



**STANDARD SPECIFICATIONS
FOR
ROAD AND BRIDGE
CONSTRUCTION**

2006 EDITION

Adopted by
the
Montana Department of Transportation
and the
Montana Transportation Commission

Montana Department of Transportation



serving you with pride

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SECTION 101 DEFINITIONS AND TERMS

101.01 GENERAL

The Standard Specifications are written to the Contractor. They define the Contractor's responsibility in meeting each specification. The short sentences, written in the active voice, explain what the Contractor must do. The Specifications outline the expectations of the Department, and explain what the Contractor must provide the Department. Unless otherwise noted, all actions are to be performed by the Contractor. "Will" statements mean the Department or Engineer is responsible or will perform the action.

The active voice writing style is recommended by the Federal Highway Administration Technical Advisory 5080.16. Examples of the writing styles are as follows:

A. Passive Voice: The Contractor shall construct the temporary detour as specified in the contract.

B. Active Voice: Construct the temporary detour as specified in the contract.

The titles and headings of the sections, subsections, and sub-parts are for the convenience of reference and do not necessarily have a bearing on their interpretation.

When a publication is specified, it refers to the most recent date of issue, including interim publications, before the date of bid receipts for the project unless the issue of a specific date or year is specified.

Whenever the following abbreviations and terms are used in the contract, the intent and meaning is interpreted as follows:

101.02 ABBREVIATIONS

AA	Aluminum Association
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGC	Associated General Contractors of America
AIA	American Institute of Architects
AISC	American Institute of Steel Construction, Inc.
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute, Inc.
ARA	American Railway Association
AREA	American Railway Engineering Association
ARM	Administrative Rules of Montana
ARTBA	American Road and Transportation Builders Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
CFR	Code of Federal Regulations
CRSI	Concrete Reinforcing Steel Institute
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards

GSA.....	General Services Administration
IES.....	Illuminating Engineering Society
IMSA.....	International Municipal Signal Association
ITE.....	Institute of Transportation Engineers
MCA.....	Montana Code Annotated
MDT.....	Montana Department of Transportation
MIL.....	Military Specifications
MUTCD.....	Manual on Uniform Traffic Control Devices
NBS.....	National Bureau of Standards
NEC.....	National Electric Code
NEMA.....	National Electrical Manufacturer's Association
OSHA.....	Occupational Safety and Health Administration
PCI.....	Pre-stress Concrete Institute
SAE.....	Society of Automotive Engineers
SSPC.....	Steel Structures Painting Council
UL.....	Underwriters Laboratory
USASI.....	United States of America Standards Institute
WASHTO.....	Western Association of State Highway Transportation Officials
WWPA.....	Western Wood Products Association

101.03 DEFINITIONS

ACTUAL COST

The cost incurred by the Contractor in the performance of work. Actual cost includes labor, material, actual ownership cost of equipment determined from the owner's records, or invoiced rental rates, and administrative overhead.

ADDENDUM OR AMENDMENT

Contract revisions developed after advertisement and before opening proposals.

ADDITIONAL WORK

Additional work is an increase in the quantity of a contract item.

ADVERTISEMENT

The public announcement inviting proposals for the advertised work.

AWARD

The acceptance of a proposal by the Commission.

BASE

One or more layers of specified material placed on the subgrade to support the surface course.

BIDDER

Any individual or entity submitting a proposal for advertised work.

BID DOCUMENTATION

All writings, working papers, computer printouts, charts, and all other data compilation that contain or reflect information, data or calculations used by the Bidder to determine the bid proposal submitted, including but not limited to material relating to the determination and application of:

- A. Equipment rates;
- B. Overhead rates and related time schedules;
- C. Labor rates;
- D. Efficiency or productivity factors;
- E. Arithmetic extensions;
- F. Subcontractor and material supplier quotations; and
- G. Manuals standard to the industry used by the bidder in determining the proposal may be included by reference and must show the name and date of the publication and its publisher.

The term "Bid Documentation" does not include documents provided by the Department for use by the Bidder in the preparation of the bid proposal.

BOARD OF CONTRACT APPEALS

The Board consists of the Chief Engineer, the Preconstruction Engineer and the Chief Counsel, with the Construction Engineering Services Engineer as Secretary to the Board. The FHWA Field Operations Engineer and Construction Engineer are non-voting members.

BRIDGE

A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway, and having a track or passageway for carrying traffic or other moving loads and a length measured along the center of roadway exceeding 20 feet (6.1 m) between under-copings of abutments or extreme ends of openings for multiple boxes.

The bridge length is the overall length measured along the line of survey stationing between backs of abutment backwalls or between ends of the bridge floor, but never less than the total clear opening of the structure.

The bridge roadway width is the clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or, in the case of multiple heights of curbs, between the bottoms of the lower risers.

BUSINESS DAY

Business Day. All days are considered business days except Saturdays, Sundays and holidays.

CALENDAR DATE OF COMPLETION

The fixed calendar date that all work on the project is to be complete.

CALENDAR DAY

Every day shown on the calendar beginning and ending at midnight.

CHANGE ORDER

A written order issued to the Contractor covering changes to the original contract, and establishing the agreed-upon basis of payment and time adjustments for the work affected by the changes.

CHIEF ENGINEER

The Highways Engineering Division Administrator is designated "Chief Engineer" for the Department who establishes engineering policy, resolves technical issues and resolves Contractor disputes.

COMMISSION

As provided by Section 2-15-2502 MCA, (as amended), the Transportation Commission is a quasi-judicial board assigned to the Department of Transportation for administrative support only.

CONFORMITY

Is compliance with:

- A. Reasonable and customary manufacturing and construction tolerances where working tolerances are not specified; or
- B. The specified working tolerances.

CONTRACT

The written agreement between the Commission and the Contractor detailing the obligations of the parties for the performance of the prescribed work.

The contract includes the proposal; contract form; contract bond; specifications; general and detail plans; Detailed Drawings; Notice to Proceed; Materials Manual; and all change orders, extra work orders, including authorized contract time extensions, that are required to complete the project.

CONTRACT BOND

The approved security on the Department's form, executed by the Contractor and its surety or sureties, guaranteeing the complete execution of the contract and all supplemental agreements thereto and payment of all legal debts pertaining to the construction of the project.

CONTRACT ITEM (PAY ITEM)

A specific unit of work for which a price is provided in the contract.

CONTRACT TIME

The number of working days or the fixed calendar date allowed for completing the contract, including authorized time extensions.

CONTRACTOR

The individual or legal entity contracting with the Commission to perform the prescribed work.

CULVERT

Any structure not classified as a bridge that provides an opening under the roadway.

DELAY

Any event, action, force, or factors that causes the contract work to extend beyond the specified contract time.

- A. **Compensable Delay.** An excusable delay for which the Contractor may be entitled to additional compensation.
- B. **Excusable (Non-compensable) Delay.** A delay to the contract or milestone/phase completion date that was beyond the Contractor's control and for which a contract or milestone time extension may be granted.
- C. **Non-excusable Delay.** A reasonably foreseeable delay to the contract completion date within the Contractor's control. No monetary compensation or time extension will be granted.

DEPARTMENT OF TRANSPORTATION

The State of Montana, Department of Transportation, acting through the Director and the Commission when the State is the awarding authority. Where Department is used alone, it

means the Montana Department of Transportation. The Department's mailing address is: Montana Department of Transportation, 2701 Prospect Avenue, P.O. Box 201001, Helena, MT 59620-1001.

DETAILED DRAWINGS

An edition of special drawings, including necessary detailed instructions that pertain to certain items of work contained in Department projects.

DIFFERING SITE CONDITIONS

Subsurface or latent physical conditions at the site that:

- A. Differ materially from those indicated in the contract; or
- B. Differ materially from conditions normally encountered or, those conditions generally recognized as inherent in the nature of the work required in the contract; or
- C. Unknown physical site conditions of an unusual nature. This does not refer to non-physical conditions (i.e., working relationships, etc.)

DIRECTOR

The chief administrative officer of the Department, as established by law, and the Director's authorized agents.

ENGINEER

The District Administrator acting directly or through an authorized representative, responsible for engineering and administrative supervision of the project.

EQUIPMENT

All machinery, tools, apparatus, and supplies necessary for the upkeep, maintenance, construction, and completion of the project.

EQUITABLE ADJUSTMENT

An adjustment in the contract price or time.

EXTRA WORK

Work added to the original contract required for the completion of the contract.

EXTRA WORK ORDER

A written agreement amending the contract that identifies work to be paid for at agreed prices or by force account under Subsection 109.04.

FORCE ACCOUNT WORK

A basis of payment to perform extra work when procedures of negotiation are unsuccessful. Force account work will be paid for under Subsection 109.04.2.

HOLIDAYS

Legal holidays are defined in the State of Montana laws (Section 1-1-216 MCA).

INSPECTOR

The Engineer or Project Manager's authorized representative assigned to make inspections of work and materials furnished.

INVITATION FOR BIDS

The advertisement for proposals for work or materials on which bids are requested. The advertisement goes out to interested parties to allow potential bidders an opportunity to examine the site, material sources, etc. It will indicate the estimated quantities and location of the work to

be done or the character and quantity of the material to be furnished and the time and place of the opening of proposals.

LABORATORY

The Department testing laboratory or other testing laboratory designated by the Engineer.

MAJOR ITEM

Individual bid items having an original contract value equal to or exceeding 5 percent of the total original contract amount.

MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD)

The FHWA *Manual on Uniform Traffic Control Devices* its current edition and its revisions. It includes the basic principles for the design and use of traffic control devices, but recognizes that engineering judgment is essential to the proper use of traffic control devices. The manual may be supplemented by Standard or Supplemental Specifications, Special Provisions, and by project circumstances when approved by the Engineer (See MUTCD, Section 2A.03 Standardization of Application).

MATERIALS

Substances specified for use in the construction of the project. Furnish new materials unless otherwise specified or approved.

MEDIAN

The portion of a divided highway separating the traveled ways for traffic in opposite directions. Separation may be by open ground, raised median, or paint not including centerline stripping.

NOTICE TO PROCEED

Written notice to the Contractor to proceed with the contract work including the starting date of contract time.

PAVEMENT STRUCTURE

The combination of base course and surface course placed on a subgrade to support and distribute the traffic load to the roadbed.

PLANS

The approved contract drawings showing the location, type, dimensions, and details of the work required under the contract.

PROFILE GRADE

The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

PROJECT

The specific section of the highway or location on which construction is to be performed under the contract.

PROJECT MANAGER

The Engineering Project Manager, referred to as Project Manager or EPM, the authorized representative of the Engineer. The Project Manager is responsible for direct oversight and documentation of the project. The Project Manager is the Contractor's first contact for all project related issues unless another person or agency is specifically stated in the contract.

PROJECT RECORDS

All correspondence, reports, proposals, minutes, articles, logs, calendars, diaries, computations, tabulations, computer printouts, bills, statements, invoices, vouchers, bills of lading, schedules, purchase orders, contracts, agreements, accounts, checks, tape recordings, photostats, video recordings, photographs, sketches, drawings, charts, graphs, transcripts, and other similar objects, any of which pertains to a project or project costs, of a Contractor and its subcontractors.

PROPOSAL

A written offer by a bidder, on Department furnished forms, to complete the project at the quoted prices within the specified contract time. Also called "Bid Proposal."

PROPOSAL FORM

The approved form on which bids must be prepared and submitted.

PROPOSAL GUARANTY

The security furnished with a proposal to guarantee that the bidder enters into the contract if its proposal is accepted.

QUALITY ASSURANCE

- A. Acceptance Plan.** A statistically based procedure for evaluating acceptance test results.
- B. Lot.** A discrete quantity of material evaluated for acceptance.
- C. Price Reduction.** A pre-established decrease in payment to the Contractor for a contract bid item in which the quality and workmanship, determined by statistical means is at the lower limit of the acceptance range.
- D. Quality Assurance.** A statistical based process to determine the acceptability of a given product. Also known as "lot by lot" or "lot" basis or system.
- E. Quality Incentive Allowance.** A pre-established increase in payment to the Contractor for a contract bid item in which a superior level of quality and workmanship, determined statistically, was performed.
- F. Random Sampling.** A selection procedure in which all potential samples have an equal chance of being selected for testing.

QUALITY CONTROL

- A. Quality Control.** Operational techniques and activities used to control the quality of a product or service in order to satisfy given requirements.
- B. Quality Control Plan.** A Contractor prepared plan describing the type and frequency of Contractor inspection, sampling, and testing necessary to measure and control the various properties governed by the contract specifications.

RENTAL RATES

Hourly rates approved by the Department for furnishing and operating various types of construction equipment.

RESOURCES

The labor, equipment, and material necessary to perform work on a contract bid item or other contract work element.

RESPONSIVE BID

A bid that meets all requirements of the Proposal and Instructions to Bidders.

RESPONSIBLE BIDDER

A bidder that the Department determines has the skill, ability, and integrity to perform the project. The Department's standards of responsibility are in Section 18.3.201, Administrative Rules of Montana.

RIGHT-OF-WAY

Land, property, or interest, acquired for or devoted to a highway. Also R/W or ROW.

ROAD, HIGHWAY OR STREET

A public way for vehicular travel, including the entire area within the right-of-way.

ROADBED

The graded portion of a highway within the top and side slopes prepared as a foundation for the pavement structure and shoulders.

ROADSIDE

The areas between the outside edges of the shoulders and the right-of-way boundaries and other areas within the right of way not intended for motorized travel.

ROADSIDE DEVELOPMENT

Those items necessary for:

- A. The preservation of landscape materials and features;
- B. The rehabilitation and protection against erosion of areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; and suitable plantings; and
- C. Other improvements that increase the effectiveness and enhance the appearance of the highway.

ROADWAY

The portion of a highway within the limits of construction.

SHOULDER

The portion of the roadway adjacent to 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 right of way constructed for pedestrian use.

SPECIAL PROVISIONS

Modifications to the Standard and Supplemental Specifications applicable to an individual project.

SPECIFICATIONS

The compilation of provisions in this book, the Supplemental Specifications, and Special Provisions for the performance of the project.

STATE

The State of Montana acting through its authorized representative.

STRUCTURES

Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains, and other features that may be encountered in the work.

SUBCONTRACTOR

An individual or legal entity, to which a Contractor subcontracts, assigns or otherwise disposes of any part of the work. This includes subcontractors at any contract tier, such as sub-subcontractors, etc.

SUBGRADE

The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.

SUBSTRUCTURE

All of the 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 authorized representative in responsible charge of the work.

SUPERSTRUCTURE

The entire structure except the substructure as defined in this Section.

SUPPLEMENTAL SPECIFICATIONS

Approved additions and revisions to the standard specifications.

SURETY

The legal entity or individual, other than the Contractor, executing a bond furnished by the Contractor (see Section 28-11-401 MCA).

SURFACE COURSE

One or more 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. The top layer is sometimes called the "wearing course."

TITLES (OR HEADINGS)

The titles or headings of the divisions, sections, and subsections are for convenience of reference and do not have any bearing on their interpretation.

TOPSOIL

Topsoil under Section 203 is soil that supports normal plant growth.

Topsoil under Section 610 is soil that supports normal plant growth and meets Subsection 713.05 requirements.

TRAVELED WAY OR PRESENT TRAVELED WAY

The existing paved or graveled roadway section in use including the shoulders and auxiliary lanes. Also referred to as the PTW.

UNBALANCED BID

- A. Materially Unbalanced.** A bid that generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid results in the lowest ultimate cost to the Department.
- B. Mathematically Unbalanced.** 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.

WORK

The furnishing of all resources necessary to complete the project.

WORKING DAY

All days are considered working days except Saturdays, Sundays, holidays, days on which the Contractor is specifically required by the contract to suspend construction operations, and all days during the period of November 16 through April 15 with no construction activities. Working days will be charged from November 16 through April 15 for all days construction activities occur that have any impact on the traveling public, exclusive of emergency and maintenance repairs to the project.

WORKING DRAWINGS

Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or other supplementary plans or similar data that the Contractor is required to submit to the Project Manager.

**SECTION 102
BIDDING REQUIREMENTS
AND CONDITIONS**

102.01 JOINT-VENTURE BIDS

Execute a "Declaration of Joint Venture and Power of Attorney" form, available from the Department's Contract Plans Bureau, to submit bid packages for highway construction as a joint venture. Designate the joint venture business name and specifically authorize a person to execute all bid packages and contracts with the Transportation Commission on behalf of all individuals and legal entities of the joint venture. Authorize this person to receive all monies due under the contract and issue binding receipts and releases with the Department. Include joint-venture affidavits in the proposal.

Joint venture firms do not need to separately incorporate.

102.02 CONTENTS OF BID PACKAGE

The bid package ordinarily includes the following:

- A. Proposal;
- B. Disadvantaged Business Enterprise (DBE) Requirements;
- C. Schedule of Items;
- D. Special Provisions;
- E. Current Supplemental Provisions;
- F. Wage Rate Schedules;
- G. Other documents included by reference but not attached;
- H. FHWA Form 1273 (Required Contract Provisions for Federal-aid Construction Contracts), when applicable;
- I. EEO Affirmative Action Requirements on Federal and Federal-aid Construction Contracts; and
- J. Contract Plans.

102.03 CONTRACTOR REGISTRATION

Montana law requires all contractors to register with the Montana Department of Labor & Industry.

Register before executing a contract on federal-aid projects.

Register before submitting a bid on state-funded projects.

Contact the Department of Labor & Industry at 1-406-444-7734 for more information.

102.04 ISSUANCE OF PROPOSALS

The Department reserves the right to refuse to issue a bid package to a bidder for any of the following reasons:

- A. Uncompleted work that the Department determines might hinder or prevent the prompt completion of additional work;
- B. Default under previous contracts;
- C. Failure to reimburse the Department for an overpayment made on any contract or contracts after written notification of the overpayment that is due;
- D. Failure to pay, or satisfactorily settle, all bills due for labor and material on any contract in force at the time of issuance of proposals;
- E. Unsatisfactory performance on a previous or current contract; or
- F. Misconduct that is of such a serious nature as to adversely affect the Contractor's ability to perform future work.

Request bid packages from the Department.

Pay the Department the sum stated in the Invitation for Bids for each copy of the bid package.

102.05 QUANTITIES OF WORK IN THE PROPOSAL

Submit unit bid prices for the estimated quantities.

Estimated quantities may be increased or decreased under the contract.

Payment is made for the actual quantities of work performed and accepted or materials furnished and accepted under the contract.

102.06 EXAMINATION OF DOCUMENTS AND SITE OF WORK

Examine the proposed work site including the existing field staking and documents before submitting a proposal. Submitting a proposal is an affirmative statement by the bidder that the bidder has examined the site and is satisfied with the conditions to be encountered in performing the work and the bid package requirements.

The Department is not bound by any statement or representation concerning conditions or description of the work unless included in the bid package. Do not rely on oral explanations or instructions given by Department employees or agents before award of the contract. Accept these as non-binding oral explanations or instructions and relying on them is solely at the Bidder's risk.

Immediately submit any request for an explanation of the meaning or interpretation of the bid package, in writing, to the Engineer or to the Department's Q & A Forum found at <http://www.mdt.mt.gov>.

The records of any subsurface investigation conducted by the Department are available for inspection as a public document. When not included in the bid package, inspect available records at the Materials Bureau, Bridge Bureau in Helena, or the District where the project is located.

The records of subsurface investigations are not a part of the bid package or contract, but are available to all bidders for informational purposes only. There is no warranty or guaranty, either expressed or implied, that the subsurface investigation records disclose the actual conditions that will be encountered during the performance of the work. Department subsurface investigation results may differ from a bidder's independent subsurface evaluation due to different sampling techniques, the date of the investigation, etc. Using or relying on Department subsurface investigations is at the bidder's risk. The Bidder must perform and rely on its independent subsurface evaluation made before submitting a bid proposal. Submittal of a bid is an affirmative statement that an independent subsurface evaluation was made and Department subsurface investigations were not relied on. Individual test boring log data included in the Department's subsurface investigation records apply only to that particular boring taken on the date indicated. The character of any material or conditions between or around test borings on the date of the site examination is not conclusive.

Submission of a bid waives any potential claim of the above, including a claim of justifiable reliance on such information or materials.

Do not take advantage of an apparent error, omission or ambiguity in the bid package. Upon discovery, immediately notify the Engineer in writing if an error, omission, or ambiguity exists and why it appears erroneous, omitted, or ambiguous. Advise bidders submitting a subcontract quotation of this obligation and clarify their responsibility to include this information with their subcontract quotation. The Department will clarify the error, omission, or ambiguity and, if necessary and possible, issue an addendum to all prospective bidders before opening bid packages.

