Testing frequency must be equal to or greater than the Minimum Testing Requirements, available here: <http://dot.state.nm.us>

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 subplot, 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 subplot 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:

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 shall 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, unless otherwise approved by the Assistant District Engineer for Construction, the Department will determine the pay factor using the Department's test values only for all characteristics.

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 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 (2) 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 in conjunction with the District Lab Supervisor 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

Identify the individual who will administer the plan. The individual shall have full authority to take actions necessary for the successful operation of the plan. Quality Control Technicians (QCT's) performing the actual sampling, testing, or inspection shall 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 Bureau. Allow the Project Manager to witness all sampling and testing. Take additional samples if directed by the Project Manager. The sampling plan shall be submitted as a component of the Quality Control Plan.

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 original Quality Control test results (on approved forms including all original supporting handwritten worksheets and notes) to the Project Manager within 1 Working Days of sampling. The Technician performing the testing shall sign and certify the results as "true and accurate to the best of my belief and knowledge" prior to providing the results to the Department. Failure to provide the results within 1 Working Day of sampling may result in the Project Manager ordering the Contractor to cease HMA operations until said results are provided to the Project Manager.

901.2.6 Records

Maintain copies of the complete set of original Quality Control test records (including supporting documents (calculations, scratch sheets, internal forms etc.) and, upon request, make them available to the Project Manager within 24 hours. No hard copy Laboratory testing documentation shall 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 copies of test documentation for a minimum of three (3) years after the Physical Completion Date of the Project.

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 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

TTCP 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. The maximum pay factor per lot is 1.0.

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 (Agency, Contractor or Combined); 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 Assistant District Engineer for Construction will decide if the Material may remain in place and determine the final pay factor for the material in question. If less than three (3) samples are obtained at the time a lot is terminated, they shall be incorporated in the prior lot. If no prior lot exists, the disposition of the material shall be decided by the Assistant District Engineer for Construction after evaluating with Non-QLA criteria in accordance with Section 423.3.6.2.1.1.

The Project Manager may reject Material that appears to be defective based on visual inspection.

901.5 QUALITY LEVEL ANALYSIS (QLA)

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:

$$\bar{x} = \frac{\sum x}{n} \quad (\text{Equation 1})$$

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:

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{(n-1)}} \quad (\text{Equation 2})$$

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:

$$Q_U = \frac{USL - \bar{x}}{s} \quad (\text{Equation 3})$$

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:

$$Q_L = \frac{\bar{x} - LSL}{s} \quad (\text{Equation 4})$$

Where,

Q_L is the lower quality index

\bar{x} is the arithmetic mean

LSL is the lower specification limit or TV minus allowable deviation below TV

s is the sample standard deviation

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 Q_U or Lower Quality Index Q_L ." 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 Q_U or Lower Quality Index Q_L ." 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:

$$Q = (P_U + P_L) - 100 \quad (\text{Equation 5})$$

Where,

Q is the quality level

P_U is the percent of test values below 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:

$$CPF = \frac{[f_1(PF_1) + f_2(PF_2) \dots f_j(PF_j)]}{[f_1 + f_2 \dots f_j]} \quad (\text{Equation 6})$$

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—Reserved

901.7 BASIS OF PAYMENT

The Department will pay for *Contractor Process Quality Control* on QLA Projects 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.