Do not submit a bid proposal or a subcontract quote without receiving clarification. Failure to provide written notification is a waiver of the error, omission or ambiguity, and additional compensation or contract time will not be allowed.

The Department, for most projects, prepares preliminary bid packages (plans and special provisions) to provide advance notice to prospective bidders of the general requirements for those projects. Preliminary packages are not in final form, and there may be substantial changes between the preliminary and final bid package released for bid letting. Use the preliminary packages only for general familiarization with the project. Request final bid packages for use in bidding. Do not base any bid on a preliminary package.

102.07 BIDDING REQUIREMENTS

Submit bids only using the Electronic Bid System (EBS) that generates the required Proposal, Schedule of Items, Disadvantaged Business Enterprise (DBE) requirements, and indicates acknowledgement of addenda if applicable.

- A. Distribution Procedures.** The Department will make electronic bid files, and addendum files available to prospective bidders. Bidders may obtain EBS packages free of charge from the Department's Contractor's System Internet Site, <http://www.mdt.mt.gov>. Hardcopy bid packages are available for a fee from the Contract Plans Bureau.
- B. Bidding Requirements.** Ensure bids submitted using the EBS format contain a Proposal guarantee, an EBS generated Proposal, Schedule of Items, and DBE requirements when applicable.

Ensure the EBS Schedule of Items is a single continuous printout for each individual bid, evidenced by all Schedule of Items sheets having the same check number. Written changes to the Schedule of Items, or a bidder's non-submission of every page from the Expedite Bid EBS file, (including all Schedule of Items pages and all DBE pages), automatically renders the bid non-responsive, and the bid will not be read or considered.

Acknowledge addenda using the amended EBS project file to generate the Proposal, Schedule of Items and DBE requirements. The printout indicates acknowledgment of receipt of addenda when the correct project file is used. Return a computer disk containing the complete project files for all projects bid with the bid package. It is the bidders responsibility to ensure that they acquire and apply addenda files when applicable.

- C. Determination of Bid Responsiveness.** Bids are opened at the designated time and inspected to determine if the following requirements are met:
- 1. Schedule of Items.** Unit Prices are provided for all required bid items. A complete and verifiable Schedule of Items is provided. Each sheet of the Schedule of Items must contain the same check number, to ensure that the unit bid prices correspond with the total. There are no written changes to the Schedule of Items.
 - 2. Proposal Guarantee.** The bid bond is on the most current version of the Department-furnished form; is signed and sealed in the proper places; a copy of the agent's Power of Attorney for the insurance company is attached; and contains the correct and complete project number; all signatures are original (stamped signatures are unacceptable). If using Bid Submission via Internet and Bid ExpressTM, a qualified Surety Company must verify the Contractor bond.
 - 3. Addenda.** All addenda are acknowledged by using the correct electronic file.
 - 4. Proposal.** The proposal is signed and notarized in the designated places or in acceptable digital format; and all signatures are original (stamped signatures are unacceptable).

A bid is non-responsive if any of the above requirements is not met.

For non-responsive bids, only the Contractor's name, and the reason for the non-responsiveness determination, will be announced at the letting. The Department retains non-responsive bids.

Submission of a bid is a statement by the bidder that sufficient time was available to adequately prepare a Proposal and conduct a complete investigation of the work site and all contract documents.

102.08 REJECTION OF BID PROPOSALS

The Commission reserves the right to reject bid Proposals, waive technicalities, or advertise for new Proposals.

A Proposal is irregular and will be rejected as non-responsive for any of the following:

- A.** Failure to complete the bid bond or Proposal, provided by MDT, by all specified persons, including notaries, in the correct blocks.
- B.** There are unauthorized additions, conditional or alternate bids, or irregularities that make the bid package incomplete, indefinite, or ambiguous.
- C.** The Proposals for two or more projects advertised separately are connected or made contingent one upon the other so that the Proposal for one project carries a provisional deduction in the bid price on one or more of the other projects.
- D.** Any unauthorized provisions are added reserving the right to accept or reject an award or to enter into a contract pursuant to an award.
- E.** More than one Proposal for the same work from an individual, firm, corporation, partnership, or joint venture under the same or different name is submitted using the same format. (See Subsection 102.10(B)(6)).
- F.** Evidence of collusion among bidders exists. Participants in collusion will not receive recognition as bidders, either singly or as a joint venture, for future Department work until reinstated as qualified bidders.
- G.** Bidder fails to properly complete and sign, by original signatures, on the most current Department-furnished Proposal and bid bond forms. Stamped signatures are not authorized.
- H.** Failure to acknowledge receipt of electronic addenda by using the correct electronic files.
- I.** Failure to provide a complete Schedule of Items, or an unverifiable Schedule of Items. Each sheet of the Schedule of Items must contain the same check number, to ensure that the unit bid prices correspond with the total.
- J.** The bidder does not submit all pages from the Expedite Bid EBS file.

A bid Proposal is considered irregular and may be rejected as non-responsive for any of the following:

- A.** The Department-furnished Proposal is altered.
- B.** Bidder fails to include a name and mailing address.
- C.** The unit prices contained in the Proposal are mathematically and/or materially unbalanced.
- D.** Information entered in the Proposal by the bidder is not legible.
- E.** There are changes in the Proposal such as erasures, strikeouts, and whiteouts that are not initialed in ink.
- F.** Non-compliance with the Disadvantaged Business Enterprise (DBE) requirements. If Bid Express™ Software indicates an error, the Department will determine if the Proposal is non-responsive.

102.09 PROPOSAL GUARANTY

Make the Proposal guaranty unconditionally payable to the Department for no less than 10 percent of the Proposal. Provide the guaranty by bid bond with the Proposal. The guaranty must be a bid bond executed by a surety corporation authorized to do business in the State of Montana.

102.10 DELIVERY AND PUBLIC OPENING OF PROPOSALS

Bid Proposals are opened and read publicly at the place, time, and date specified in the "Invitation for Bids."

Deliver by the date and hour set for the opening of bid Proposals to the Department officials conducting the bid opening. Bid Proposals received after the specified time are returned to the bidder unopened.

The clock designated by the Department bid opening officials determines the bid opening time.

Do not submit bid Proposals by facsimile machines.

A Proposal not properly addressed and identified is returned to the bidder after it is opened.

A. Bid Submission by Sealed Envelope. Place the bid Proposal in a sealed envelope plainly marked to indicate the contents. Mail or deliver to: Montana Department of Transportation, Contract Plans Bureau, 2701 Prospect Avenue, P.O. Box 201001, Helena, Montana 59620-1001.

Mailed Proposals must be received by the Department's official conducting the bid opening before the bid opening time. The Contractor is solely responsible for the Proposal's delivery.

B. Internet Bid Submission Via the Internet and Bid Express™. (Optional Bid Submission Procedure)

1. Access to the electronic bidding information is available on Bid Express™ at www.bidx.com and the MDT Contractors System Internet Site at <http://www.mdt.mt.gov>.
2. When installing the Bid program, enter the vendor code that was issued by MDT. Before running the electronic bidding programs, read the on-line help documentation for the Expedite software.
3. Acknowledge all addenda in the electronic bid submitted.
4. "Joint Venture Bids" are not able to be submitted to Bid Express™.
5. Select tools and then check bid from the Windows Expedite menu to check the bid and ensure there are no errors prior to submitting the electronic bid. The electronic bid may be changed and resubmitted electronically to Bid Express™ as many times as desired before the advertised cutoff time. The last bid submitted for a given Bid opening as of the cutoff time will be the only bid considered. If a bidder chooses to submit Proposal using Bid Express™ and also submits a hard copy bid, the electronic copy of the bid controls.
6. Make no claim against the Department in the event it is unable to submit it's bid to Bid Express™ and/or Bid Express™ is unable to submit the bid(s) to the Department. The Department reserves the right to postpone or cancel the public opening and reading of bids in the event of internet, Bid Express™ or MDT technical difficulties.

102.11 WITHDRAWAL OF PROPOSALS

Submit withdrawal requests to the Department in writing or telegram before the time set for opening bid proposals. A bidder may withdraw any proposal in person or through an authorized agent before any bid proposal on that project is read.

102.12 DEBARMENT

Federal statutes and regulations adopted pursuant to federal statutes, require that any firm or individual submitting a bid on a federal-aid project certify compliance with Part XI of FHWA Form 1273 (Required Contract Provisions - Federal-aid Construction Contracts) and that firm or individual must obtain and furnish the Department certification that all subcontractors, material suppliers, vendors, and other lower tier participants used are in compliance with Part XI of FHWA Form 1273.

Make certification part of each subcontract, material supply agreement, purchase order, and other covered lower tier transaction. Covered lower tier transactions include primary material purchases for contract items incorporated into the work.

The Department's debarment policies and procedures are in the Administrative Rules of Montana, beginning at Section 18.3.101.

102.13 MATERIALS GUARANTY

The successful bidder may be required to furnish a complete statement of the origin, composition, and manufacture of materials to be used in the construction of the work, together with samples to be tested for conformance with the contract requirements. Include the costs of furnishing the statements and samples in the bid.

102.14 RESERVED

102.15 VENUE

In the event of any dispute concerning a project, whether over its advertisement, bidding, award, execution, or claim, any litigation filed by or against the Department has venue in Lewis and Clark County.

102.16 CONSENT TO CONTRACT PROVISIONS

The submission of a bid is an affirmative statement that the bidder and its proposed Subcontractor(s) consent to all of the bid package provisions upon which the bidder has submitted its bid. That consent extends to all portions of the bid package and applies to all the bidder's subcontractors. Do not submit a bid proposal unless consent to all the bid package provisions is given.

**SECTION 103
AWARD AND EXECUTION
OF CONTRACT**

103.01 CONSIDERATION OF PROPOSALS

Bid proposals will be compared on the basis of the summation of the item total prices shown in the bid schedule.

103.02 AWARD OF CONTRACT

The contract will be awarded within 45 calendar days after the bid opening to the lowest responsive, responsible, and qualified bidder whose bid proposal complies with all the requirements. The successful bidder will be notified in writing of the acceptance of the proposal and the award of the contract.

If the contract is not awarded within 45 calendar days, all bid proposals will be rejected and the proposal guaranties returned. The Commission can extend the 45-day time period.

103.03 ASSIGNMENT OF CLAIMS

In consideration of being awarded the contract, the Contractor, on its own behalf and on behalf of its subcontractors, assigns to the Department all claims or causes of action for any antitrust law violations, or damages arising there from, as to goods, materials, and services purchased under the terms of the contract or any change order that may result from the contract.

103.04 CANCELLATION OF AWARD

The award of the contract may be canceled at any time before the execution of the contract by all parties without liability against the Department.

103.05 RETURN OF PROPOSAL GUARANTY

Except for the three lowest bidders, all proposal guaranties other than bid bonds will be returned immediately following opening and checking of the proposals. The retained proposal guaranties of the unsuccessful two lowest bidders will be returned within 10 calendar days following the award of the contract. The successful bidder's proposal guaranty will be returned after a satisfactory contract bond has been furnished and the contract has been executed.

103.06 CONTRACT BOND

Furnish an executed contract bond or bonds in a sum equal to the contract amount under Subsection 103.07. Use a form provided by the Department and executed by a surety company authorized by law to transact business in the State.

103.07 EXECUTION AND APPROVAL OF CONTRACT

Return to the Contract Plans Bureau in Helena no later than 5:00 p.m. on the 20th calendar day after receipt, not counting the date of receipt of the contract documents:

- A. The signed contract;
- B. The contract bond; and
- C. A copy of the insurance policy or a certificate of insurance.

A proposal is not binding unless all the above requirements have been satisfied.

Do not begin work before:

- A. The contract is executed;
- B. Contract bond is completed;
- C. Evidence of the required insurance is provided; and
- D. Possessing a current special fuel user permit issued under 15-70-302 MCA.

The contract, bond, and insurance are subject to legal approval after execution by the Contractor and Surety.

103.08 FAILURE TO EXECUTE CONTRACT

Upon failure to execute the contract and file acceptable bonds and insurance policies within 20 calendar days after receipt of the contract, under Section 18-1-204 MCA, the award will be canceled and the proposal guaranty forfeited. Award may then be made to the next lowest responsive, responsible and qualified bidder, or the work may be re-advertised.

103.09 SUBMISSION OF BID DOCUMENTATION

When required by the contract, no later than seven calendar days after the date of bid-opening (the date of bid opening to count as the first full day), the apparent low bidder must submit to the Contract Plans Bureau, during its regular work hours, a legible copy of all bid documentation it used to prepare its bid. If the seventh day is a holiday, turn the documentation in earlier. The term "Bid Documentation," as used in this specification, means any writings, working papers, computer printouts, charts, schedules of any kind (e.g., CPM, bar chart, etc.), and any data compilations, computerized or not, used by the Contractor to determine the bid it submits for this project. "Bid Documentation" includes, but is not limited to, Contractor equipment internal rates for ownership, Contractor overhead rates, labor rates, efficiency or productivity factors, scheduling calculations, written review or analysis of the site of the work, written analysis of how the work should be performed, arithmetic extension, worksheets used to prepare the bid (identifying by name and edition any software programs used to prepare them), and all quotations to the extent that these items were used in formulating and determining the amount of the bid. "Bid Documentation" also includes identification of all manuals which are standard to the industry used by the Contractor in determining the bid for this project. (Include these manuals in the bid documentation and the inventory by reference to their title, author, edition, date and page or section number.) The term does not include bid documents provided by the Owner (e.g., plans, specifications, etc.) for use by the Contractor in bidding on this project.

Place the bid documentation in sealed envelopes no smaller than 8 1/2-inch x 11-inch and no larger than 10-inch x 13-inch. If multiple sealed envelopes are provided in some form of container, do not lock or seal it. The container will be emptied and the sealed envelopes secured by an agent of the Department's Construction Administration Services Bureau at the place of storage in Helena. An agent of the Contractor, at its discretion, may be present at the time the documentation is placed in the storage container. Furnish with the bid documentation, a complete inventory on the Department-furnished form found elsewhere in the proposal titled "Bid Documentation Inventory." A copy of the inventory will be placed in the storage container, one will be kept in the Construction Administration Services Bureau's project file, and the Contractor retains one.

A bidder's failure to provide its full bid documentation automatically makes its bid unresponsive and it will be rejected. It will also be considered a refusal to enter into the contract, and the bidder's proposal guaranty will be forfeited due to its failure to evidence its good faith in fully submitting that bid. The second low, responsive responsible bid will then be reviewed and required to meet the above requirements.

If the apparent low bidder, for whatever reason, is not awarded the contract, the apparent second low bidder will be told that it has seven calendar days from the date of its verbal notification (followed immediately in writing) to comply with the above requirements. That Contractor must comply with those requirements.

The bid documentation will remain in the storage container during the life of the contract and will be returned after a certificate of completion has been issued for the project and a release of

claims has been signed. An agent of the Contractor may be present at the time the documents are removed from the storage container.

In the event that a claim requesting compensation, reimbursement or contract time is made, or an action in any court, based upon the contract, is filed, the copies of the bid documentation become the property of the Department for its use, specifically including use in preparing for and conduct of all claims, disputes, or litigation. Failure to submit all documentation and inventory as required above, or listing on the inventory documentation that is not actually provided as required, will be considered a material breach of the contract, is a failure to comply with a condition precedent to filing of a claim or lawsuit, acts as a total and final waiver of all claims or disputes involving matters that would have been included (e.g., claims of delay, changed site conditions, loss of productivity, etc.), and subjects the Contractor to action under ARM 18.3.101 et seq.

SECTION 104 SCOPE OF WORK

104.01 INTENT OF CONTRACT

Furnish all resources required to complete the work under the contract within the specified time, and for the amount bid.

104.02 DIFFERING SITE CONDITIONS, SUSPENSIONS OF WORK, AND SIGNIFICANT CHANGES IN THE CHARACTER OF WORK

104.02.1 Differing Site Conditions

During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the party discovering such conditions must promptly notify the other party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.

Upon written notification, the Engineer will investigate the conditions. If the Engineer determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made and the contract modified in writing accordingly. The Engineer will notify the Contractor of the determination whether or not an adjustment of the contract is warranted.

No contract adjustment, which results in a benefit to the Contractor, will be allowed unless the Contractor has provided the required written notice.

No contract adjustment will be allowed under this clause for any effects caused on unchanged work.

104.02.2 Suspensions of Work Ordered by the Engineer

If the performance of all or any portion of the work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the Contractor must submit to the Project Manager in writing a request for adjustment within seven calendar days of receipt of the notice to resume work. Set forth the reasons and support for such adjustment in the request.

Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the contract in writing accordingly. The Contractor will be notified of the Engineer's determination as to whether or not an adjustment of the contract is warranted.

No contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of the contract.

104.02.3 Significant Changes in the Character of Work

The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations do not invalidate the contract nor release the surety, and the Contractor agrees to perform the work as altered.

If the alterations or changes in quantities significantly change the character of the work under the contract, whether such alterations or changes are in themselves significant changes to the character of the work or by affecting other work cause such other work to become significantly different in character, an adjustment, excluding anticipated profit, will be made to the contract. The basis for the adjustment must be agreed upon before the work is performed. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable.

If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

The term "significant change" applies only to the following circumstances:

- A.** When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction.
- B.** When a major item of work, as defined in Subsection 101.03, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity will apply only to that portion in excess of 125 percent of the original contract item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.
- C.** When an item of work, not defined as a major item in Subsection 101.03, is increased in excess of 150 percent or decreased below 50 percent of the original contract quantity. Any allowance for an increase in quantity will apply only to that portion in excess of 150 percent of the original contract item quantity, or in case of a decrease below 50 percent, to the actual amount of work performed.

104.02.4 Change Orders

Change orders will include the following information:

- A.** A description of the altered, increased, or decreased work or description of other change necessitating the change order;
- B.** An estimate of the types and quantities of work to be performed and a listing of the agreed prices and contract unit prices at which payment will be made; and
- C.** Contract time adjustments.

Change orders must be executed by both parties to the contract and become a part of the contract.

Payment for the work will be made for the actual quantities of work performed at the prices specified in the change order.

104.03 EXTRA WORK

Perform unanticipated work, not included in the contract, if determined necessary to complete the project. Perform extra work as directed. Payment for extra work is made under Subsection 109.04.

Extra work performed without an executed written order will not be paid for.

104.04 MISCELLANEOUS WORK

This is any minor work or material that is necessary to the work.

Miscellaneous work, as provided for in the contract, is measured by the respective unit for either the material or work performed, as directed in writing by the Project Manager.

Payment for miscellaneous minor work is at agreed prices or on a force account basis.

104.05 MAINTENANCE OF THE WORK

104.05.1 General

Perform maintenance work on completed and uncompleted parts of the project until acceptance under Subsection 105.15.

Maintenance includes, but is not limited to the following:

1. Patching chuck holes with asphalt mix;
2. Reshaping the subgrade, side slopes, ditch sections, or aggregate courses, as necessary;
3. Cleaning debris from drainage courses, culverts, and inlets;
4. Removing rocks or earth from the roadway and ditch sections;
5. Removing debris resulting from construction activities;
6. Providing access to residences, businesses, and roads and keeping the present accesses open;
7. Repair or replace minor damaged parts of the work
8. Repair or replace extensive damage, not by Contractor negligence, under Subsection 104.02.4;
9. Maintenance of the constructed roadway under Subsection 203.03.5;
10. Disposing of removed matter;
11. Maintenance of irrigation water under Subsection 104.05.6; and
12. Other maintenance-type work not specifically described but necessary for the maintenance and protection of traffic or of completed and uncompleted portions of the project.

Maintenance work performed before acceptance under Subsection 105.15 is incidental to other contract items.

104.05.2 Failure to Properly Maintain Roadway or Structure

The Project Manager will immediately notify the Contractor if it fails to maintain the project. Failure to remedy unsatisfactory maintenance within 24 hours after receipt of the notice will cause the Department to take over project maintenance. The cost of the maintenance will be deducted from monies due or to become due the Contractor, or otherwise be billed to the Contractor.

104.05.3 Maintenance for Traffic and Detours

- A. Maintenance for Traffic.** Keep the road open to traffic during the work or provide detour roads as specified or directed.

Maintain the work under construction to accommodate traffic. Construct and maintain all accesses to parking lots, garages, businesses, residences, farms, etc. The cost of this work is incidental to other items of the contract.

Provide traffic control meeting the approved traffic control plan, Section 618 - Traffic Control, and the MUTCD.

- B. Special Detours.** When the contract has the bid item Detour - Construct, Maintain, and Remove, it includes constructing and maintaining the detour, including constructing and removing temporary bridges, pipes and associated work and obliterating the detour road.

Do not use all or any portion of an existing structure, as defined in Subsection 101.03, without the Engineer's approval. Do not modify existing structures or construct temporary

structures without Department approval before starting work. This work is incidental to the contract item.

The Department will provide the right-of-way for temporary detours or bridges specified in the contract.

104.05.4 Maintenance for Traffic During Work Suspensions

A. Temporary Suspension. Make passable and open to traffic all portions of the project, connections, and temporary roadways before temporary work suspensions. Maintain parts of the project, connections, temporary roadways, and detours under traffic at Contractor expense during work suspensions.

B. Winter Suspension. Be responsible for all traffic control, maintenance, and snow removal, during winter weather shutdowns, including the time between November 16th and April 15th, for all roadways not completed through the first lift of plant mix surfacing. Furnish all necessary supervision, personnel, and equipment to maintain the road in a safe condition and at the highest level of service to traffic.

The Contractor may request that the Department furnish all resources to perform snowplowing, sanding, de-icing and incidental work during winter suspension. This work would be detailed in a written agreement. The Contractor would reimburse the Department, under an accounts receivable, for all Department winter maintenance expenses.

Before the winter shutdown, a Contractor's representative, the District Maintenance Chief, the District Construction Engineer, and the Project Manager will review the project to develop the agreement details.

Failure to maintain the project under these requirements will invoke Subsection 104.05.2.

Repair or replace all work and materials lost or damaged due to temporary use of the project. Maintenance work for acts of God or acts of the public enemy, or that are outside the Contractor's control during work suspensions is paid for at contract unit prices or as extra work.

104.05.5 Reserved

104.05.6 Maintenance of Irrigation Water

Construct or move irrigation structures, boxes, channel changes, and culverts to maintain irrigation water flow at Contractor expense.

Do not shut off irrigation water in an irrigation ditch without the water-master or ditch owners written permission.

104.06 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK

Obtain the Engineer's approval to use excavated materials found in other parts of the work. The quantity of excavated material used will be paid for under the pay item for which the material is used.

Payment will not be made under any other pay item for excavating the material. Replace the removed material with acceptable material at Contractor expense.

Do not excavate or remove material from within the right-of-way that is outside the grading limits without written permission.

104.07 FINAL CLEANING UP

Clean the highway, borrow pits, and all ground used in performance of the work of all rubbish, debris, excess materials, temporary structures, and equipment before final acceptance.

Meet the requirements of Subsection 106.02.5 for final cleanup of borrow and aggregate sources.

The final cleanup work of the project area and the pits, borrow areas, or quarries is not paid for directly but is incidental to other contract items.

Specify the conditions for final cleanup in all landowner agreements. Complete all cleanup conditions before final project acceptance.

104.08 VALUE ENGINEERING PROPOSALS

Cost savings generated on the contract from cost reduction proposals offered by the Contractor and approved by the Department will be shared.

The Contractor is encouraged to submit proposals for modifying the contract that reduces the total cost of construction. The cost reduction proposal must not impair the essential functions or characteristics of the project including but not limited to service life, economy of operation, ease of maintenance, reliability, desired appearance, and safety.

Submit the proposal in writing and include the following information:

1. A description of both the existing work and proposed changes for performing the work with a discussion of the comparative advantages and disadvantages;
2. An itemization of the necessary changes to the contract if the proposal is accepted;
3. A detailed cost estimate for performing the work under the existing contract and under the proposed change detailing quantities and dollar amounts for each work item;
4. An estimate of the effect the proposed changes would have on other costs to the Department;
5. A time frame within which the Department must make a decision;
6. The dates, project numbers and the action of the Department if the proposal was previously submitted; and
7. A statement of the effect implementation of the proposal would have on the contract completion time.

The Department is not required to consider a proposal or be liable to the Contractor for failure to accept or act on a proposal submitted under this specification including delays to the work attributable to the proposal. Proposals that are similar to a change in the contract that are under consideration or have been adopted by the Department before the submittal will not be accepted. The Department reserves the right to make these changes without compensation to the Contractor.

Continue to perform the work according to the contract requirements until the Department has taken final action on the proposal. Consider the proposal rejected if the Department's final decision is not received within the time frame specified in the Contractor's submittal.

The Department will determine the acceptability and the estimated net savings in construction costs from the adoption of all or part of a proposal. The Department will disregard the contract unit prices if these prices do not represent a fair measure of the value of work to be performed or to be deleted. The Department's costs for reviewing and implementing proposals including any increased costs to the Department resulting from its application will be deducted from the total estimated cost saving to arrive at the net savings.

The Department's cost of investigating a proposal is at the Contractor's expense with the submittal of a proposal constituting the Department's authority to deduct these costs from any monies due or that may become due to the Contractor under the contract.

Proposals accepted by the Department in whole or in part will be by a change order. The change order will incorporate the changes in the contract necessary to implement the proposal and will include any conditions placed on the approval by the Department. The change order will establish the estimated net savings in the cost of performing the work attributable to the proposal and provide for payment of 50 percent of the estimated net savings to the Contractor.

Acceptance of proposals does not extend the contract time unless specifically provided for in the change order.

The payment amount specified in the change order constitutes full compensation to the Contractor for the proposal and the performance of the work.

The Department reserves the right to apply a proposal for general use on other contracts administered by the Department. When an accepted proposal is applied for general use, only the Contractor who submitted the initial proposal is eligible for compensation and this compensation applies only to those contracts awarded to the Contractor before submission of the accepted proposal. Proposals that are identical or similar to previously submitted proposals are eligible for consideration and compensation under this specification if the proposals were not previously adopted for use in other contracts administered by the Department. Subject to these provisions, the Department reserves the right to use all or any part of any submitted proposal without obligation or compensation to the Contractor.

This specification applies only to the Contractor awarded the contract. No consideration will be given to, and no payment made for any claims for additional compensation for changed conditions that are attributable to the approved proposal.

SECTION 105 CONTROL OF WORK

105.01 AUTHORITY OF THE ENGINEER

The Engineer will decide all questions regarding the quality and acceptability of materials furnished, work performed, the rate of progress of the work, the interpretation of the contract, and the acceptable fulfillment of the contract. Contract time will continue to be charged during suspensions under A of this Subsection and Subsection 105.09(2).

- A.** The Engineer will suspend the work wholly or in part for failure to:
 - 1. Correct conditions unsafe for project personnel or the public; or
 - 2. Carry out provisions of the contract; or
 - 3. Carry out orders of the Engineer.
- B.** Work may also be partially or wholly suspended for:
 - 1. Periods necessary due to unsuitable weather; or
 - 2. Conditions unsuitable for the prosecution of the work; or
 - 3. Any condition or reason determined to be in the Department's interest.

105.02 CONTRACTOR FURNISHED DRAWINGS AND SUBMITTALS

The plans show the details of structures, lines, grades, typical roadway cross sections, location and design of structures, and a summary of items appearing in the bid package.

Furnish the Department with Contractor prepared working drawings that detail required work not included in the contract plans. Prepare all working drawings using English or Metric units as shown in the contract. Upon request, submit manufacture literature describing the materials and equipment to be incorporated into the work. This requirement to submit drawings and literature applies to all items not specifically requested elsewhere in the contract.

The Department has 20 working days to review the submittals before returning them to the Contractor. The Department has 20 working days to review drawings returned for correction and that are re-submitted for review. The Department will consider extending contract time should the Department review exceed the 20 working day review time limit.

Working drawings, falsework plans, and calculations for facilities open to public travel are to be signed by a professional engineer before submittal to the Project Manager.

105.03 CONFORMITY WITH PLANS AND SPECIFICATIONS

105.03.1 General

Perform work and furnish materials to meet the contract requirements.

Provide materials and workmanship uniform in character and meeting the plan dimensions and contract specifications.

When a contract item does not meet the contract requirements but is adequate to serve the design purpose, the Engineer will determine the extent the work will be accepted and remain in place. The Engineer will document the basis of acceptance by change order, providing an adjustment in the contract unit price.

When a contract item does not meet the contract requirements resulting in work inadequate to serve the design purpose, remove and replace or correct the work by and at Contractor expense.

105.03.2 Items Designated for Acceptance on a Lot Basis (Quality Assurance)

Contract items listed in Table 105-1 are designated for acceptance on a lot-by-lot basis. The elements in the table are evaluated and the contract items accepted under this provision. All other contract items are evaluated for acceptance under the specifications covering those items.

An element of a lot will be evaluated for conformance when results of one or more tests are outside specified tolerance limits for that element.

All the individual test results in the lot for the element to be evaluated will be averaged, and the percent of price reduction for the lot determined by the applicable formula.

1. The formula $P = (Xn + aR - Tu) \times F$ will be used if a maximum limit only is specified; or when the average of the test values is above the midpoint of a specified band or above a job mix target value.
2. The formula $P = (TL + aR - Xn) \times F$ will be used if a minimum limit only is specified; or when the average of the several test values is below the midpoint of a specified band or below a job mix target value.

TABLE 105-1
CONTRACT ITEMS - EVALUATION ELEMENTS

ELEMENTS EVALUATED						
Item	Aggregate Gradation	Fineness Modulus	Penetration	Compaction	Cleanness Value	Fracture
Selected Surfacing	X					
Sand Surfacing	X					
Crushed Base Course Type A	X					X
Crushed Base Course Type B	X					
Crushed Top Surfacing Type A	X					X
Crushed Top Surfacing Type B	X					
Crushed Aggregate Cover Material	X				X	X
Portland Cement Treated Base	X					
Plant Mix Surfacing and Base	X			X		X
AC in Plant Mix Surfacing and Base			X			
Portland Cement Concrete Paving	X	X				

Where:

- P is the percent of reduction in contract unit price.
- Xn is the average of the several test values from samples taken from the lot, with n indicating the number of values.
- A is a variable factor to be used as n changes according to the following: when n is 3, a = 0.45; n is 4, a = 0.38; n is 5, a = 0.33; n is 6, a = 0.30; and n is 7, a = 0.28.
- R is the difference between the highest and lowest values in the group of several test results from the lot.
- Tu is the upper or maximum tolerance limit permitted by the specifications.
- TL is the lower or minimum tolerance limit permitted by the specifications.
- F is the price reduction factor to be applied for each element as shown in Table 105-2.

TABLE 105-2
TABLE OF PRICE REDUCTION FACTORS

ELEMENT	FACTOR "F"
100% size sieve	1
1/2-inch (12.5 mm) sieve and larger	1
No. 100 to 3/8-inch (0.150 mm to 9.5 mm) sieve, inclusive (except 100% size sieve)	Cover Material, 2 All Other Aggregates, 3
No. 200 (0.075 mm) sieve	Cover Material, 3 All Other Aggregates, 6
Fine aggregate fineness modulus	12
Penetration, 85-100 asphalt cement	3
Penetration, 120-150 asphalt cement	2
Penetration, 200-300 asphalt cement	1
Compaction	12
Fracture	2

If P is less than 3 or a negative quantity, the lot will be accepted as being in conformance. If one or more elements for a contract item show a positive P value, the positive values will be added and the resulting sum used to determine whether the lot is in conformance. If the total P value is between 3 and 25, the Engineer may require correction or accept the lot at a reduced price. If P is greater than 25, the Engineer may: (1) require complete removal and replacement with specification material at Contractor expense; (2) require corrective action to bring the material into conformance at Contractor expense; or (3) where the finished product is found to be capable of initially performing the intended purpose but with a reduced service life expectancy, permit leaving the material in place with an appropriate price adjustment calculated using a P value ranging between 25 and 50.

Immediately halt production following written notification when either of the following has occurred:

1. Three consecutive lots for a contract item have an individual total P value of 5 or more.
2. Beginning with the second lot, when three tests within one lot have one or more elements outside the specification bands and the total P value for the lot is 5 or more.

Make adjustments to bring the product within the specification limits before resuming production. The Contractor does not have the option of accepting a price reduction in lieu of producing specification material. Continued production of non-specification material is prohibited. Material that is obviously defective may be isolated and rejected without regard to sampling sequence or location within a lot.

105.03.3 Quality Incentive Allowance

A. Gradation. When "Volumetric Acceptance" is not specified, a 1.05 pay factor will be applied to non-commercial plant mix surfacing lots where the results of aggregate gradation tests for the No. 4 (4.75 mm), No. 40 (0.425 mm), and No. 200 (0.075 mm) sieves are not more than one-half the allowable tolerance from the job mix target value.

A 1.05 pay factor will be applied to crushed base course Type "A" surfacing lots where the results of aggregate gradation tests for the No. 4 (4.75 mm) and No. 40 (0.425

mm) sieves are not more than one-half the allowable tolerance from the job mix target value.

B. Density.

1. When "Density Acceptance by Cores" is specified, a 1.05 pay factor will be applied to the lots of plant mix surfacing when the average density for the lot (Xn) is from 94 percent to 95 percent, inclusive, of the Maximum Specific Gravity (Rice's Method) and the range (R) is three or less.
2. When "Density Acceptance by Cores" is not specified, a 1.05 pay factor will be applied to the lots of plant mix surfacing using the Marshall method where the average density for the lot (Xn) is from 97 percent to 98 percent, inclusive, of the target Marshall density and the range (R) is three or less.

C. Quality Incentive Allowances. Quality incentive allowances will be used to offset any price reductions. Any quality incentive allowance remaining after all price reductions have been deducted will be paid for as a lump sum when all work on the item is complete. Quality incentive allowances for gradation are waived when the plan quantity of surfacing is less than the standard lot size.

105.03.4 Table of Contractor Submittals

To assist in identifying all required submittals and clarifying the submittal process, the contract may include a Table of Contractor Submittals as a Special Provision.

The table may not be all-inclusive and does not include submittals required by other Special Provisions.

Provide all submittals required by the contract, including those not listed in the table.

If a discrepancy exists, submittals required by other Special Provisions in the contract take precedence over the Table of Contractor Submittals.

Submit all required submittals to the Project Manager unless another person or agency is specified. When another person or agency is specified to receive the submittal, also submit one copy to the Project Manager.

105.04 COORDINATION OF CONTRACT PROVISIONS

All documents referred to in Subsection 101.03 (Contract) are essential parts of the contract, and a requirement occurring in one is binding as though occurring in all. They are complementary and describe and provide for a complete contract. If a discrepancy exists, the governing ranking is:

Dimensions

1. Plan
2. Calculated
3. Scaled

Information

1. "Question and Answer Forum" Information
2. Special Provisions
3. Table of Contractor Submittals
4. Plans
5. Supplemental Specifications
6. Standard Specifications
7. Supplemental Detailed Drawings
8. Detailed Drawings

105.05 COOPERATION BY CONTRACTOR

The Department will furnish the Contractor at least 15 sets of contract documents. Keep at least one set available on the project at all times.

Cooperate with the Engineer, Project Manager, the Inspectors, and other Contractors during the contract work.

Staff the project with a Superintendent experienced in the type of work to be performed under the contract. Ensure the Superintendent, when not physically on the project, has the ability to communicate with Department representatives by phone, cell phone, radio, or other electronic means.

Maintain a Contractor representative having the Superintendent's authority, when the Superintendent is not physically on the project or available for immediate communication. Notify the Project Manager in writing of the identity and contact information of that representative before that person assumes the authority.

Give the Superintendent the authority to execute orders or instructions of the Project Manager or authorized representative and the authority to obtain all resources to complete the contract, including directing all Subcontractor operations.

Provide the Project Manager, the Superintendent's name in writing before work starts.

The Project Manager or authorized representative will issue instructions to the superintendent.

Notify the Project Manager in writing at least 24 hours in advance of changes in the Contractor's representative.

Failure to maintain a Contractor's Superintendent or authorized representative on the project is cause for the Project Manager to stop work until one is assigned. All cost associated with delay in the stopped work is solely the Contractor's responsibility.

105.06 COOPERATION WITH UTILITIES

Underground, overhead, and non-utility facilities will be relocated or adjusted to clear conflicts with the contract. Some or all of these facilities may be relocated or adjusted during the contract work. Perform the contract work without damaging these facilities.

Conduct on-project meetings on a weekly or biweekly basis with utility company representatives having facilities within the project limits and the Project Manager. Have the first meeting on the project before grading and excavation work begins to discuss the utility locations and progress on utility relocation work. A list of utility representatives is furnished in the contract.

Cooperate with utility owners in the removal and rearrangement of utility facilities to minimize interruption to utility service and duplication of work by the utility owner.

Submission of a bid is an affirmative statement that the Contractor has considered in the bid proposal all permanent and temporary utility facilities in the present or relocated positions as specified in the contract and as revealed by its site investigation. No additional compensation is allowed for delays, inconvenience, or damage sustained due to interference from the utility facilities or their re-location work.

The contract indicates utility items to be relocated or adjusted and who is to perform the work. The contract indicates the means of adjudication, if any, if the utility owners fail to relocate or adjust the facilities.

105.07 COOPERATION BETWEEN CONTRACTORS

The Department reserves the right to contract for and perform other or additional work on or near the work for the project.

Conduct the work without interfering with or hindering the progress or completion of the work by other Contractors. Cooperate with other Contractors working within the limits of the project.

Each Contractor involved must accept all liability, financial or otherwise, in connection with the contract and protect and hold harmless the Department from damages or claims that may arise because of inconvenience, delay, or loss experienced because of the presence and operations of other Contractors working within the limits of the same project.

Coordinate and sequence with the work of other contractors. Do not store materials, tools, machinery, and other equipment in locations that interfere with the work of other Contractors.

105.08 CONSTRUCTION STAKES, LINES, AND GRADES

105.08.1 Finish Grade Control

Provide all finish grade control required to establish the surfacing sections shown in the plans. Calculate the finish grades for the subgrade and each surfacing course using the plan information and the furnished staking notes. Special borrow is a surfacing course for finish grade control purposes.

The Department will set construction stakes establishing lines, slopes, and profile grade for roadwork, excluding finish grade control, and will furnish the Contractor these staking notes.

Run a level circuit to check the project benchmarks on each roadway section where finish grade is being controlled.

Establish finish grades using survey personnel that are trained, experienced, and skilled in construction layout and staking. Do not hire Department personnel to perform any finish grade control work.

The Department will provide control for culverts, protective and accessory structures and appurtenances as required. Use provided controls as the field control to perform the work. Request all Department furnished construction staking in writing. Staking requests must be submitted on form CSB105_08_1. Department construction staking will be performed once for a given type and location. If construction staking is required more than once, submit an additional request to the Project Manger in writing with justification.

105.08.2 Bridge Survey

The Department will establish control points defining median or roadway centerline, bridge centerline, and benchmarks for elevation control.

Establish and maintain all other survey controls required to control bridge alignment and grade meeting the plan dimensions and elevations using survey personnel trained, experienced, and skilled in construction layout and staking. Do not hire Department personnel to perform survey work.

Furnish horizontal and vertical control meeting the Department's Survey Manual requirements. Furnish the original survey notes upon request. Furnish the notes showing the initial layout and primary controls and references and the method of independent check before starting work on the substructure units. Submit a copy of the structure excavation cross-section notes. The Project Manager reserves the right to re-survey any pay item area.

Make calculations from the plan information to control alignment and elevation. Correct all mis-locations, mis-alignments, and incorrect elevations caused by Contractor calculations, layouts, and surveys at Contractor expense. Submit the proposed method of correction for approval. Do not begin the corrective work until the proposal has been reviewed and approved.

105.08.3 Materials and Equipment

Furnish all materials and equipment required to perform this work.

Keep survey notes in a standard field notebook, written in a clear, orderly, neat manner meeting the Department's Survey Manual requirements and standard surveying practice. If survey notes are generated electronically, produce notes in a format meeting these requirements. The Project Manager will inspect the field notes for acceptance. The finished notes become the Department's property.

Perform the work meeting all contract requirements.

105.08.4 Construction Requirements

Use a finish grade control method that provides positive horizontal and vertical alignment control for the required surfacing sections and ride quality.