Pay Item

Contractor Process Quality Control

Pay Unit

Lump Sum

Table 901.7:1 QUALITY LEVEL ANALYSIS BY THE STANDARD DEVIATION METHOD UPPER QUALITY INDEX QU OR LOWER QUALITY INDEX QL															
Pu or Pl	n=														
	3	4	5	6	7	8	9	10 to 11	12 to 14	15 to 17	18 to 22	23 to 29	30 to 42	43 to 66	67 to ∞
100	1.16	1.49	1.72	1.88	1.99	2.07	2.13	2.20	2.28	2.34	2.39	2.44	2.48	2.51	2.56
99	—	1.46	1.64	1.75	1.82	1.88	1.91	1.96	2.01	2.04	2.07	2.09	2.12	2.14	2.16
98	1.15	1.43	1.58	1.66	1.72	1.75	1.78	1.81	1.84	1.87	1.89	1.91	1.93	1.94	1.95
97	—	1.40	1.52	1.59	1.63	1.66	1.68	1.71	1.73	1.75	1.76	1.78	1.79	1.80	1.81
96	—	1.37	1.47	1.52	1.56	1.58	1.60	1.62	1.64	1.65	1.66	1.67	1.68	1.69	1.70
95	1.14	1.34	1.42	1.47	1.49	1.51	1.52	1.54	1.55	1.56	1.57	1.58	1.59	1.59	1.60
94	—	1.31	1.38	1.41	1.43	1.45	1.46	1.47	1.48	1.49	1.50	1.50	1.51	1.51	1.52
93	1.13	1.28	1.33	1.36	1.38	1.39	1.40	1.41	1.41	1.42	1.43	1.43	1.44	1.44	1.44
92	1.12	1.25	1.29	1.31	1.33	1.33	1.34	1.35	1.35	1.36	1.36	1.37	1.37	1.37	1.38
91	1.11	1.22	1.25	1.27	1.28	1.28	1.29	1.29	1.30	1.30	1.30	1.31	1.31	1.31	1.31
90	1.10	1.19	1.21	1.23	1.23	1.24	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.26	1.26
89	1.09	1.16	1.18	1.18	1.19	1.19	1.19	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.20
88	1.07	1.13	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
87	1.06	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.11	1.11	1.11	1.11	1.11	1.11	1.11
86	1.04	1.07	1.07	1.07	1.07	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
85	1.03	1.04	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
84	1.01	1.01	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
83	0.99	0.98	0.97	0.96	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94
82	0.97	0.95	0.93	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.90	0.90
81	0.95	0.92	0.90	0.89	0.88	0.88	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
80	0.93	0.89	0.87	0.86	0.85	0.85	0.84	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.83
79	0.91	0.86	0.84	0.82	0.82	0.81	0.81	0.81	0.80	0.80	0.80	0.80	0.80	0.80	0.79
78	0.88	0.83	0.81	0.79	0.79	0.78	0.78	0.77	0.77	0.77	0.76	0.76	0.76	0.76	0.76
77	0.86	0.80	0.77	0.76	0.75	0.75	0.74	0.74	0.74	0.73	0.73	0.73	0.73	0.73	0.73
76	0.83	0.77	0.74	0.73	0.72	0.72	0.71	0.71	0.70	0.70	0.70	0.70	0.70	0.70	0.70
75	0.81	0.74	0.71	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.67	0.67	0.67	0.66
74	0.78	0.71	0.68	0.67	0.67	0.65	0.65	0.65	0.64	0.64	0.64	0.64	0.64	0.64	0.63
73	0.75	0.68	0.65	0.64	0.63	0.62	0.62	0.62	0.61	0.61	0.61	0.61	0.61	0.61	0.60
72	0.73	0.65	0.62	0.61	0.60	0.59	0.59	0.59	0.58	0.58	0.58	0.58	0.58	0.58	0.57
71	0.70	0.62	0.59	0.58	0.57	0.57	0.56	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.54
70	0.67	0.59	0.56	0.55	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52
69	0.64	0.56	0.53	0.52	0.51	0.51	0.50	0.50	0.50	0.49	0.49	0.49	0.49	0.49	0.49

Table 901.7:1 QUALITY LEVEL ANALYSIS BY THE STANDARD DEVIATION METHOD UPPER QUALITY INDEX QU OR LOWER QUALITY INDEX QL															
Pu or Pl	n=														
	3	4	5	6	7	8	9	10 to 11	12 to 14	15 to 17	18 to 22	23 to 29	30 to 42	43 to 66	67 to ∞
68	0.61	0.53	0.50	0.49	0.48	0.48	0.48	0.47	0.47	0.47	0.46	0.46	0.46	0.46	0.46
67	0.58	0.50	0.47	0.46	0.45	0.45	0.45	0.44	0.44	0.44	0.44	0.43	0.43	0.43	0.43
66	0.55	0.47	0.45	0.43	0.43	0.42	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.41	0.40
65	0.51	0.44	0.42	0.40	0.40	0.39	0.39	0.39	0.38	0.38	0.38	0.38	0.38	0.38	0.38
64	0.48	0.41	0.39	0.38	0.37	0.37	0.36	0.36	0.36	0.36	0.35	0.35	0.35	0.35	0.35
63	0.45	0.38	0.36	0.35	0.34	0.34	0.34	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.32
62	0.41	0.35	0.33	0.32	0.32	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30
61	0.38	0.30	0.30	0.30	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
60	0.34	0.28	0.28	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
59	0.31	0.27	0.25	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.30	0.25	0.23	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
57	0.25	0.20	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.20	0.18	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.15	0.13	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.10	0.10	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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.															