105.08.5 Survey Tolerances and Inspection

The Department will perform finish grade checks based on the following:

- A. Subgrade.** Three random stations per 1,000-foot (300-meter) section will be checked. The 1,000-foot (300-meter) section will be accepted if 80 percent or more of the points checked are within a vertical tolerance of ± 0.10 foot (± 30 mm), and the horizontal alignment is within 0.30 foot (90 mm) of the true line. If not within required tolerances, rework the entire 1,000-foot (300-meter) section. Three new random stations will be checked after rework is completed. Random checks will be performed for finish ditch grade control to assure proper drainage.
- B. Special Borrow.** Three random stations per 1,000-foot (300-meter) section will be checked. The 1,000-foot (300-meter) section will be accepted if 80 percent or more of the points checked are within a vertical tolerance of ± 0.10 foot (± 30 mm), and the horizontal alignment is within 0.30 foot (90 mm) of the true line. If not within required tolerances, rework the entire 1,000-foot (300-meter) section. Three new random stations will be checked.
- C. Aggregate Surfacing.** Six random stations per 1,000-foot (300-meter) section will be checked. Each 1,000-foot (300-meter) section will be accepted if 85 percent or more of the points checked are within a vertical tolerance of ± 0.10 foot (± 30 mm), and the horizontal alignment is within 0.30 foot (90 mm) of the true line. If not within required tolerances, rework the entire 1,000-foot (300-meter) section. Six new random stations will be checked.

Sections that are obviously defective may or may not be checked prior to rejection.

A station check consists of centerline, shoulders, any break in cross slope, and intermediate points not to exceed intervals of 20 feet (6 m). All elevation checks are taken on the material, not on the finish grade control. The Project Manager may increase or decrease the number of stations being checked. The Project Manager will perform the finish grade check by the close of the working day following the notification of a completed section. Contract time will be extended day for day, without any other compensation, for Department caused delays beyond the allotted time to perform the finish grade check.

105.08.6 Method of Measurement

- A. Finish Grade Control.** Finish grade control is measured by the course foot (kilometer) along the roadway centerline to the nearest 50 feet (0.01 kilometer). A course foot (course kilometer) is one foot (one kilometer) for each two-lane roadway including shoulders and ditches. Each traffic lane is considered as one-half course foot (one-half course kilometer) including the adjacent shoulder, ditch, parking, turning, median lanes, and chain up areas.

The subgrade and each surfacing course requiring finish grade control are measured separately by the course foot (course kilometer) for each roadway section, ramp, intersecting roadway, PTW connection, temporary detour, and each frontage road.

Finished grade control for approaches is not measured for payment.

- B. Bridge Survey.** Bridge survey is measured by the lump sum.

105.08.7 Basis of Payment

Payment for the completed and accepted quantities is made as follows:

<u>Pay Item</u>	<u>Pay Unit</u>
Finish Grade Control	Course Foot (kilometer)
Bridge Survey	Lump Sum

Correct all deficient work due to incorrect finish grade control or bridge survey and reset reference points lost or destroyed by traffic or construction at Contractor expense.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

105.09 AUTHORITY AND DUTIES OF PROJECT MANAGER

Each project will be staffed with a Project Manager who is the Engineer's direct representative. The Project Manager has immediate charge of the engineering details of each construction project and is responsible for the administration and satisfactory completion of the project.

The Project Manger can:

1. Reject defective material.
2. Suspend work being improperly performed.
3. Execute any authority delegated to the Project Manager by the Engineer.

The Project Manager will be identified before work begins.

105.10 AUTHORITY AND DUTIES OF INSPECTORS

Department Inspectors are authorized to:

- A. Inspect all work being done and materials furnished. Inspection extends to all or any part of the work and to the preparation or manufacture of the materials to be used. Inspection does not relieve the Contractor's obligation to perform the work as specified in the contract.
- B. Reject materials or suspend the work until the issue can be referred to and decided by the Project Manager.

Inspectors, Technicians, and Aides cannot:

- A. Revoke, alter, enlarge, or relax any requirements of the contract.
- B. Final approve or accept any portion of work.
- C. Issue instructions contrary to the contract.

Only the Engineer is authorized to make contract changes, waive or alter the contract specifications, and then only if it is made in writing. Assure that the change, waiver, or alteration is in writing before taking action on it.

105.11 INSPECTION OF WORK

All work is subject to Department inspection. Inspectors may not be at all work activities nor available for all work shifts for each work activity. Perform the work meeting the contract requirements regardless of inspection.

Allow the Inspector access to all parts of the work and furnish information and assistance necessary to make a complete and detailed inspection. Provide a safe environment for the Inspector during the inspections.

Inspection of the work does not relieve the Contractor of its responsibility to meet the contract requirements. The Inspector cannot waive contract requirements.

Remove or uncover portions of the finished work as directed. Once examined, restore the work to the contract requirements. If the work is acceptable, the uncovering, or removing and replacing the covering or making good the parts removed is paid for as extra work. If the work is

unacceptable, the uncovering, removing, and replacing the covering or making good the parts removed is at Contractor expense.

Work done or materials used without inspection by an authorized Department Inspector may be ordered removed and replaced at Contractor expense.

When a government agency, political subdivision, a utility or railroad is to accept or pay a portion of the cost of the work covered by the contract, the organization's representatives may inspect the work. The inspection does not make that entity a party to the contract nor permit it to interfere with the rights of either party to the contract.

105.12 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK

Work not meeting the contract requirements is unacceptable, unless determined acceptable under Subsection 105.03.

Remove and replace any unacceptable work before final acceptance at Contractor expense. This requirement has full effect regardless of the fact that the unacceptable work or defective materials were known or overlooked by the Inspector.

Work done contrary to instructions received, or beyond the plan limits, or extra work done without the permission of the Project Manager will not be considered for payment. Work so done may be ordered removed, restored or replaced at Contractor expense.

Neither the Contractor nor the Department incurs any liability by reason of any verbal directions or instructions received from the Project Manager. The Department will not be liable for extra materials furnished or used, or for extra work or labor done, unless required by written order from the Project Manager.

If the Contractor fails to follow any order made under this Subsection, the Project Manager has the authority to remove, replace, or restore the work and deduct the costs from any monies due or to become due the Contractor.

105.13 EQUIPMENT

Submit to the Project Manager a list of all construction equipment to be used on the project. Include the year, make, model, type, and serial number for each piece of construction equipment.

Submit this list at the pre-construction conference. Submit updates whenever other construction equipment is brought onto the project.

105.14 RESERVED

105.15 ACCEPTANCE

105.15.1 Reserved

105.15.2 Final Inspection

Upon notice of completion of the entire contract, the Project Manger will arrange to make a final inspection. When all work is complete but deferment of final inspection is necessary for causes outside the Contractor's control, the Project Manager will issue a suspend work order and contract time charges will cease.

If the contract work is found satisfactorily completed, the inspection will constitute the final inspection. If the inspection discloses unsatisfactory work, the Project Manager will issue instructions to the Contractor on the necessary corrections. Immediately comply with the instructions. When the deficiencies are corrected, another inspection will be made which constitutes the final inspection.

Upon completion of the final inspection, submit a completed "Contractor's Final Inspection" (Form CSB 105_15_2). The form is available from the Department's website or the Project

Manager. The Contractor's project superintendent must sign the certification, which must be sworn to and notarized. The certification must state that:

1. The Department and the Contractor have visually inspected the work, and the Contractor verifies that the work was completed in full accordance with the specifications and the requirements of the contract.
2. The Project Closeout Checklist for the Storm Water Pollution Prevention Plan (SWPPP) has been completed, all necessary corrective actions taken and the SWPPP transferred to the appropriate entity.
3. Liquidated damages have or have not been assessed, and damages that have been assessed are or are not disputed by the Contractor.
4. The Contractor is aware that the Department will not consider the contract for "final acceptance" until the Contractor has fully completed its FHWA Form PR 47 (if required), required labor and materials certifications and documentation, and reviewed and agreed to the final estimate.

Completion and acceptance of the Contractor's Final Inspection is not a statement or commitment by the Department that the work meets the contract requirements, and does not waive or alter any of the contract's terms. The contract bond remains in effect until the certificate of completion is executed and the contract is accepted by the Commission.

105.15.3 Final Acceptance

When the final estimate is accepted by the Contractor under Subsection 109.08, submit a completed "Contractor's Request and Certification for Acceptance" (Form CSB 105_15_3). The form is available from the Department's website or the Project Manager. An authorized officer of the Contractor must sign the certification, which must be sworn to and notarized. The certification must state that:

1. The work requested for acceptance has been completed in accordance with the contract's specifications, and the required materials have been used, both in quality and quantity.
2. All claims to be made on the contract have been fully submitted in writing to the Engineer, and are current as of that date.
3. There are no pending investigations referencing alleged nonpayment to subcontractors or suppliers.
4. There are no pending labor compliance or nonpayment claims on the contract.
5. There are no known environmental violations, and the Contractor is responsible for any violations issued for damages prior to the transfer of the SWPPP.

If any of the above is not completed in full before the certification is submitted, the Project Manager will inform the Contractor that the acceptance of the contract is rejected. If the contract receives final acceptance, a Certificate of Completion will be issued within 10 days and the final estimate submitted to Accounting for payment.

105.16 CLAIMS FOR ADJUSTMENT AND DISPUTES

105.16.1 Notice of Claim

Notify the Project Manager in writing by no later than the next business day of disagreements that are to be the subject of a claim for additional compensation, time extension, contract change, or other remedy. Provide full details in the written notice why additional compensation, time extension, contract change, or other remedy is warranted. Include in the notice of claim all documentation showing the history of the disagreement.

Upon submission of the written notice, immediately begin keeping and maintaining complete and specific daily records using the Department's "Claim Cost Record" (Form CSB105_16_1) of

all details and costs directly related to the disagreement. The form is available from the Project Manager or the Department's website. Base equipment costs on internal rates for ownership, depreciation, and operating expense. Provide the Project Manager with updates of details and costs related to the disagreement as they develop.

Failure to timely provide the written notice as required waives the Contractor's right to make any claim for the disagreement. Ensure that any notice of disagreement is fully and completely explained and documented, as the Department expects and requires early notice to mitigate costs and to fully document any potential costs.

The Project Manager will attempt to resolve the disagreement after the written notice is submitted. The Project Manager will issue a written response no more than 14 calendar days after receipt of the written notice.

105.16.2 Submission of Certified Claims

If an agreeable resolution is not reached within 14 calendar days of the written notice, the Contractor may submit a Certified Claim using the "Certified Claim" (Form CSB105_16_2) to the Project Manager no more than seven calendar days after receipt of the Project Manager's response. The form is available from the Project Manager or the Department's website. Include all Claim Cost Records to date with the Certified Claim. Provide copies to the District Construction Engineer and the Construction Engineering Services Engineer of the Engineering Division. The Project Manager will continue to attempt to resolve the disagreement after the Certified Claim is submitted.

Detail the following in the Certified Claim:

- A.** Reasons for each requested remedy, referenced to the applicable contract provisions;
- B.** Objections to the Project Manager's response, and
- C.** Basis for and amount of any additional compensation, extension of time, contract change, or other remedy, including any potential solutions.

The Prime Contractor must verify the claim data and certify the claim, whether originating from the Prime Contractor, Subcontractor, supplier or materialman, for the Department to consider it. Only the Prime Contractor may submit the Certified Claim.

Failure to timely submit the completed Certified Claim form and the Claim Cost Records as required is a material breach of contract and waives the Contractor's right to make any claim for the disagreement or be entitled to any compensation, time extension or contract change related to the disagreement.

Allow the Project Manager access to and provide copies of all records when requested by the Department. Make other project records available for technical and audit evaluation during the project and after the claim-related work has been performed. Promptly furnish written clarification and any additional information or data requested by the Department.

After the Certified Claim is submitted, continue keeping and maintaining complete and specific daily records using the Department's "Claim Cost Record" form of all details and costs directly related to the claim. Base equipment costs on internal rates for ownership, depreciation, and operating expense.

Submit claim updates every month until the claim is resolved. Include all costs incurred and any other pertinent information discovered after the Certified Claim was submitted, and include copies of all Claim Cost Records for that month.

Do not change the basis of a claim after submitting the written notice. Do not supplement a faulty submission to rebut or dispute a decision made by the Project Manager. Claims that have changed in basis or that have been supplemented due to an original faulty submission will not be considered, and are waived by the Contractor.

The Contractor waives the claim and any compensation, time extension, or contract change for any of the following:

1. Not filing a timely, complete written notice;
2. Not submitting a timely and complete Certification of Claim form;
3. Not submitting monthly claim updates as required; or
4. Not keeping and submitting timely and complete Claim Cost Records.

105.16.3 Decision on Claims

The District Construction Engineer will provide a written decision no more than 30 calendar days after receipt of the Certified Claim. If additional time is required to research and evaluate the Claim, the District Construction Engineer can extend the time period 14 calendar days by notifying the Contractor in writing.

To advance the claim, appeal the District Construction Engineer's decision to the Board of Contract Appeals (Board). Submit the appeal by letter to the Construction Engineering Services Engineer no more than 30 calendar days after receipt of the District Construction Engineer's decision. Provide a copy of the appeal to the District Construction Engineer. The District Construction Engineer's decision is final unless appealed no more than 30 calendar days after receipt of the decision. If appealed, the District Construction Engineer will forward the original claim, supporting documents or evidence, and the District's evaluation to the Construction Engineering Services Engineer.

If the District Construction Engineer denies the Certified Claim, the Contractor may request a non-binding, independent third party mediation to the Construction Engineer of the Engineering Division. The request for third party mediation must be submitted in writing no more than 30 calendar days after the date of the Contractor's appeal. The Contractor and the Construction Engineer must mutually agree to the mediator and schedule the mediation date within 14 days of the request for mediation or the claim will proceed to the board. All costs associated with mediation are shared equally between the Contractor and the Department. Mediation does not suspend the Contractor's requirement to continue submitting monthly updates and maintaining the required cost records. Claims undergoing third party mediation will not be submitted to the Board unless the mediation is unsuccessful.

The Construction Engineering Services Engineer will submit the claim to the Board. Board meetings are scheduled on a quarterly basis, with the schedule available on request from the Construction Engineering Services Engineer. Claim appeals received less than 60 days in advance of the next scheduled Board meeting may not be presented to the Board until the following scheduled meeting.

The Board will only review those documents and evidence submitted in the original claim, its supporting documents, and the District's evaluation, but may request further information from the District Construction Engineer or the Contractor.

The Board may affirm, overrule, or modify, in whole or in part, the decision of the District Construction Engineer. The decision of the Board is the final decision.

SECTION 106 CONTROL OF MATERIAL

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS

The contract specifies the basis of acceptance for materials and assemblies.

106.01.1 Source of Supply

Use only materials that meet the contract requirements. Submit a list of the names and addresses of the suppliers, producers, manufacturer's and fabricators furnishing products for the contract. Itemize the list as shown in the contract schedule of items.

Material may be inspected and tested at the source of supply before delivery to the project. All materials may be inspected, tested, and possibly rejected before incorporated into the work.

Determine the quality and quantity of materials produced at or developed from any source based on the contract documents and by conducting an independent source investigation.

If payments due the owner of a materials source become delinquent and the owner notifies the Department, a sum equal to the amount of the delinquent payments may be withheld from estimate payments due the Contractor.

106.01.2 Samples, Tests, and Cited Specifications

A. Materials accepted by Certification. Ensure all required certifications for materials are furnished to the Department and the Department has inspected and accepted the certification before incorporating the materials into the work.

The Project Manager may grant written permission to place materials before receiving certifications for materials only under the following conditions:

1. Not placing the materials poses immediate danger to traffic or the general public; or
2. Not placing the materials would cause a delay in the work resulting in damage to the project or adjacent property.

The Project Manager may require that materials be removed and replaced at Contractor expense if the certification(s) are not furnished.

B. Materials Accepted by Department Testing. Do not incorporate material into the work until it is inspected or sampled by the Department.

Reference to a specification or test designated in AASHTO, ASTM, Federal Specifications, or other recognized, nonproprietary national organization, is the specification or test method that is current on the date of advertisement for bids and as amended by the Department's Test Method Manual. Copies of individual test methods are available from the Department's Materials Bureau in Helena.

Department material tests are by and at the Department's expense. Where there is a difference in the test methods, the order of precedence for tests is:

1. The Department's Standard Material Test Methods in the Materials Manual
2. AASHTO
3. ASTM

Submit representative preliminary material samples in the specified quantities for testing upon request. The testing of preliminary samples does not constitute acceptance of the materials. Only materials delivered for incorporation into the work will be accepted or rejected based on the test results specified in the contract.

106.01.3 Unacceptable Materials

All materials not meeting the contract requirements will be accepted or rejected under Subsection 105.03.

106.02 LOCAL MATERIAL SOURCES

106.02.1 General

Local aggregate, borrow and topsoil materials sources include prospected sources, Contractor-furnished sources, and mandatory sources.

Provide the source for obtaining local materials unless mandatory sources are specified. When prospected sources are identified in the contract, use the prospected sources or locate other sources of material. Contractor-furnished sources must be approved by the Engineer. The Contractor must:

- A.** Provide an approved reclamation plan meeting Subsection 106.02.5 before using any materials source;
- B.** Comply with Section 106 of the National Historic Preservation Act; and
- C.** Adhere to state and federal requirements and obtain clearance from the State Historic Preservation Officer before using material from surfacing and borrow sources.

106.02.2 Prospected Sources

Contact the Department for information on Department prospected local material sources.

The Department is not responsible for the quantity or quality of materials indicated in the prospected source reports. Test data included in the reports are based on the samples tested from the exact locations shown using standard tests. No interpretation is made or intended by the Department. Any interpretation is the judgment of the person examining the tests. See Subsection 102.06 concerning verifying quantity and quality by an independent subsurface investigation before submitting a bid.

If a "Surfacing Materials Prospect Report" shows a prospected source to be "Department-optional" or "Department-owned," the material may be available for use, possibly with a royalty or other cost. Do not sell material from Department-owned or Department-optional sources without a written agreement establishing royalty refunds to the Department.

Follow Department made arrangements with landowners for sampling and obtaining material from the prospected material sources.

Pay all royalties and adhere to all agreed stipulations, including contouring of pits, topsoil conservation and replacement, seeding, repair or obliteration of haul roads, cattle guards, and fencing; the cost of which is incidental to and included in the materials cost.

106.02.3 Contractor-furnished Sources

Acquire the rights to take materials from Contractor-furnished sources and pay all related costs, including costs due to increased haul length, exploring and source development.

Furnish material that meets all statutory and regulatory requirements for being non-toxic and non-hazardous. Do not furnish material from mine tailings and waste, slag, sources within state and federal superfund sites, or sources within areas known or suspected to be contaminated with toxic substances or petroleum products unless laboratory reports from an approved laboratory indicate the material meets these requirements.

The Department will process and test samples to determine the suitability of the material. See Subsection 106.10 for the number of Department furnished tests at Department expense.

Arrange with the Project Manager for representative samples to be taken and witnessed by the Department at least 30 calendar days before beginning aggregate production. Provide all equipment and labor necessary for the sampling.

Source approval is based on part or all the following sample test results:

- A.** Wear Test MT-209 (acceptance);
- B.** Volume Swell Test MT-305 (acceptance);
- C.** Trial Mix Marshall Properties MT-306 (informational);

- D. Resistance of Compacted Asphalt Mixtures to Moisture-induced Damage AASHTO T 283-02 (MT 330); and
- E. Adhesion MT-322 (informational).

Passing wear and volume swell test results are mandatory for Department approval of bituminized material aggregate sources. Passing wear test results are mandatory for Department approval of untreated aggregate sources.

Assume all risk for producing aggregate from sources not meeting the wear test (MT 209). The Department will randomly test stockpiled aggregate for wear acceptance.

The Department's approval of the source does not release the Contractor from the responsibility to produce aggregate meeting all specified acceptance requirements.

106.02.4 Mandatory Material Sources

Use of materials from mandatory sources is a condition for preparing a bid and executing a contract. Follow the conditions in the contract for producing materials from mandatory sources.

106.02.5 Reclamation Requirements

- A. **General.** Reclaim all land used in constructing the project as required by the approved reclamation plan. Comply with the pertinent statutes relating to the open cut mining (Title 82, Ch. 4 MCA); the hard rock mining (Title 82, Ch. 4, Part 3); water quality (Title 75, Ch.5); stream bank preservation (Title 82, Ch. 5, Part 5 and Title 75, Ch. 5); Montana County Noxious Weed Management Act Title 7, Ch. 22 Part 21; and all other applicable federal, state, and local statutes, regulations and ordinances.

The Department of Environmental Quality has final responsibility for administration of the Open Cut Mining Act and the Hard Rock Mining Act and must review and approve all reclamation plans and reclamation work. Follow all directives and instructions issued by the Department of Environmental Quality with regard to reclamation work.