Table 901.7:2 Pay Factors															
Pay factor	Minimum Required Percent of Work Within Specifications Limits for a Given Pay Factor (Pu+PL) – 100														
	n=														
	3	4	5	6	7	8	9	10 to 11	12 to 14	15 to 17	18 to 22	23 to 29	30 to 42	43 to 66	67 to ∞
1.05	—	—	—	—	—	100	100	100	100	100	100	100	100	100	100
1.04	—	—	—	—	100	99	97	95	96	96	96	97	97	97	97
1.03	—	—	—	100	98	96	94	92	93	93	94	95	95	96	96
1.02	—	—	—	99	97	94	91	89	90	91	92	93	93	94	94
1.01	100	100	100	98	95	92	89	87	88	89	90	91	92	92	93

Table 901.7:2 Pay Factors																
Pay factor	Minimum Required Percent of Work Within Specifications Limits for a Given Pay Factor (Pu+PL) – 100															
	n=															
	3	4	5	6	7	8	9	10 to 11	12 to 14	15 to 17	18 to 22	23 to 29	30 to 42	43 to 66	67 to ∞	
1.00	69	75	78	80	82	83	84	85	86	87	88	89	90	91	92	
0.99	66	72	76	78	80	81	82	83	84	85	86	87	89	90	91	
0.98	64	70	74	76	78	79	80	81	82	84	85	86	87	88	90	
0.97	63	68	72	74	76	77	78	79	81	82	83	84	86	87	88	
0.96	61	67	70	72	74	75	76	78	79	81	82	83	84	86	87	
0.95	59	65	68	71	72	74	75	76	78	79	80	82	83	84	86	
0.94	58	63	67	69	71	72	73	75	76	78	79	80	82	83	85	
0.93	57	62	65	67	69	71	72	73	75	76	78	79	80	82	84	
0.92	55	60	63	66	68	69	70	72	73	75	76	78	79	81	82	
0.91	54	59	62	64	66	68	69	70	72	74	75	76	78	79	81	
0.90	53	57	61	63	65	66	67	69	71	72	74	75	77	78	80	
0.89	51	56	59	62	63	65	66	68	69	71	72	74	75	77	79	
0.88	50	55	58	60	62	64	65	66	68	70	71	73	74	76	78	
0.87	49	53	57	59	61	62	63	65	67	68	70	71	73	75	77	
0.86	48	52	55	58	59	61	62	64	66	67	69	70	72	74	76	
0.85	46	51	54	56	58	60	61	62	64	66	67	69	71	72	75	
0.84	45	49	53	55	57	58	60	61	63	65	66	68	70	71	73	
0.83	44	48	51	54	56	57	58	60	62	64	65	67	69	70	72	
0.82	43	47	50	53	54	56	57	59	61	62	64	66	67	69	71	
0.81	41	46	49	51	53	55	56	58	59	61	63	64	66	68	70	
0.80	40	44	48	50	52	54	55	56	58	60	62	63	65	67	69	
0.79	39	43	46	49	51	52	54	55	57	59	61	62	64	66	68	
0.78	38	42	45	48	50	51	52	54	56	58	59	61	63	65	67	
0.77	36	41	44	46	48	50	51	53	55	57	58	60	62	64	66	
0.76	35	39	43	45	47	49	50	52	54	56	57	59	61	63	65	
0.75	33	38	42	44	46	48	49	51	53	54	56	58	60	62	64	
Reject Values less than those shown above																
Note: If the value of (Pu+PL) – 100 does not correspond to a (Pu+PL) – 100 value in this table, use the next lower (Pu+PL) – 100 value																

Item	Property	Testing frequency	Test method
Aggregate for Base Course, Hot Mix Asphalt, Warm Mix Asphalt, PCCP, and Open Graded Friction Course	Sampling	As specified	AASHTO T 2, 248
	Gradation	1 per 1,000 ton	AASHTO T 11, 27, 146 ^a
	Fractured Faces		NMDOT Method FF 1
	Sand Equivalent		AASHTO T 176 ^c
	Plasticity Index		AASHTO T 89, 90
	Moisture Content	As needed to control operations	AASHTO T 255
RAP (Recycled Asphalt Pavement) used in HMA, WMA and Base Course	Sampling	As specified	AASHTO T2, 248
	Gradation	2 per Day (on RAP that is prepared for inclusion in the Base Course or HMA)	AASHTO T30, 164, 308
	Asphalt Content		AASHTO T308
Aggregates for HMA & WMA	Los Angeles Wear	As needed to confirm quality	AASHTO T 96
	Soundness Loss	Based on AASHTO TP 58	AASHTO T 104 AASHTO T 85
	Absorption	Testing results	
Aggregate for PCCP	Sampling	As specified	AASHTO T 2, 248
	Gradation	1 per 1,000 ton	AASHTO T 11, 27
	Sand Equivalent		AASHTO T 176
	Moisture Content	As needed to control operations	AASHTO T 255
Aggregates for Base Course	Sampling	As specified	AASHTO T 2, 248
	Moisture Content	1 per 1,000 ton	AASHTO T 255
	Density		AASHTO T 180
	Gradation		AASHTO T 11, 27
	Thickness		^b
^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 inch using a measuring tape, and then replacing and recompacting the removed material.			
^c This test will not be done for Base Course.			