- B. **Reclamation Plan.** Submit a copy of the approved reclamation plan before removing earth, quarried rock, sand, gravel, or other substance from any materials source. Follow the Department of Environmental Quality "Format For Reclamation Plan" and "Mapping Guidelines" when developing reclamation plans. The format and guidelines are available from:

Department of Environmental Quality
Permitting and Compliance Division
Industrial and Energy Minerals Bureau
Open Cut Mining Section
Helena, MT 59620-0901

The time allowed for approval of reclamation plans is included in the Open Cut Mining Act, Section 82-4-434 MCA.

- C. **Reclamation Work.** Perform reclamation immediately after removing the necessary material. Leave all slopes in a stable condition and, if topographic conditions permit, grade to no steeper than 3:1 after final grading. Grade the excavated area to maintain the natural contour of the land and blend into the surrounding terrain. Remove or grade all outcroppings to daylight where possible.

Strip and stockpile all topsoil and overburden from the material source, stockpile site, crushing area, and equipment parking areas before excavating material. Salvage all topsoil from all new or widened haul, access, and service roads before grading or surfacing. Reclaim all roads when removal operations are complete. Store overburden or subsoil separately from topsoil and replace before topsoil is replaced on reclaimed areas. Uniformly re-distribute all topsoil to the entire reclaimed area.

Seed all re-topsoiled areas during the first seeding season following grading and topsoil replacement. Contour-seed all slopes steeper than 3:1.

Fence newly seeded, reclaimed areas including roads where required to protect from livestock. Use Type F-3M fence.

Do not locate material sources in a flowing stream or on a stream floodway at a location likely to develop a new channel to the stream during flooding. Leave the final floor elevations of material sources high enough to not be impacted by fluctuations in the groundwater table, unless addressed in the approved reclamation plan. Provide protection and safety of persons and property adjacent to the work.

D. Method of Measurement and Basis of Payment. Reclamation of material sources is incidental to the materials cost.

106.02.6 Protection of Livestock and Property

Prevent livestock from straying into or out of any materials source.

Protect all irrigation facilities from construction operations. Promptly repair or replace damaged irrigation facilities to the landowner's satisfaction at Contractor expense.

106.02.7 Rejects (Excess Fines)

Material referred to as "rejects" are inherent in a rock pit, gravel pit, or quarry, or accumulated during crushing and screening operations. Stockpile rejects, from material sources owned or optioned by the Department and not acceptable for use on the project, at a site selected or approved by the Engineer when requested. Stockpiled reject material is paid for at 15 cents per ton mile (10 cents per metric ton kilometer) for haul in excess of 200 feet (61 meters) from the crusher site to the stockpile.

Retain title to all rejects accumulated during aggregate production from Contractor-furnished sources. Department purchased rejects are paid for at an agreed purchase price.

106.03 CERTIFICATION OF COMPLIANCE

The Engineer may designate certain materials or assemblies that can be incorporated into the work by Certificates of Compliance that state they meet the contract requirements. A manufacturer's authorized representative must sign the certificate. Clearly identify each lot of certified materials or assemblies delivered to the work in the Certificate of Compliance.

Materials or assemblies used on the basis of Certificates of Compliance may be sampled and tested at any time. Materials not meeting contract requirements will be rejected.

106.04 PLANT INSPECTION

Meet the following conditions if materials are Department inspected at the source of supply or manufacture:

- A.** Provide the Inspector full cooperation and assistance during inspections.
- B.** Provide the Inspector full entry to all parts of the plant used in the manufacture or production of the materials.
- C.** Furnish the facilities to determine if the material furnished meets contract requirements.
- D.** Provide and maintain adequate safety measures.

Materials inspected at the source may be re-inspected before incorporation into the work. Materials not meeting the contract requirements will be rejected.

106.05 FIELD LABORATORY

The Department will furnish all field offices and laboratories.

Furnish 110 to 120 volt alternating current of sufficient capacity and a potable water supply to operate all testing equipment for the offices and laboratories at Contractor expense.

106.06 QUALIFIED PRODUCTS LIST (QPL)

MDT Materials Bureau maintains a Qualified Products List (QPL). Obtain further information and requirements on the QPL website, located at <http://www.mdt.mt.gov> contracting/consultant link.

The QPL is limited to certain types of items. Different types of products may be added to, or deleted from the QPL. Procedures for qualifying, listing, and de-listing products are available on the QPL website.

Materials listed as approved on the QPL at the time the materials are delivered to the project may be accepted as a pre-approved QPL item in lieu of the normal sampling and testing procedures.

Submit the documentation required by the QPL.

Work to qualify or list products on the QPL is not measured for payment.

106.07 HANDLING AND STORAGE OF MATERIALS

Store and handle materials to preserve their quality. Stored materials are subject to inspection and re-testing before incorporating into the work. Locate stored materials for ease of inspection.

Obtain approval to use portions of the right-of-way for storage and placing the plant and equipment.

Obtain additional required space at Contractor expense. Do not use private property for storage without the landowners or lessees written permission. Furnish copies of the written permission to the Project Manager. Restore all storage sites to original condition at Contractor expense.

Transport bulk materials in vehicles that do not cause material loss or segregation.

106.08 DEPARTMENT-FURNISHED MATERIAL

Department furnished material will be delivered or made available at the locations specified.

Include the cost of handling and placing Department-furnished materials in the contract unit price for the item.

Be responsible for all Department furnished material. Deductions will be made from any monies due for shortages, deficiencies, and damage that occur after delivery. Demurrage charges, resulting from failure to accept the material at the designated time and location will be deducted from monies due the Contractor.

106.09 DOMESTIC MATERIALS

Furnish domestic steel or iron materials for permanent incorporation in the work. Domestic material is material that all manufacturing processes, including coating of steel or iron, occur in the United States. Pig iron, and processed, pelletized and reduced iron ore may be manufactured outside the United States. Furnish the appropriate manufacturer's mill tests and certifications documenting the manufacturing processes, including coatings of covered materials, performed in the United States. A minimal quantity of foreign manufactured steel and iron material may be used if the cost of the material, including delivery costs to the project, does not exceed one-tenth of one percent of the total contract amount or \$2,500.00, whichever is greater. Do not incorporate steel or iron materials into the project until the proper documentation is furnished.

106.10 BITUMINOUS AND CONCRETE MIX DESIGNS AND TESTING OF SURFACING MATERIAL SOURCES

The Department will furnish the number of mix designs and tests shown in Table 106-1, at no cost to the Contractor:

TABLE 106-1
NUMBER OF MIX DESIGNS AND TESTS FURNISHED AT NO COST

DESCRIPTION	NO. FURNISHED PER CONTRACT
Plant Mix Surfacing Mix Design	2 per grade
Plant Mix Base Mix Design	2 per grade
Portland Cement Concrete Mix Design	1 per class
Cement Treated Base Mix Design	2 per grade
Surfacing Material Testing Package	
Indicated source(s) shown on plans	2
Surfacing source(s) furnished by the Contractor	2

The Contractor will be charged the Department's cost for each additional mix design and testing package furnished. The total cost will be deducted from the progress estimate payments using the schedule of the current charges for additional testing packages and mix designs available from the Project Manager.

SECTION 107
LEGAL RELATIONS AND
RESPONSIBILITIES TO THE PUBLIC

107.01 LAWS, RULES, AND REGULATIONS TO BE OBSERVED

Observe and comply with all of the following:

- A.** Federal and state laws and regulations;
- B.** Local laws and ordinances; and
- C.** Regulations, orders and decrees of bodies or Tribal ordinances having any jurisdiction or authority.

Protect and indemnify the Department and its representatives against any claim or liability arising from the violation of any of the above listed items, whether violated by the Contractor, a Subcontractor, materialman, or supplier, or any of their employees or agents.

Follow all rules and regulations of federal, state, and local health officials. Do not require an employee of the Contractor or Subcontractor (s) to work in surroundings, or under conditions that are unsanitary, hazardous or dangerous to health or safety. Admit any inspector of the OSHA or other legally responsible agency involved in safety and health administration without delay and without presentation of an inspection warrant to all areas of the work and project site upon presentation of proper credentials.

Comply with and enforce all federal, state, and local safety standards (i.e. the Montana Scaffolding Act, etc.) for Contractor's workers and its Subcontractor's workers on the project, protecting and indemnifying the Department and its representatives from all claims, suits, damages or liabilities from all accidents or safety violations, and ensuring the public's safety. The Contractor is not to enforce safety standards for Department employees.

Follow federal, state and local laws, rules and regulations regarding unlawful employment practices including race, religion, color, sex or national origin discrimination, and that define actions required for Affirmative Action and Disadvantaged Business programs.

Work within a State or National Forest is under the regulations of the authority having jurisdiction governing the forest.

Immediately notify the Engineer in writing if any discrepancy or inconsistency is discovered between the contract and any law, ordinance, regulation, order or decree.

107.02 PERMITS, LICENSES, AND TAXES

Obtain all legally required permits and licenses, pay all charges, fees, taxes, and fuel taxes giving all notices necessary and incidental to the lawful prosecution of the work.

107.03 PATENTED DEVICES, MATERIALS, AND PROCESSES

Do not use any design, device, material, or process covered by letters of patent or copyright, without a legal agreement with the patentee or owner. Indemnify and hold harmless the Department, any affected third party, or political subdivision from all claims for infringement for the use of any patented design, device, material or process, or trademark or copyright. Indemnify the Department of all costs, expenses, and damages obligated for payment by reason of an infringement during the prosecution or after the completion of the project.

107.04 RESTORING SURFACES OPENED BY PERMIT

The Department may grant permits to construct or re-construct a utility facility in the highway or street for authorities of the municipality in which the work is done. Do not allow any individual, firm, or corporation to make an opening in the street without a Department permit. Do not allow any person or persons to make an opening unless authorized by the Engineer. Parties bearing

permits may make openings in the street. When requested by the Engineer, repair these openings. The work is paid for under Subsection 104.03 or as provided in the contract. Repair to the same standards as the original work.

107.05 FEDERAL-AID PARTICIPATION

Federal laws, rules, or regulations in conflict with any provisions of a federally assisted contract prevail and take precedence over conflicting contract provisions.

Federally assisted work is under Department supervision and subject to inspection and approval of the United States Government. Inspections by authorized Federal representatives do not make the United States a party to the contract and does not interfere with the rights of the contract parties.

107.06 PUBLIC CONVENIENCE AND SAFETY

Conduct construction with minimum obstruction to traffic. Provide safety and convenience to the public and protect persons and property including, but not limited to, items specified in Subsection 104.05 and Section 618.

Do not close public roads without the Engineer's permission.

107.07 RAILWAY - HIGHWAY PROVISIONS

Responsibilities for work involving railway property are:

A. Contractor. Perform work on railroad right-of-way without interfering with the movements of trains or traffic on railway property. Do not cross the railway right of way or tracks except at temporary or existing, open public grade crossings.

Furnish signed copies of the "Contractor Requirements and Acknowledgment for Working on Railroad Right of Way" found in the contract to the railroad and Project Manager before entering railroad property and starting work.

Provide advance notice, as agreed to between the Contractor and railway officials, before working on railway property, hauling across railway tracks, or blasting within 1000 feet (305 m) of railway property.

Comply with Subsections 107.09 and 107.18 when blasting or performing other work on or near railway property.

Furnish insurance for all work performed as required by Subsection 107.13 or the contract. Make arrangements with the railway company for railway crossings not specified in the contract at Contractor expense.

Reimburse the railroad company for all costs of railway flagging, other protective services, and installation of temporary crossings for haul roads for Contractor-furnished material sources based on billings submitted by the railway company.

B. Department. The Department will:

1. Enter into an agreement with the Contractor and the railway company when required by the railway company;
2. Arrange for railway crossings specified in the contract and pay for the crossings, railway flagging and other protective services necessary for work performed on or near railroad right of way, including haul road track crossings to Department-optioned or owned material sources; and
3. Forward billings for flagging, track crossings, and other protective service billings for Contractor-requested crossings, submitted to the Department by the railway company.

C. Railway. Railway companies must:

1. Furnish all flagging or other protective service as necessary for the safe operation of trains or traffic on railway property, and

2. Construct, maintain, protect, and remove temporary crossings and submit billings for flagging or other protective services to the Contractor or Department.

107.08 LOAD RESTRICTIONS

Do not exceed legal load restrictions when hauling material and equipment on public roadways and bridges within and beyond the project limits and on all new and existing portland cement concrete roadways, treated base courses, bituminous surfacing lifts and courses, including plant mix base, plant mix surfacing, and seal and cover.

Do not place loads on a concrete pavement, treated base, or structure before the curing period has been achieved.

Repair damaged roadways and structures resulting from construction operations at Contractor expense.

Measure and analyze truck legal load limits by the bridge formula before hauling any material over existing or newly paved roadways and bridges. Furnish a drawing showing distances between axles, truck tare weight, and the overall length of each truck.

Show a minimum of two applications using the bridge formula on the drawing. Include on the first application the overall length between axles. For the second application, do not consider the steering axle, and add the value obtained from the bridge formula to the anticipated load on the steering axle. Use the lesser of the two values obtained as the legal load. Retain a copy of the appropriate drawing in each truck. Do not exceed established legal load weights for single axle and tandem axles.

The weight on a truck in excess of the maximum legal weight as determined above will be deducted from the quantity considered for payment.

Comply with this provision and all applicable laws, rules, and regulations related to operation of motor vehicles on public roads.

Trucks operated on public roads may be checked by the Department's Motor Carrier Services and fines levied for exceeding legal loads.

Do not use existing bridges, new bridges, or bridges to be removed but still in use by the public as work platforms, work bridges, or to support or move equipment without the Engineer's written approval.

Approval will be granted only where load analysis and review of traffic control, safety, and convenience show it to be in the public interest.

No additional compensation will be considered or allowed for any violation of these provisions.

107.09 USE OF EXPLOSIVES

Transport, store, handle, and load explosives and blasting agents following all laws and ordinances as well as the applicable requirements of Title 29, Title 30, and Title 49 of the Code of Federal Regulations when using, handling, loading, transportation, and storing explosives and blasting agents.

Use explosives without endangering life or property and be responsible for all resulting property damages, injury, or death.

Only use persons experienced in the handling of explosives and do not fire explosives until sounding a warning and removing all persons from the radius of danger.

Notify each property owner, railway company, and public utility company having facilities near the blasting area of the intent to use explosives to enable them to take precautions to protect their property from injury. Be responsible for damages to property or injury to persons attributable to the use of explosives.

107.10 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE

Preserve all public and private property when performing work. Do not disturb or damage land monuments and property markers until witnessed or referenced by the Project Manager.

Be responsible for all damage to public and private property resulting from any act, omission, neglect, or misconduct in the manner or method of executing work until the project is accepted. This responsibility includes damage caused by compaction, vibratory, and impact equipment.

Replace or restore damaged property to its original condition at Contractor expense.

Conduct a review of all public roadways to be used by Contractor equipment, including haul operations, before work begins. Arrange for a local road authority representative and the Project Manager to attend the review.

The parties are to review and document the roadways existing condition and determine a dispute resolution process if an agreement on roadway restoration cannot be reached.

Once the roadway is no longer in use by the Contractor, conduct another review by the same parties. The parties are to reach an agreement on what is required to restore the roadway comparable to its original condition.

Perform all work required to restore the roadway comparable to its original condition and obtain the Engineer's approval of the work once completed.

Roadway restoration is not measured for payment.

107.11 ENVIRONMENTAL PROTECTION

107.11.1 General

Follow all state, local, and federal laws and regulations controlling pollution of the environment. Take precautions to prevent pollution of streams, lakes, ponds, reservoirs, and wetlands with silt, fuels, oils, bitumens, chemicals, or other harmful materials. Prevent pollution of the atmosphere from particulate and gaseous matter.

Obtain all required permits and furnish copies of all permits or authorizations before starting activities that require permits.

107.11.2 Water Pollution and Siltation Regulations

Attention is directed to Title 75, Chapter 5, MCA, (Water Quality) and the administrative rules of the Water Quality Bureau, Department of Health and Environmental Sciences.

Under the Water Pollution Control Act, Construction De-watering - General Discharge Permits and Short-term Construction Authorizations are required for construction activities that may result in a violation of water quality standards of streams, lakes, or other bodies of water located on or adjacent to the project.

Under the Federal Water Pollution Control Act, as administered by the U.S. Army Corps of Engineers, Permits Branch, P.O. Box 5, Omaha NE 68101, Section 404 Permits are required for discharging dredged or fill material into wetlands or waters under the jurisdiction of the Corps. Information on Section 404 Permits may be obtained from the Corps offices in Helena or Billings.

Other requirements relating to water pollution control are covered in Section 208.

A. Construction De-watering - General Discharge Permits. Obtain a Construction De-watering - General Discharge Permit from the Water Protection Bureau, Department of Environmental Quality in Helena before de-watering any cofferdam or other excavation. Copies of the permit are available from the Water Protection Bureau. A permit is valid for a project only when accompanied by an authorization letter. Do not start work authorized by a Construction De-watering - General Discharge Permit, until an executed copy of the authorization letter is submitted.

The General Discharge Permit may require the treatment of wastewater by pumping the water to retention ponds for clarification or provide other approved treatment.

B. Short-term Construction Authorization. Obtain all Short-term Construction Authorizations, under ARM 16-20.633(3a), for all operations involving activities or improvements that would violate the Montana Water Quality Standards.

Forms for "Application For Authorization" for short-term construction activities may be obtained from the Department of Environmental Quality (DEQ), Permitting and Compliance Division.

Applications for Authorization require furnishing the following information:

1. A detailed description of all construction activities that may result in stream sedimentation or turbidity (e.g., riprap work, instream work with equipment, dredging, channeling, excavating);
2. A list of the type of equipment planned for use to accomplish the work described in (1) above and a discussion of how the equipment is to be used in conjunction with the project;
3. The date construction activity is anticipated to commence;
4. The estimated completion date;
5. A discussion of the alternatives considered or available for minimizing or eliminating stream sedimentation as a result of construction activity; and
6. A location map; plan and elevation drawings showing the temporary facilities relationship to the stream channel. Include photographs if possible.

C. Section 404 - Nationwide and Individual Permits. Attention is directed to the Federal Water Pollution Control Act. Follow the provisions of this act, with special attention directed to Section 404.

Construction activities in and around wetlands or waterways may be covered by a U.S. Army Corps of Engineers Nationwide Permit or may require an individual Section 404 Permit. Obtain all permits necessary for activities relating to the construction that are not covered by a Section 404 Permit already obtained by the Department. These activities may include, but are not limited to, temporary fills and berms, haul roads, work bridges, and the like, which require fill below the ordinary high-water limits of streams, wetlands, lakes, or other water bodies under the jurisdiction of the Corps.

The contract will include any additional conditions and requirements for applicable Section 404 permits.

107.11.3 Air Quality

Operate all equipment including, but not limited to, hot-mix paving plants and aggregate crushers to meet the minimum air quality standards established by federal, state, and local agencies.

No additional payment will be made for the use or installation of dust or smoke control devices, for the disruption of work or loss of time occasioned by the installation of such control devices, or for any other related reasons.

107.11.4 Noise Pollution

Follow all applicable laws and regulations and all requirements contained in the contract regarding noise pollution.

The contract may include additional requirements for projects located in or near urban areas.

107.11.5 Noxious Weed Management

Follow the requirements of the County Noxious Weed Management Act, Title 7, Chapter 22, Part 21 MCA, and all county and contract noxious weed control requirements. Determine the specific noxious weed control requirements not specified in the contract of each county where the project is located before submitting a bid.

All costs incurred to meet the weed control requirements are incidental to other items of the contract.

107.11.6 Reserved

107.12 FOREST PROTECTION

Observe sanitary laws and regulations regarding the performance of the work within or adjacent to State or National Forests and Parks. Keep all areas in a neat condition, dispose of all refuse, and obtain permits for the construction and maintenance of construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures.

The Contractor, subcontractors, and their employees must prevent, suppress, and assist in preventing and suppressing forest fires, and immediately notify a forest official of the location and extent of any fire discovered.

Maintain spark arresters to meet the Forest Supervisor's requirements on all steam, gas, or diesel-driven machinery used and on all flues at construction camps.

107.13 INSURANCE REQUIREMENTS

107.13.1 Insurance on All Contracts

Obtain commercial general liability insurance with a general aggregate limit of \$2,000,000; an occurrence limit of \$1,000,000; and products and completed operations limit of \$1,000,000. Obtain insurance from an insurer with a Best rating of A- or better on the date the policy is written.

Obtain a policy that:

- A.** Provides coverage on an occurrence basis and not on a claims made basis;
- B.** Provides the owners and Contractor protective coverage with the same limits as the commercial general liability insurance, with the State of Montana, its agents, employees, and officers as an additional named insured;
- C.** Does not contain exclusions for explosion, collapse, and underground damage hazards; and
- D.** Provides that all insurance or self insurance maintained by the State, its agents, employees, and officers is excess of the Contractor's insurance and does not contribute with it.

Do not start work until the Department has been furnished evidence that adequate insurance has been obtained.

The insurance requirements are a condition precedent to the contract. Failure to obtain and maintain all required insurance, or permitting the insurance to lapse before the contract is complete and accepted is considered a material breach of the contract.

107.13.2 Insurance Involving Railroads

Furnish Railroad Protective Liability Insurance on behalf of the railroad when equipment or personnel are located or work is done on any railroad right of way.

The limits of liability are specified in the contract.

Obtain public liability and property damage insurance as specified in Subsection 107.13.1 before working within 50 feet (15.25 m) from the nearest rail but still on railroad property.

Submit copies of the Railroad Protective Liability Insurance policy, and a certificate of insurance required in Subsection 107.13.1 for transmittal to and approval by the railroad. Do not use or enter railroad property until railroad approval is received and the policies are in effect. This applies to all work done as a part of the project.

107.13.3 Reserved**107.13.4 General**

Furnish insurance policies with an endorsement that prohibits canceling, altering, amending or reducing coverage without giving a minimum of 30 calendar days written notice by the insurance company to the insured and the Department. Keep the required insurance in full force and effect until all work has been satisfactorily completed and accepted under the terms of the contract. A Montana resident agent must countersign all insurance policies issued under the contract. If the state where the insurance is being purchased has a reciprocal agreement with the State of Montana and the insurance company is licensed to do business in the State of Montana, a countersignature by a Montana Resident Agent is not required.

107.14 THIRD PARTY BENEFICIARY CLAUSE

It is specifically agreed between the parties to the contract that it is not intended to create anyone as a third party beneficiary or to authorize anyone not a party to the contract to maintain an action for damages pursuant to the terms or provisions of the contract.

107.15 RESPONSIBILITY FOR DAMAGE CLAIMS

Indemnify and hold harmless the Department and the Department's officers and employees from all actions or claims brought because of injuries or damages to persons or property caused by the actions or omissions of the Contractor's employees or agents.

107.16 OPENING SECTIONS OF PROJECT TO TRAFFIC

The Engineer may open certain sections of the work before completion or acceptance of the contract. Opening these sections does not constitute acceptance of the work, or waive any contract requirement.

Pending completion and acceptance of the roadway, complete all repairs or removals on sections of opened roadway caused by defective materials, work or by causes other than ordinary wear and tear meeting Subsection 107.17 requirements.

If shoulders, drainage structures, or other elements of the work are not completed on schedule, the Engineer may order all or a portion of the project open to traffic. Liability and responsibility for maintaining the work before final acceptance remains in effect. Complete the remaining work with minimum interference to traffic.

107.17 CONTRACTOR'S RESPONSIBILITY FOR WORK

Protect the work against loss, injury, or damage caused by the elements, traffic, or any other cause, including, but not limited to, fire, theft, pilferage, vandalism, or third-party negligence until final acceptance. Rebuild, repair, and restore all loss, injury and damages to the work resulting from the above causes before final acceptance at Contractor expense.

Rebuilding, repairing, and restoring damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor (including, but not restricted to: acts of God such as earthquake, flood, tornado, or other cataclysmic phenomenon of nature or acts of the public enemy or of governmental authorities) will be paid for under Subsection 104.03. This does not excuse, or allow compensation or repayment for any act or omission by the Contractor or its subcontractors, either in violation of law, regulation, ordinance, etc., or for any act or occurrence, which could have or should have been foreseen.

Expect probable adverse weather and stream flow conditions to occur. The cost of delay, loss, injury, or damage occurring to dikes, cofferdams, caissons, work bridges, haul bridges, or any other construction item or equipment, caused by adverse weather and stream flow conditions is the Contractor's responsibility.

The above requirements do not apply to units or portions of the project accepted under Subsection 105.15.

Repair of damage not caused by the Contractor to installed delineators, impact attenuators, median barrier, guardrail, guideposts, light poles, sign supports, and the like, that have been accepted as complete and to any building that has been completed in its entirety, is fully functional, and is open to the public, will be paid for under Subsection 104.03.

Payment for repair of damages resulting from public traffic and use does not entitle the Contractor to:

- A. The release of any part of unpaid contract funds; or
- B. Relief from responsibility for defective workmanship or materials; or
- C. A waiver of any contract provision.

Conduct the work to assure maximum convenience and safety to the general public and to the property owners adjacent to the work.

Maintain access for adjacent property owners at all times.

Take precautions to prevent damage to the project during work suspensions. Provide for drainage and erect all necessary temporary structures, signs, or other facilities at Contractor expense.

107.18 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES

Protect railway, telegraph, telephone, and power company properties or other property from damage, loss or inconvenience from construction before starting work. Cooperate with the utility owners in the removal and rearrangement of underground or overhead utility lines or facilities to minimize interruption to service and duplication of work by the utility owners.

Call the Utilities Underground Location Center (1-800-424-5555) or other notification system for the marking and locating of the utilities before excavation. Do not damage underground facilities during excavating and backfilling work.

Obtain and carry a \$2,000,000.00 comprehensive insurance policy covering underground work and resulting damage to underground utilities in addition to the insurance required by Subsection 107.13.

Provide and maintain temporary drainage facilities if existing surface drainage, sewers, or underdrains are interrupted at Contractor expense until permanent drainage facilities are completed. Protect and preserve existing tile drains, sewers, other subsurface drains, conduits, and other underground structures affected by construction that can remain in use without any change.

Immediately stop work if a utility line, cable, pipe or other facility is exposed or damaged during the work. Notify the Project Manager and the utility company of the damage and its location. Cooperate with the utility company if utility services are interrupted due to an accidental break until service has been restored. The Project Manager will stop work in the area of the damaged utility should the Contractor not stop work voluntarily. Resume work upon notice from the Project Manager. No compensation is made for delays associated with utility damage caused by the contractors work.

The Department will withhold monies from estimates due or to become due the Contractor for all utility damage and related costs not reimbursed by the Contractor under this Subsection.

Do not begin work around fire hydrants until provisions for continued service have been made and approved by the local fire authority. Provide continuous repair until service is restored if water service is interrupted.

Repairs to damaged utility facilities or structures resulting from construction operations and negligence is at Contractor expense. Be responsible to the utility owners and operators for

damage, injury, expense, loss, inconvenience, delay and for any legal suits, actions, or claims that may result from the work.

The Commission may require the Contractor to furnish protective public liability and property damage insurance to each corporation, company, partnership, or individual owning or operating the properties affected.

107.19 FURNISHING RIGHT-OF-WAY

The Department will obtain all right-of-way for the project.

Exceptions will be noted in the bid proposal and award of the contract may not be made until right-of-way is obtained. The submission of a bid is an affirmative statement that the bidder accepts this condition and waives any damage that could be claimed.

Claims for damage or loss of anticipated profits because of this delay will not be considered by the Department. Consideration will be given for an appropriate extension of the contract time if the award is substantially delayed.

107.20 PERSONAL LIABILITY OF PUBLIC OFFICIALS

The Department, and its authorized representatives are acting solely as agents and representatives of the State when carrying out or exercising the power or authority granted under the contract.

There is no liability on them either personally or as officials of the State.

107.21 NO WAIVER OF LEGAL RIGHTS

Once the work is complete, the Department will expeditiously make final inspection and notify the Contractor of acceptance. Final acceptance does not prevent the Department from correcting any measurement, estimate, or certificate made before or after contract completion and from recovering from the Contractor, or surety, or both overpayment's sustained for failure to fulfill the obligations under the contract. A Department waiver of any breach of any part of the contract does not constitute a waiver of any other or subsequent breach.

Be liable to the Department for latent defects, fraud, or gross mistakes as may amount to fraud, or with regards to the Department's rights under any warranty or guaranty.

107.22 PROTECTION OF ARCHEOLOGICAL AND HISTORICAL FINDINGS

Submit written evidence that no historic or pre-historic sites on or eligible for listing in the National Register of Historic Places are located on property used for construction activities that are outside of the Department obtained right of way, easements, material sites, or other areas designated in the contract before construction starts. These areas include but are not limited to staging areas, Contractor furnished material sites, or other related areas to be used for the work.

Submit the legal descriptions, the acreage (hectares) involved, a description of the work activity, a site plan, and a description of the ground surface of all sites not included in the contract plans. Within 10 working days, the Department will notify the Contractor if the presence or potential of cultural resources exists in the areas and recommend if a professional cultural resource survey is needed or not needed. If a survey is not recommended, no further cultural resource work is required.

If a survey is recommended, hire a professional cultural resource contractor to perform a survey. A directory of cultural resource contractors is available from the Department Archeologist.

If the survey does not identify any historic or pre-historic site within the area of proposed disturbance, the Department will issue a notice to proceed with the work. If the cultural resource contractor or the Department identify any historic or pre-historic sites within the proposed area of

disturbance, the Department, in concert with SHPO will determine whether the site(s) may be eligible for listing in the National Register of Historic Places.

Choose one of the following options if a site is eligible:

- A. Do not use or disturb the proposed site.
- B. Request the Department to proceed with the steps to comply with 36 CFR 800. Use a professional cultural resource contractor to perform all field work, surveys, etc. required to complete the process identified by the Department. No additional compensation or delay considerations are allowed under these requirements.

Immediately stop work if archeological or historical artifacts are encountered. Immediately notify the Project Manager of the find. The Project Manager will stake the area to remain undisturbed until further notice.

107.23 DISCOVERY OF UNDERGROUND STORAGE TANKS

Take the following action if an underground storage tank or tanks are encountered, the existence or location which was previously unknown to the Department or Contractor, on the project within the highway right-of-way, or in any other area of the project, including the Contractor's own work areas:

- A. Immediately stop work in the vicinity and notify the Project Manager of the find and notify the State authority:

Waste and Underground Tank Management Bureau
Department of Environmental Quality
Permitting and Compliance Division

- B. Immediately notify the local fire authority and, within 24 hours notify the State authority if there is evidence of a tank leak or pipe leak. The State authority to be contacted is:

Underground Storage Tank Program
Department of Environmental Quality
Environmental Remediation Division
1-800-457-0568

- C. Immediately protect people and property from fire, explosion, vapor, and other potential hazards and, prevent further release of the tank's contents. Take all actions requested by the Project Manager and the Underground Storage Tank Program personnel.
- D. Perform the tank closure work as directed by the MT Dept. of Environmental Quality.
- E. Do not resume work in the immediate vicinity of the tank until approved.

Costs incurred from the discovery of underground storage tanks within the highway right-of-way are paid for as extra work under Subsection 104.03. Costs from the discovery of underground storage tanks outside the highway right-of-way are at the Contractor's expense.

107.24 DISCOVERY AND REMOVAL OF UNKNOWN HAZARDOUS MATERIALS

If the Contractor discovers hazardous material (i.e., asbestos, PCBs, petroleum, PCPs, hazardous waste or radioactive material, etc.), the existence or location which was previously unknown to the Department and the Contractor and not identified in the contract, the Contractor must immediately stop work in that area. Immediately notify the Project Manager. Work may continue in unaffected areas believed to be safe.

The Department will equitably compensate the Contractor under Subsection 109.04.3 for costs associated with the delay to work in the affected area.

Once notified of the contaminated site, the Department will determine whether a separate Contractor will be used to assess and clean up the contaminated site before permitting the Contractor to resume work in the contaminated area. The separate Contractor must obtain all

necessary clearances (procedures, permits, etc.) from the regulatory agencies before starting any work. If the Department, after consulting with the Contractor, determines that the Contractor can perform the work it is subject to Subsection 107.26 and is paid for under Subsection 109.04.3.

If the Contractor does not want to perform the work, it agrees and accepts that it waives any potential claim for itself, its subcontractors, and suppliers for damages for delay from the Department's securing another Contractor to perform the clean-up work.

If the area is determined to pose a hazard to the traveling public, close off all access to the area as directed.

107.25 ACCESS TO CONTRACTORS RECORDS

Allow access by the Department or its authorized representative, and the FHWA to all project records, and the project records of all Subcontractor's, under Section 18-1-118 MCA, by the Legislative Auditor and Legislative Fiscal Analyst to determine compliance with the contract terms.

107.26 LIABILITY FOR CERCLA/CECRA CLAIMS

The Department will indemnify, protect, and hold harmless, the Contractor for any actions which the Department specifically directs or reasonably requires the Contractor to perform only if said action is the subject of litigation or administrative action under CERCLA, 42 U.S.C. Section 9601, et seq., or CECRA (Section 75-10-701 et seq. MCA), and it does not fall within the exceptions below.

Indemnify, protect, and hold harmless the Department for any omissions or actions not specifically directed by the Department if said omissions or actions are the subject of litigation or administrative action pursuant to CERCLA or CECRA. Actions or omissions which are chosen either in type, scope, location, amount or method by the Contractor are not "specifically directed or reasonably required" by the Department.

Further indemnify, protect, and hold harmless, the Department for any negligent actions by the Contractor, its subcontractors, their employees or agents, including any actions that may be the subject of litigation or administrative action pursuant to CERCLA or CECRA.

When the Contractor is directed by the contract to obtain hazardous material liability insurance coverage for a project, that contract requirement controls and has priority over this specification.

107.27 DIESEL FUEL USED ON THE PROJECT

Use taxed clear fuel as required by state law to construct the project.

Violation of state law will result in a six-month suspension of the violating firm from participation in Department contracts not already awarded on the date of suspension. Prime contractors are responsible for compliance of their own equipment, and the equipment of all subcontractors and their subcontractors.

SECTION 108

PROSECUTION AND PROGRESS

108.01 SUBCONTRACTING OR ASSIGNMENT OF CONTRACT

108.01.1 Subcontracting

Do not subcontract, assign, or otherwise dispose of more than 60 percent of any portion of the contract cost without the written consent of the surety and the Department.

Include in the written subcontract or assignment or in a separate written document with the subcontract or assignment the following language:

"In consideration of being awarded this subcontract, and in consideration of having this subcontract approved by the State of Montana, the Subcontractor hereby assigns to the State of Montana any and all claims or causes of action for any antitrust law violations, or damages arising there from, as to goods, materials, and services purchased under the terms of this subcontract or any change order that may result from this subcontract."

108.01.2 Contract Performance

Perform at least 40 percent of the contract cost with the Contractor's organization. Designated contract "Specialty Items" may be performed by subcontract without regard to the 40 percent limitation.

Where an entire item is subcontracted, the percentage of the total work subcontracted is based on the contract item unit price. When a portion of an item is subcontracted, the percentage of the work subcontracted will be based on either the subcontract item unit price or on an estimated percentage of the contract item unit price, determined by the Construction Administration Services Engineer.

Do not allow a Subcontractor at any contract tier to start work until its subcontract is consented to by the Construction Administration Services Engineer in Helena. Include two executed and certified copies of the subcontract, a letter from the surety consenting to the subcontract, and a copy of the proposed Subcontractor's current special fuel users permit issued under 15-70-302 MCA.

Do not subcontract or assign more than the allowable 60 percent by including additional labor, equipment, and supervision costs on the Contractor's payroll records to circumvent the subcontracting provisions.

Inform the Subcontractor of all the contract provisions. The minimum wage included in the contract applies to labor performed on all work subcontracted, assigned, or otherwise disposed of.

Attach to each subcontract all required contract provisions and predetermined minimum wage rates. Include in the subcontract these words: "The Subcontractor agrees to comply with all of the labor provisions contained in the attached "Special Required Contract Provisions" and "Minimum Wage Determination."

All subcontractors are agents of the Contractor. The Contractor is responsible for all work, material furnished, project documentation provided by, and indebtedness incurred by its subcontractors.

Written consent to subcontract, assign or transfer the contract does not release the Contractor from liability under the contract and bond.

108.02 NOTICE TO PROCEED

Work is to begin and time charges start on the date stipulated in the "Notice to Proceed". Do not begin actual work nor permit subcontractors to begin work until all Subsection 103.07 requirements are met.

If work cannot begin on the date in the Notice to Proceed due to reasons beyond the Contractor's control, these conditions, dates, and reasons will be recorded in the weekly "Assessment of Contract Time" form and no time will be charged. Begin work when the Engineer determines and issues a notice to resume work and that assessment of contract time will start.

108.03 PROSECUTION OF WORK**108.03.1 General**

Begin obtaining all air quality, water quality and storm water runoff permits, approval of reclamation plans, and archaeological and historical clearances immediately upon receipt of the notice of contract award letter from the Department. Furnish the completed applications to secure permits, approvals or clearances as they are submitted to the respective agency. Furnish approved permits, reclamation plans and clearances necessary to complete the work in conformance with all federal, state and contract requirements.

The Department will reimburse all reasonable costs incurred in securing the permits, approvals and clearances if the Department does not execute the contract for reasons outside its control.

A pre-construction conference will be held on a mutually agreed date between the Contractor, Department and other parties interested in the work before work within the project limits begins. The Contractor's superintendent in charge of the project must attend the conference. Encourage subcontractors to attend. A pre-construction conference will not be scheduled or held and no work (other than obtaining permits) may begin until the Project Manager approves the schedule meeting all requirements of Subsection 108.03.2.

Obtain written approval before starting night work. Provide work area flood lighting for night work and do not rely solely on equipment lights. Night work approval may be rescinded at any time.

Suspending and resuming work on all or a part of the contract will be by Subsection 105.01.

Work may be suspended on working day contracts for unsuitable weather or for other conditions that are detrimental to the work accuracy and quality. Prevent damage and repair damaged work that was not protected during the suspension at Contractor expense. No time extensions will be approved for work to correct non-protected work.

Store materials to protect against damage and without obstructing, endangering or impeding traffic.

Do not allow water to pond on the roadway or within the construction limits, excluding environmental protective devices. Open ditches and shoulder drains, and take other actions to protect the public and the work.

The Department does not authorize project suspension by the Contractor and time will be charged during unauthorized project suspensions. If the Contractor suspends the project, provide written notification of the suspension to the Project Manager seven calendar days before the suspension. The Contractor is responsible for all maintenance required during unauthorized suspensions and for all work and materials required due to the suspension.

108.03.2 Project Schedules

For projects not subject to Subsection 108.03.3 CPM requirements, submit two copies of an Activities Schedule Chart (ASC), and two copies of a Written Narrative (WN) that details the work and time (working days, calendar days or completion date) to complete the contract.

The Contractor may use a Critical Path Method (CPM) schedule as the ASC if it meets the requirements described in Subsection 108.03.2 herein and results in no additional cost to the Department.

A. Include in the ASC:

1. A bar chart chronologically sequenced and to time scale showing the following:
 - a. All work activities with a completion duration of five or more working days. (For this requirement, "working days" does not exclude the period from November 16 through April 15.)
 - b. Any work activity that has an impact on completion of the project.
2. The relationship of each work activity listed in Subsection 108.03.2(A)(1) to other work activities, permits, plans, submittals and approvals required to complete the project.
3. Work activity durations by working days or calendar days as appropriate. Note non-working periods exceeding three days on each activity bar.

B. Include in the WN:

1. The proposed work process sequence describing the relationship of the work activities listed in Section A. herein required to complete the contract, including shop drawing submittals, permits (including estimated maximum waiting periods for all required permits), fabrication and delivery activities.
2. A detailed description and the progress time of each work activity listed in Section A. herein, measured by working day or calendar day, as appropriate.
3. A detailed description of the ASC, including holidays, planned workdays per week, number of shifts per day, hours per shift, size of work crews and resources used.

Submit an updated ASC and WN every month in which work is performed, one week before the end of the project's monthly estimate cycle. The ASC and WN should show current progress and all revisions or modifications that reflect changes in the method or manner of the work, specification changes, extra work, changes in duration, changes in shifts, work crews or resources. If the work is not proceeding consistent with the Contractor's most recent ASC and WN, the Project Manager may require that the Contractor submit two copies of an updated ASC and WN that accurately reflect the Contractor's progress, resource allocation for the project, and revised schedule. Submit the updated ASC and WN within one working day of the Project Manager's request. It is the Contractor's responsibility to ensure that the WN and ASC submitted meet the above requirements and accurately reflects the work progress. The Project Manager may suspend work under 105.01.A. if the WN and ASC do not accurately reflect the actual progress of the work; the suspension may continue until accurate WN and ASC are submitted.