Table 901.7:4 Minimum Process Control Guidelines for Hot Mix Asphalt and Warm Mix Asphalt (QC)			
Item	Property	Testing frequency	Test method
HMA & WMA	Sampling	As specified	AASHTO T 168 / Agency Method AS-1
	Hydrated Lime or Anhydrite Based Material Content	Daily	Totalizing Weighing Device
	Flat/Elongated Particles	Daily	ASTM D 4791
	Fine Aggregate Angularity	Daily	AASHTO T 304
	Asphalt Content	1 per 1,000 ton ^c	AASHTO T 308
	Gradation		AASHTO T 30, 164, 308
	Air Voids		AASHTO T 166, 209, 269
	Voids in Mineral Aggregate (VMA)		AASHTO R 35
	Voids Filled with Asphalt (VFA)		AASHTO R 35
	Dust to Binder Ratio		AASHTO R 35
	Gyratory Tests		AASHTO T 312
	Thickness ^a		
	Mat Density, Cores ^b		AASHTO T 166, 209
	Density (Nuclear)	As needed to control operations	AASHTO T 310
	Temperature	As needed to control operations	—
^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 Density calculation will use the daily average of Contractor and Department maximum specific gravity as validated by <i>F-test</i> and <i>T-test</i> in the daily calculation. ^c Minimum of one (1) test per Day and three (3) tests per subplot except for maximum specific gravity. Obtain a minimum of two (2) tests per Day for maximum specific gravity. If subplot size is reduced to 3,000 tons or less, perform testing at a rate of 1 per 1,000 tons with a minimum of one (1) per Day.			

Table 901.7:5 Minimum Process Control Guidelines for Portland Cement Concrete Pavement (QC)			
Item	Property	Testing frequency	Test method
Fresh Concrete for PCCP	Unit Weight	1 per 125 yd ³	AASHTO T 121
	Air Entrainment	1 per 125 yd ³	AASHTO T 152
	Slump	1 per 125 yd ³	AASHTO T 119
	Compressive Strength	1 per 125 yd ³	AASHTO T 22, 23, 231
PCCP in Place	Thickness ^a	2 per 2,500 yd ^{2 b}	—
^a Complete corrective Work specified in Section 450.3.5.2, "Surfacing Smoothness Requirements," before determining pavement thickness ^b 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 (QA)					
Item	Property	Point of Acceptance	Sublot size	Lot size	Test method
Base Course	Sampling	As specified	—	—	AASHTO T 2, 248
	Gradation	Processed Windrow	1 per 2,000 ton	20,000 tons	AASHTO T 11, 27
	Thickness	After compaction			c
	Density				AASHTO T 180, 238, 239
HMA & WMA	Sampling	As specified	—	—	AASHTO T 168
	Asphalt Content	Behind Laydown Machine, Before compaction	One tenth of the lot size, ^f	15,000 to 30,000 tons	AASHTO T 308
	Gyratory Tests				AASHTO T 312
	Gradation				AASHTO T 30, 308
	Air Voids				AASHTO T 166, 209, 269
	Voids in Mineral Aggregate (VMA)				AASHTO R 35
	Dust to Binder Ratio				AASHTO R 35
	Thickness	After compaction			d
	Mat Density Cores ^a				AASHTO T 166, 209

Table 901.7:6 Minimum Acceptance Guidelines (QA)					
Item	Property	Point of Acceptance	Sublot size	Lot size	Test method
Fresh Concrete for PCCP	Air Content	Deliver to grade	1 per 500 yd ³	5,000 yd ³	AASHTO T 152
	Compressive Strength				AASHTO T 22, 23, 231
In-Place PCCP	Thickness ^b	—	2 per 10,000 yd ²	30,000 yd ²	^e
^a Density calculation will utilize daily average of Contractor and Department maximum specific gravity as validated by <i>F-test</i> and <i>T-test</i> . The Department will obtain a minimum of one (1) maximum specific gravity sample per Day. ^b Complete corrective Work specified in Section 450.3.5.2, "Surfacing Smoothness Requirements," before determining pavement thickness ^c 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 lath) across the hole and measuring the thickness to the nearest 1/4 inch using a measuring tape. ^d 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 inch using a measuring tape. ^e Determine thickness by actual survey conducted before and after the construction of the PCCP at fixed, randomly selected locations. ^f A lesser sublot size for Acceptance purposes as determined by the Project Manager before production of material begins can be established.					

A

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