Any delay in beginning or prosecuting work that is caused by the Contractor's failure to provide an ASC or WN when and as required is solely the responsibility of the Contractor, and is not an excusable delay.

Prosecute the work with the resources required to complete the contract within the time shown in the Contractor's updated ASC and WN.

The Department may withhold ten percent of each monthly progress estimate for failure to submit an original or updated ASC or WN on time and in the manner required. Payment withheld for violation of the schedule requirements will be included in the next progress estimate following the Contractor's submission of the required ASC and WN. The Project Manager's approval does not attest to the validity of the ASC or WN.

108.03.3 Critical Path Method (CPM) Scheduling

When requested, furnish one workstation copy of a computer software package compatible with Windows© operating systems to produce a Critical Path Method (CPM) schedule for the

contract work. Payment for the workstation copy of the computer software package will be made at invoice cost. Schedule all contract work including that of subcontractors, vendors and suppliers.

Prepare the initial CPM schedule as an Activity On Node (AON) or Precedence Diagramming Method (PDM).

The Project Manager may withhold ten percent of each monthly progress estimate for failure to submit an original or updated CMP schedule on time and in the manner required. Payment withheld for violation of the schedule requirements will be included in the next progress estimate following the Contractor's submission of the required CPM schedule. The Project Manager's approval of the CPM schedule does not attest to the validity of the Contractor's assumptions, logic constraints, dependency relationships, resource allocations, labor and equipment or other schedule aspects.

A. Preparation and Submission of Schedule. Prepare an initial schedule and submit a disk with the software package used to develop the CPM schedule and one ANSI D (24-inch by 36-inch) paper copy. Submit all items listed in Item C herein.

Attend a meeting scheduled by the Project Manager within 10 calendar days of the Project Manager's receipt of the CPM schedule to review, correct or adjust the CPM schedule if required.

Make all schedule adjustments and corrections discussed at the meeting and re-submit a disk with the revised schedule within 15 calendar days after the meeting. Plan and execute the work to meet project milestones and completion dates.

B. Initial Schedule Requirements. Include the requirements listed in Subsection 108.03.3(C) and the following:

1. Total Float Sort; Responsibility/Early Start Sort; Area/Early Start Sort;
2. 60-day look ahead bar charts by early start; and
3. Logic diagram having a maximum 100 activities for each ANSI D (24-inch by 36-inch) size sheet. Ensure each sheet includes project number, page number, title, match data or diagram correlation and key to identify all components used in the diagram.

C. Schedule Requirements.

Submit schedules that include:

1. Activity identification numbers;
2. Activity descriptions;
3. Finish to start relationships with no lead or lags;
4. Activity durations of not more than 20 working days and not less than one working day unless otherwise approved by the Project Manager. Submit activity manpower, equipment, unit quantities and production rates to the Project Manager for review;
5. Material procurement separated into at least two activities, fabrication and delivery. Include time for delivering all submittals and 30 calendar days for Department review of working drawing submittals as separate items in the schedule logic for all items requiring submittal, review and approval;
6. Activities coded to reflect the party performing each activity (only one party performs each activity) including subcontractors and suppliers and the area/location of each activity; and
7. Work days per week, holidays, number of shifts per day, hours per shift and major equipment to be used.

Use only contractual restraints in the schedule logic. Do not use any other schedule restraints such as activity mandatory start and finish dates or mandatory zero float constraints.

Float is defined as the amount of time between when an activity "can start" and when it "must start". Float is a shared commodity, not for the exclusive use or financial benefit of either party. Either party has the full use of float until it is depleted.

Show the sequence and interdependence of all activities required for the complete performance of all items of work under this contract, including acquiring all the environmental permits. Show all network "dummies" on the diagram.

The Department reserves the right to limit the number of activities on the schedule to between 50 and 500 activities.

Describe the activities so that the work is identifiable and the progress on each activity is measurable.

D. Schedule Updates and Progress Payments. Schedule and attend monthly project progress meetings to compare the schedule to the actual finish dates of completed activities, the remaining duration of uncompleted activities and the proposed logic and/or time estimate revisions. Provide the status of activities at these meetings, and the schedule updates based on this information, once it has been verified.

Each month of the project, one week before the end of the project's monthly estimate cycle, submit a schedule on disk containing:

1. An updated I node - J node sort;
2. Total Float Sort;
3. A narrative report describing the critical path, logic revisions or modifications to the schedule, including, but not limited to: changes in the method or manner of the work, changes in specifications, extra work, changes in duration, etc.; and
4. Any revised activity on node diagrams for the following:
 - a. Delay in the completion of any critical activity;
 - b. Actual prosecution of the work that is different than that represented on the CPM schedule; and
 - c. The addition, deletion, or revision of activities required by contract modification(s), or logic revisions.

The contract time will be adjusted only as specified in the contract. Furnish documentation to support requests for time extensions for milestone dates or the contract completion date.

108.03.4 Method of Measurement

CPM schedule is measured by the lump sum. Other scheduling requirements are not measured for payment.

108.03.5 Basis of Payment

Payment for all costs associated with CPM scheduling is included in the lump sum contract unit price for critical path method (CPM) scheduling. Payment for all costs associated with other scheduling requirements is included in the payment for other items of work.

The Department may withhold ten percent of each monthly progress estimate for not submitting the monthly schedule updates as required. Payment withheld for violation of the schedule requirements will be included in the next progress estimate following the Contractor's submission of the required schedule.

Partial payments for CPM scheduling will be made based on the lump sum contract unit price as follows:

1. 50 percent when the initial schedule is finalized.
2. 75 percent when the overall project is 50 percent complete.
3. 100 percent when all updates have been submitted.

108.04 LIMITATION OF OPERATIONS

Conduct the work to minimize interfering with traffic and work already started. Finish a section of roadway before starting work on any additional sections if it is essential to public convenience.

108.05 CHARACTER OF WORKERS

Provide workers with the skill and experience to perform the work.

Remove any person employed who does not perform work in a proper and skillful manner or who is intemperate or disorderly. Do not re-hire these employees without the Engineer's approval.

Failure to remove the employee or employees or failure to furnish suitable and sufficient personnel to perform the work may result in a written notice to suspend the work.

108.06 METHODS AND EQUIPMENT

Use equipment of the size and mechanical condition to perform and produce the specified quality of work. Do not use equipment that damages the roadway, adjacent property, or other highways.

Operate all equipment with adequate lighting at night.

Do not use methods or equipment other than as specified unless requested in writing and authorized by the Engineer. Include in the request a full description of the proposed methods and equipment to be used and the reasons for the change. Produce work meeting the contract requirements.

Discontinue use of alternate methods or equipment if the Engineer determines that the work does not meet contract requirements. Remove and replace or repair deficient work with work of specified quality at Contractor expense. No change will be made regarding payment for authorizing a change in methods or equipment.

108.07 DETERMINATION OF COMPENSATION AND EXTENSION OF CONTRACT TIME FOR EXCUSABLE, NONCOMPENSABLE, AND COMPENSABLE DELAYS

Time allowed for completion of the contract is determined by either the "Calendar Date" or the "Working Day" provision in the contract.

108.07.1 Calendar Date Contracts

Complete all work by the fixed calendar date specified in the contract. The fixed calendar completion date will be extended:

- A. If the contract is awarded more than 10 calendar days after bid opening; or
- B. For extra work according to the calendar days computed under Subsection 108.07.5; or
- C. For authorized suspensions of work.

The new completion date is determined by adding the number of calendar days between the tenth day after bid opening and the award date; the calendar days computed under Subsection 108.07.5; or the number of calendar days during authorized suspensions to the specified fixed calendar completion date.

The actual completion date is the date the Engineer accepts the project as complete under Subsection 105.15.3.

Contract time overruns for assessment of liquidated damages will be computed as the number of calendar days elapsing between the contract completion date and the actual completion date.

108.07.2 Reserved

108.07.3 Working Day Contracts

Complete all work within the number of working days specified in the contract.

A working day is defined in Subsection 101.03. Holidays designated as nonworking days are defined in Subsection 101.03.

Working days will be assessed against the contract time except for days when inclement weather or the aftermath of inclement weather prevents the performance of operations that would be in progress for:

1. At least 60 percent of the normal daily schedule being worked from April 16 through November 15.
2. At least 60 percent of the normal daily schedule being worked or four hours, whichever is less, from November 16 through April 15.

All days worked from November 16 through April 15 will be considered a chargeable day except for the following:

1. Producing and stockpiling surface aggregates; and
2. Emergency and maintenance repairs to the project.

Assessment of time begins on the effective date of the Notice to Proceed.

If work cannot be performed at the regular starting time because of inclement weather or the effects of inclement weather and the work crew is dismissed, no time will be charged for that day.

Do not work on holidays or Sundays without the Engineer's approval. Work done on Saturdays, Sundays, and approved holidays will be assessed as working days.

Producing and stockpiling surfacing aggregates, pre-wetting, making emergency repairs to the project, and providing protection for the public may be accomplished on Saturdays, Sundays, holidays, and during a work suspension period without assessment of time with the following exception:

- The period from November 16 through April 15 is chargeable for state maintenance stockpiling projects.

Chargeable or non-chargeable working days will be determined and agreed upon daily between the Project Manager and the Contractor's superintendent. Except for the period November 16 through April 15, the Project Manager will furnish a weekly report showing the number of working days:

- A. Charged for the preceding week;
- B. Previously charged;
- C. Specified for contract completion;
- D. Of approved time extensions, except for days covered under Subsection 108.07.5, second paragraph; and
- E. Remaining to complete the contract.

The report will be furnished every Monday.

From November 16 through April 15, the Project Manager will furnish a report showing the information listed above, for any week that the Contractor has chargeable days.

File a written protest with the Project Manager within ten calendar days of receipt of the weekly report of any alleged discrepancies in the time assessed. Failure to file a protest is conclusive evidence that the time assessed is accepted as correct.

108.07.4 Delays

The following delays will be considered for extensions of contract time.

- A. **Excusable or Non-compensable Delay.** Contract time allowed for the performance of the work may be extended for delays caused by acts of God, acts of the public enemy,

fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, unusually severe weather, or delays not caused by the Contractor's fault or negligence.

- B. Compensable Delay.** Contract time may be extended for delays caused by the Department under Subsection 108.07.6.

108.07.5 Extensions

Provide a written request detailing the reasons for requesting a time extension. A plea that insufficient contract time was specified is not a valid reason for a time extension. If the Department finds that the work was delayed because of conditions beyond the control of and not the fault of the Contractor, the contract time will be extended in the amount justified. The extended time for completion is in full force and effect as though it were the original time for completion.

The contract time as awarded is based on the estimated quantities as defined in Subsection 102.05. No decrease in contract time will be made for any decrease in a contract item. The contract time will be increased based on the quantity and difficulty of added work. The minimum time allowed for any additional work is computed by the following formula:

$$\text{Time Extension in Days} = \frac{\text{Total Dollar Amount of Additional Work}}{\text{Total Amount of Contract as Awarded}} \times \text{The Contract Time as Awarded}$$

The computed time extension will be rounded to the nearest whole day.

No additional contract time will be allowed for:

- A. Increases in percentages of asphalt in plant mix materials.
- B. The addition of anti-stripping additives to bituminous materials.
- C. The addition of or for increases in hydrated lime or mineral fillers to plant mix materials.
- D. Increases in traffic control devices.
- E. Delays for slow delivery of materials from the supplier or fabricator.
- F. Material deliveries delayed for reasons of late ordering, financial considerations, or other foreseeable and preventable causes within the Contractor's control.

Delays in material deliveries for unusual market condition caused by an industry-wide strike, national disaster, or an area-wide shortage beyond the Contractor's control will be considered as a basis for granting additional time.

Submit written documentation substantiating the reasons for the late delivery or non-availability of materials. The documentation must be from the original supplier and document the dates the material was ordered by the Contractor and the reason for late delivery or non-availability of the material. Include a statement elaborating on the efforts to obtain materials from alternate suppliers.

108.07.6 Delay Compensation

Requests for any compensation for delay under this provision must fully comply with the provisions of Subsection 105.16, in addition to the following requirements.

Notify the Project Manager of the request for delay consideration. Keep daily records of all non-salaried labor, material costs, and equipment expenses for all operations affected by the delay.

Maintain a daily record of each operation affected by the delay and the location, by stations, of the affected operations. The Department will maintain daily records of the operations by stations. Each Monday, the two records will be compared. Prepare and submit, each Monday, written reports to the Project Manager containing the following information:

1. Number of days behind schedule;

2. A summation of all operations that have been delayed, or will be delayed;
3. An explanation for compensable delays and how the Department's act or omission delayed each operation;
4. An estimate of the time required to complete the project; and
5. An itemization of all extra costs incurred, including:
 - a. Relating the extra costs to the delay and document how they are calculated and measured;
 - b. Identifying all non-salaried project employees for whom costs are being compiled; and
 - c. Summarizing the time charges for equipment, identified by manufacturer's number for which costs are compiled.

Provide a written summation of the comparison of the detailed reports within ten calendar days. Define all disagreements between specific records.

Failure to meet to review the Department's records or to report disagreements between the records is considered the Contractor's acceptance of the records as accurate.

A. Procedures Following Completion of Work Allegedly Delayed. Submit a written report within 15 calendar days of project completion, or phase of work allegedly delayed, containing the following information:

1. A description of the operations delayed and the documentation and explanation of the reason for the delay, including all reports prepared for the Contractor by consultants, if used; and
2. An item-by-item measurement and explanation of extra costs requested for reimbursement due to the delay.

All costs shown in the report submitted to the Department must be certified by an accountant.

The Engineer will review the submittal and any reports prepared by the Project Manager. The Engineer will provide a written decision to the Contractor within 60 calendar days of receiving the submittal.

In the case of compensable delays, if it is determined that the Department is responsible for delays to the Contractor's operations, the Engineer's written decision will reflect the nature and extent of any equitable adjustment to the contract as specified in Subsection 109.04.3.

108.08 FAILURE TO COMPLETE ON TIME

For each working day or calendar day the contract remains uncompleted after the specified contract completion time, including approved adjustments, a daily charge will be made against the contract. This daily charge, determined from Table 108-1 will be deducted from any money due the Contractor. This deduction is for liquidated damages for added Department contract administration costs for failure to complete the work on time.

TABLE 108-1
SCHEDULE OF LIQUIDATED DAMAGES

ORIGINAL CONTRACT AMOUNT		DAILY CHARGE
From More Than	To and Including	Working Day or Calendar Day
\$ 0	\$ 50,000	\$ 478
\$ 50,000	\$ 100,000	\$ 618
\$100,000	\$ 500,000	\$ 967
\$ 500,000	\$ 1,000,000	\$ 1,171
\$ 1,000,000	\$ 2,000,000	\$ 1,505
\$ 2,000,000	\$ 5,000,000	\$ 2,341
\$ 5,000,000	\$ 10,000,000	\$ 2,804
\$ 10,000,000	—	\$ 3,379

Permitting the Contractor to continue and complete the work after the specified contract completion time or approved extensions granted does not waive the Department's rights under the contract.

The Commission may waive such portions of the liquidated damages as may accrue after the work is substantially complete (e.g., a few punch list items to be completed) and in condition for the safe and convenient use by the traveling public. If the Contractor disputes the liquidated damages on the accepted "Contractor's Final Inspection" form, the Construction Administration Services Bureau will send a final notification in writing to the Contractor of the number of days to be assessed and the dollar amount of proposed liquidated damages. Submit any objections of the assessment to the Construction Administration Services Bureau in writing within thirty days of receipt of the Department's notification. Include with the objection the justification and all information to support an adjustment to the assessment. The Department will review the Contractor's information, incorporating it into the Department's recommendation to the Commission. The Construction Administration Services Bureau will provide a copy of the Department's recommendation within 45 days of receipt of the objections to the Contractor. The Contractor must state in writing within fourteen days of receipt of the Department's recommendation if an appearance before the Commission is requested. If an appearance is requested, the Department will notify the Contractor in writing of the date the Commission will review the liquidated damages recommendation. The Commission will not receive or hear new information at the meeting not already furnished in the Contractor's original response.

108.09 DEFAULT OF CONTRACTOR

If the Contractor:

- A.** Fails to begin the work under the contract within the time specified in the notice to proceed.
- B.** Fails to perform the work with sufficient resources to promptly complete the work.
- C.** Fails to perform the work in accordance with the contract requirements or refuses to remove and replace rejected materials or unacceptable work.
- D.** Discontinues the prosecution of the work.
- E.** Fails to resume work that has been discontinued within a reasonable time after notice to resume has been given.
- F.** Becomes insolvent or is declared bankrupt or commits an act of bankruptcy or insolvency.
- G.** Allows a final judgment to remain unsatisfied for a period of 10 days.

- H. Makes an assignment for the benefit of creditors.
- I. Fails to comply with contract requirements regarding minimum wage payments, EEO requirements, or any state or federally mandated affirmative action requirements.
- J. For any other cause fails to carry on the work in an acceptable manner.

The Engineer will give written notice to the Contractor and surety of such delay, neglect, or default. Failure to correct the delay, neglect, or default within 10 calendar days after the Engineer's written notice gives the Department full authority without violating the contract to take over prosecution of the work from the Contractor. The Department may appropriate or use any or all materials and equipment at the project site that is suitable and acceptable and enter into an agreement for completing the contract. The Department may use any methods determined necessary to complete the contract.

All costs and charges incurred by the Department, including the cost of completing the work under the contract, will be deducted from any monies due or that may become due the Contractor. If the expense exceeds the sum that would have been payable under the contract, then the Contractor and the surety are liable and must pay to the Department the amount of such excess.

108.10 TERMINATION FOR PUBLIC CONVENIENCE

108.10.1 General

The Department may terminate the contract in whole or part, whenever:

- A. Work cannot proceed because of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense; or an Executive Order of the President or Governor of the State with respect to the preservation of energy resources.
- B. Work cannot proceed because of a preliminary, special, or permanent restraining order of a court of competent jurisdiction where the issuance of such restraining order is primarily caused by acts or omissions of persons or agencies other than the Contractor.
- C. It is determined that termination is in the best interests of the Department.

108.10.2 Payment

Payment will be made for the actual work performed at the contract unit prices for completed items of work when the contract is terminated under Subsection 108.10.1.

An equitable adjustment for partially completed items of work and disposal of materials will be made under Subsection 109.05.

Submit to the Engineer a claim for termination costs after receipt of the notice of Termination for Public Convenience, under Subsection 108.10.1(A). Detail the claim as specified in Subsection 105.16.2 so the Engineer can determine the basis and amount of the claim. Submit the claim no later than 60 calendar days from the effective date of termination. Resolution of the claim will be through the established administrative channels. If the claim cannot be resolved and an agreement reached, appeal the claim under Subsection 105.16.3. Make all project records available to verify the claim.

108.10.3 Responsibility of the Contractor and Surety

Termination of a contract does not relieve the Contractor of any contractual responsibilities for the work nor the Surety or Sureties of the obligations under the contract bond for the work performed.

SECTION 109 MEASUREMENT AND PAYMENT

109.01 MEASUREMENT OF QUANTITIES

Work completed under the contract will be measured using the United States standard measure or the metric system when specified.

Where the standard measure is given in the English system, approximate metric equivalents are shown in parentheses. No guarantee is provided, explicit or implicit, that the units are exact conversions. Work will be accepted on the basis of measures in the contract. Specified metric tolerances apply to metric Contracts.

Metric measurements are given in the System International (SI). Metric abbreviations in the contract are as follows.

Millimeter - mm	Meter - m
Kilometer - km	Square Meter – m ²
Cubic Meter - m ³	Kilogram - kg
Metric Ton - t	Liter - L
Kiloliter - kL	Hectare - ha
Course Kilometer - cr km	Kilometer Cubic Meter- km m ³
Metric Ton Kilometer - t km	Kilometers Per Hour - km/h

The method of measurement and computations used in determining quantities of material furnished and work performed are those methods recognized as conforming to sound engineering practice.

A station, when used as a term of measurement, is 100 feet or 100 meters.

Longitudinal and transverse measurements for surface area computations will be made horizontally using the neat plan dimensions. No deductions will be made for individual fixtures having an area of 9 square feet (0.8 square meters) or less.

Structures are measured using neat lines shown on the plans or as altered to fit field conditions.

Items that are measured by the foot (meter, millimeter), such as pipe culverts, guardrail, underdrains, and the like, are measured parallel to the structure base or foundation.

Computing excavation volumes will be by the average end area method or by alternate methods involving three-dimensional measurements (delta surface).

The term "gage," when used for measuring plates, is the U.S. Standard Gage. Galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing are specified and measured as sheet thickness in inches (millimeters).

When the term "gage" refers to measuring wire, it is the U.S. Steel Wire Gage.

The term "ton" is the short ton consisting of 2,000 pounds avoirdupois (908 kg).

Measure or proportion weighed materials on certified scales at the designated locations.

Material shipped by rail may be accepted using the car weight provided that only the actual weight of material is paid for. Car weights are not acceptable for material that will be processed in mixing plants.

Obtain tare weights daily on haul vehicles, or as directed. Clearly mark each individual vehicle with a legible identification mark.

Haul materials measured by volume in approved hauling vehicles and measure materials at the point of delivery.

If approved, material specified to be measured by the ton may be weighed and converted to cubic yards (cubic meters). The Project Manager will determine the conversion factors from weight to volume subject to Contractor concurrence before using this method of measurement.

Bituminous materials are measured by the gallon or ton (liter or metric ton). Volumes are measured at 60 °F (15.5 °C) or will be corrected to the volume at 60 °F (15.5 °C) under ASTM D 1250.

Net certified scale weights, based on certified volumes in the case of rail shipments, will be the basis of measurement, corrected for loss of bituminous material from the car or distributor, wasted, or otherwise not incorporated in the work.

When bituminous materials are shipped by truck or transport, net certified weights or volume, subject to correction for loss or foaming, may be used for computing quantities.

Cement is measured by the ton (metric ton). A ton is 2,000 pounds (908 kg).

Timber is measured by the thousand feet board measure (MFBM) (cubic meter) for timber actually incorporated in the structure. Measurement is based on nominal widths and thicknesses and each pieces extreme length.

"Lump sum" payment is complete payment for the work item described in the contract.

When a complete structure or structural unit (i.e., "lump sum" work) is specified as the unit of measurement, the unit includes all necessary fittings and accessories.

Rented equipment is measured in hours of actual working time and necessary equipment travel time within the project limits. Travel time and transportation to the project is measured for special equipment, ordered by the Project Manager for force account work.

When standard manufactured items are specified, such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gage, unit weight, section dimensions, etc., this identification is the nominal weight or dimension. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

Other quantities are computed in the contract units using established engineering principles, without consideration of local rules or customs.

109.01.1 Weighing Equipment

Furnish accurate weigh equipment for material specified to be proportioned or measured for payment by weight. The weigh equipment must indicate the weight to within the smaller of:

1. Tolerances from correct weight adopted by the Montana Bureau of Weights and Measures; or
2. One-half percent of the correct weight.

Use weigh systems tested and certified by the Bureau of Weights and Measures before each use and after each scale set-up or when directed. The Project Manager will accept reports from a Montana certified scale service stating compliance with the applicable tolerances in lieu of State certification. Seal the weigh system after adjustment and testing. Evidence of tampering or scale adjustment is cause to suspend use of the scale until it is re-tested and certified.

All materials received after the last test and certification will be reduced by the percent of error in excess of the specified tolerances if the weigh system is found to overweigh (indicate more than the correct weight).

No adjustment is made for systems found to under-weigh (indicate less than the correct weight).

Repair and re-certify weigh systems under-weighing or over-weighing outside the specified accuracy limits before use.

Follow the weigh equipment manufacturers procedures or the National Bureau of Standards Handbook No. 44 procedures for weigh system testing, witnessed by the Project Manager.

Provide all equipment, tools, and labor necessary to perform the test. Test permanent scales at least annually.

The cost of furnishing, testing, operating and maintaining weigh equipment is incidental to and included in the payment for the work.

109.01.2 Metric Abbreviations in the Schedule of Items

The Department uses the following abbreviations in the Schedule of Items for the respective metric units of measurement:

Millimeter	MM
Meter.....	M
Kilometer.....	KM
Square Meter	M2
Cubic Meter	M3
Station (100 Meters)	STA
Kilogram.....	KG
Metric Ton.....	MT
Liter	L
Kiloliter	KL
Hectare	HA
Course Kilometer	CR KM
Kilometer Cubic Meter	KM M3
Metric Ton Kilometer.....	MT KM

109.02 SCOPE OF PAYMENT

Receive and accept the specified compensation as full payment for furnishing all materials, performing all work under the contract in a complete and acceptable manner and for all risk, loss, damage, or expense arising from the work, subject to Subsection 107.21.

If the "Basis of Payment" clause for unit price in the contract requires that the unit price be full compensation for work or material essential to the item, this same work or material is not measured or paid for under any other pay item in the contract.

The payment of any current or final estimate or of any unpaid contract funds does not prejudice or affect the Contractor's obligation to submit for final acceptance a completed improvement meeting the contract specifications.

In accordance with the requirements of Chapter 50, Title 15, MCA, for contracts exceeding \$5,000, including approved modifications, the Department will withhold one percent of the dollar amount of all Contractor payments. All payments by a Prime Contractor to a Subcontractor are also subject to this one percent gross receipts fee. The Prime Contractor must withhold one percent of all payments made to subcontractors.

109.03 COMPENSATION FOR ALTERED QUANTITIES

Accept payment for work quantities that vary from the contract quantities at the original contract unit prices. No allowance, except under Subsections 104.02 and 108.10, will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense and subsequent loss of expected reimbursements or from any other cause.

Only those quantities of materials actually incorporated into the final work and accepted will be paid for.

109.04 PAYMENT FOR EXTRA WORK

109.04.1 Unit Price or Lump Sum Basis

Extra work performed under Subsections 104.02 and 104.03 is paid for at the unit price or lump sum price agreed upon and specified in the authorized work order. Extra work is authorized by a change order signed by both parties.

109.04.2 Force Account Basis

Approved extra work paid for on a force account basis must be accounted for daily on report sheets signed by each parties authorized representative. The daily report sheets are the true record of extra work. Extra work on a force account basis ordered by the Engineer in writing, under Section 104, is paid for as follows:

A. Labor. The Contractor is paid the wage rates for all labor and foremen performing the extra work for the total hours worked plus at least 80 percent of the total. The 80 percent surcharge may be increased if certified documentation is submitted showing that a higher percentage surcharge is needed to cover labor costs. The wage rates used for the above computation include travel pay, if applicable, but must not include fringe benefits, whether or not paid directly to the employees. Payment as described above is full compensation for all labor related expenses incurred including but not limited to premiums for worker's compensation insurance, public liability and property damage insurance, social security, unemployment compensation, health and welfare expenses, and other expenses imposed by federal or state laws or both.

Submit evidence of the actual wage rates paid.

B. Materials. The Contractor will receive the actual delivered cost of all materials used based on invoices, plus 15 percent. The quantity of material used must be documented.

C. Equipment. The Contractor will receive the rental rates agreed upon in writing before beginning the work for any machinery or special equipment (other than small tools) used to perform the work. Rental rates are calculated using the current issue of the Departments Equipment Rental Rate Guidelines. Rates and allowances for standby time, outside rented equipment, owner-operated equipment, and moving of equipment is determined under the Equipment Rate Guidelines.

D. Bond. The actual cost chargeable to force account work of premiums for the performance bond are paid. No surcharge is allowed for the performance bond. Furnish evidence of the rate paid for the bond.

E. Miscellaneous. Accept the compensation provided for under Subsection 109.09.2 as full payment for extra work done.

F. Statements. Submit all statements for the extra work done on a force account basis on Department forms. Attach the original extra work order, material invoices and freight bills.

The Inspector will compile and forward to the Project Manager, at the end of each day, a daily record of extra work done on a force account basis, signed by both the Inspector and Contractor's Superintendent.

G. Subcontracting. Extra work performed on a force account basis by a Subcontractor under an extra work order will include the percentage allowed in Table 109-1 for administrative expenses. This administrative allowance only applies to charges for labor and materials. The allowance is applied to all charges and added percentages specified in Subsection 109.04.2 paragraphs (A), (B), and (D) above. Bid items in the original contract are not eligible for this administrative allowance.

TABLE 109-1
SUBCONTRACTING - ADMINISTRATIVE ALLOWANCES

EXTRA WORK - SUBCONTRACTOR	ADMINISTRATIVE ALLOWANCE
\$0 to \$1,000	10%
\$1,000.01 to \$10,000	\$100 plus 5% of excess over \$1,000
Over \$10,000.01	\$550 plus 3% of excess over \$10,000

Approval of this additional percentage is made after the Contractor furnishes receipted invoices.

Administrative expenses are not paid for on a force account basis above the amount allowed the Prime Contractor and Subcontractor if the work is done by a sub Subcontractor.

109.04.3 Equitable Adjustment

The equitable adjustment provided for in Subsection 105.16 is determined as follows:

- A.** If the parties agree, the price is determined using unit prices or other agreed upon prices.
- B.** If the parties cannot agree, the price is determined by the Engineer using unit prices or other means to establish cost.

The following limitations apply:

- A.** The rental rates must be actual cost not to exceed the rates established in Subsection 109.04.2 and in effect at the time the work is performed.
- B.** No claim for loss of anticipated profits on deleted or uncompleted work or consequential damages of any kind is allowed.

109.05 DELETED OR TERMINATED WORK

The Engineer may delete work by change order under Subsection 104.02.4 or may terminate the contract in whole or part, under Subsection 108.10. When the contract is terminated in part, the partial termination is treated as a deletion change order for payment under this Section. Payment for completed items is at the contract unit prices.

When any item is deleted, in whole or in part, by change order or when the contract is terminated, in whole or in part, payment for deleted or terminated work is made as follows:

1. Payment will be made for the actual number of units of work completed at the contract unit prices unless the Engineer determines the contract unit prices are inappropriate for the work actually performed. When that determination is made, payment for work performed will be as mutually agreed. If the parties cannot agree, the Engineer will determine the amount or the equitable adjustment under Subsection 109.04.3.
2. Payment for partially completed lump sum items will be as mutually agreed. If the parties cannot agree, the Engineer will determine the amount of the equitable adjustment under Subsection 109.04.3.
3. The Department will pay as part of the equitable adjustment those direct costs necessarily and actually incurred in anticipation of performing the work that has been deleted or terminated. Costs previously paid for by the contract unit prices for completed units of work are excluded.
4. The total payment for any one item in the case of a deletion or partial termination can not exceed the contract unit price as modified by approved change orders less the estimated cost (including overhead and profit) to complete the work and less any amount paid to the Contractor for the item.

5. The total payment where the contract is terminated will not exceed the total contract price, as modified by approved change orders less those amounts paid before the effective date of termination.

No claim for damages of any kind or for loss of anticipated profits on deleted or terminated work is allowed because of the termination or change order.

Contract time will be adjusted as the parties agree. If the parties cannot agree, the Engineer will determine the equitable adjustment for contract time.

Materials to be permanently incorporated into the work and ordered before the date the work was terminated under Subsection 108.10 or as deleted under Subsection 104.02, will either be purchased by the Department at the actual cost and become Department property, or the Contractor will be reimbursed for the actual cost of returning the materials to the suppliers.

109.06 PARTIAL PAYMENTS

Partial payments will be made once each month based on estimates of the value of the work performed and materials complete in place under the contract, including materials delivered under Subsection 109.07.

The Department reserves the right to withhold all or part of any partial payments earned under the contract until all special fuel user's tax payments due or owing to the State of Montana under 15-70-302 MCA or other statutory taxes are paid in full.

If the Contractor becomes delinquent in any monetary contractual obligations (e.g., prompt payment upon satisfactory completion of work, payment to owners of materials sources, etc.), the Department may withhold unpaid contract funds from each monthly estimate thereafter until the delinquency is resolved or the amount of the delinquency has been withheld. The amount of the withholding will not exceed the amount of known delinquency but, depending on the amount of the delinquency and the amount of the monthly estimate, may be in the full amount of that monthly estimate. In the event the delinquency involves nonpayment to a Subcontractor, supplier or materialman, the Department also may order forfeiture of the contract bond, or take action under Subsection 108.09.

The Department will release the withheld amounts to the Contractor upon the Engineer's receipt of a notarized statement from the entity to whom the delinquency was owed stating that the delinquency has been satisfied in full or, in the event the entity has received partial payment of the delinquency, that portion of the withheld amount may be released.

If the contract extends beyond the contract completion time, the sum specified in Table 108-1 will be deducted from any money due the Contractor.

109.06.1 Reserved

109.07 PAYMENT FOR MATERIAL ON HAND

The materials designated in Table 109-2, when produced or delivered and stockpiled at the project site or other location approved by the Project Manager may be considered for partial payment, if the following requirements are met:

1. The material meets the contract requirements.
2. The material is a manufactured end product or a fully fabricated product. Aggregate must be produced and stockpiled to the final stage for incorporation into the specified mixture or the roadway. Riprap meeting the gradations specified in Table 701-19 for the class specified in the plans is considered a manufactured end product for this Subsection.
3. Material is stored to prevent damage and theft, without obstructing or impeding the traveling public. MDT Inspectors have access to the inventory sheets and the stockpiles at all times.

4. A written request accompanied by a delivery receipt for all items received. Include the quantity for which payment is requested, the length of time the material is to be stored, the location for material stored off the project site, and sufficient detail to justify the costs.

Furnish paid invoices and updated inventory sheets to the Project Manager whenever items are added to, or removed from the stockpile. Clearly identify the project number, location, designation and the entire inventory on these sheets. Keep each projects stockpiled material separated from stockpiles belonging to other projects. Only use stockpiled material for the designated project.

5. Furnish paid invoices for all stored manufactured or fabricated materials that have not been incorporated into the permanent work within 60 days from the date payment was requested. Include a notarized statement from the supplier or fabricator certifying that their payment has been received. If a paid invoice is not furnished, the quantity of any previously allowed material remaining in storage will be deducted from the next progress estimate, and further payment will not be made until the material is incorporated into the work.

Steel items meeting Subsection 106.09 may be stored at property owned or leased by the General Contractor or approved Subcontractor if approved by the Project Manager. The property must be located in Montana and accessible to Department personnel at all times.

Payment made for material on hand does not constitute acceptance of the material.

If stored material is lost, stolen, or damaged, the materials value will be deducted from the subsequent estimate or estimates.

Payment of partial estimates for stored material, acceptance of the materials to be stored, or approval of the storage method does not relieve the Contractor's responsibility for all materials and work upon which payments have been made or the restoration of any damaged work. The payments are not a waiver by the Department of any other contract provisions or of its rights to require fulfillment of all contract terms.

Partial payment will be made at the contract unit price for the specified percentage of the quantity produced or delivered and stockpiled as follows:

**TABLE 109-2
MATERIALS IN STORAGE ELIGIBLE FOR PAYMENT**

<u>Material</u>	<u>Percent of Quantity for Partial Payment</u>
Aggregate Base and Surfacing	
0-5 Miles Haul (0-8 km).....	50
6-9 Miles Haul (10-15 km).....	60
10-20 Miles Haul (16-32 km).....	63
21 Miles and Greater (34 km)	65
Cover Material & OGFC.....	50
Aggregate for Bituminous Mixtures	
0-5 Miles (0-8 km) Haul.....	35
6-9 Miles (10-15 km) Haul.....	45
10-19 Miles (16-31 km) Haul.....	48
20-29 Miles (32-47 km) Haul.....	51
30-39 Miles (48-63 km) Haul.....	54
41 Miles (66 km) and Greater	57
Riprap	
0-5 Miles (0-8 km) Haul.....	20

6-9 Miles (10-15 km) Haul	25
10-19 Miles (16-31 km) Haul.....	30
20 Miles (32 km) and Greater	35
Aggregate for Concrete (Bridges).....	2
Aggregate for Concrete (PCCP)	8
Pavement Marking Paint.....	50
Glass Beads for Paint Striping	10
Epoxy Pavement Marking Material	40
Glass Beads for Epoxy Striping	20
Structural Steel	60
Reinforcing Steel	50
Corrugated Metal Pipe.....	30
Structural Plate Pipe or Pipe Arch	40
Prestressed Concrete Beams.....	75
Steel Girders.....	75
Bridge Elastomeric Bearing Devices	10
Bridge Pile	
Pipe Pile.....	60
H pile.....	60
Monotube	70
Bridge Pile Cutting Shoes.....	5
Bridge Joint Seals.....	50
Bridge Deck Re-Surfacing Materials.....	30
Concrete Pipe.....	40
Guardrail (Rail and Hardware).....	25
Guardrail (Posts and Blocks)	30
Fencing (Posts and Wire)	30
Precast Concrete Bridge Members	
(after curing period is completed)	60
Cantilever and Bridge Sign Structures.....	50
Sign Panels.....	60
Electrical and Signal Items	50
Steel Sign Posts	35
Wood Sign Posts	35
Posts, Metal U	40
Precast Concrete Products.....	50
Cattle guards	50
Topsoil	30
Water and Sewer Pipe and Appurtenances.....	30
Construction Fabric.....	50
Striping - Preformed Plastic	65
Words and Symbols - Preformed Plastic	75
Thermoplastic Pavement Marking Material	40
Treated Timber	50

Obtain the Engineer's written approval of off-project site storage locations for bridge prestressed beams, bridge structural steel members, concrete box structures, and other large structural items.

No payment is made for bridge deck re-surfacing materials having a manufacturer's expiration date passing before its scheduled incorporation into the work.

Haul is the distance to the nearest mile (km) via the most direct route from the aggregate production plant to the stockpiles for mix production as determined by the Project Manager.

Payment is made for aggregates that are to be stockpiled for at least 60 days or at the Engineer's discretion.

109.08 FINAL ESTIMATE

When the final inspection of the contract is complete under Subsection 105.15.2, the contract documents will be finalized and a final estimate will be prepared. The estimate will include the amount and value of each class of work performed and any extra work and materials. Deductions for all previous payments and amounts to be deducted or withheld under the provisions of the contract will be made in the final estimate. Errors made in previous partial payments will be corrected in the final estimate.

When the final estimate is complete and all required documentation (e.g., material certifications, labor dispute resolutions, FHWA Form 47, etc.) has been received, the Construction Administration Services Bureau will send a copy of the final estimate to the Contractor for review. The Contractor has thirty days to dispute the final estimate or submit the request for acceptance under Subsection 105.15.3.

To dispute the final estimate, submit the items disputed and justification to the Construction Administration Services Bureau. Provide a copy to the Project Manager. The Construction Administration Services Bureau will provide a written decision on the disputed estimate within 30 calendar days of receipt of the disputed items.

The Department reserves the right to withhold all or part of the final payments earned under the contract until all taxes and assessments due and owing to the State of Montana for any reason have been paid in full unless a written release is received from the Department or the state agency having a claim against the Contractor.

The statutory time for filing claims against the contract bond is 90 calendar days from the date of the Commission acceptance of the project. See 18-2-201 to 18-2-208 MCA. The Engineer will immediately notify the Contractor and its surety of all claims filed against the contract or bond.

109.09 MOBILIZATION

109.09.1 General

Mobilization is the preparatory work and operations performed including, but not limited to, those necessary for:

1. The movement of personnel, equipment, supplies, and incidentals to the project site;
2. The establishment of all offices, buildings, and other facilities necessary for work on the project;
3. Premium on contract bonds;
4. Insurance for the contract;
5. Other work and operations that must be performed or costs incurred before beginning contract work; and
6. Mobilization costs for subcontracted work.

109.09.2 Payment

The original contract amount is the total price of the contract as bid and includes mobilization. Partial payments for mobilization will be made based on the lump sum contract unit price as follows:

1. One percent of the original contract amount, but not more than 100 percent of the amount bid for mobilization, will be paid on the first regular estimate period following the award of the contract.
2. When 5 percent of the original contract amount is paid under the contract, 25 percent of the amount bid for mobilization or 3 percent of the original contract amount, whichever is less, will be paid.
3. When 10 percent of the original contract amount is paid under the contract, 50 percent of the amount bid for mobilization or 6 percent of the original contract amount, whichever is less, will be paid.
4. When 25 percent of the original contract amount is paid under the contract, 60 percent of the amount bid for mobilization or 8 percent of the original contract amount, whichever is less, will be paid.
5. When 50 percent of the original contract amount is paid under the contract, 90 percent of the amount bid for mobilization or 10 percent of the original contract amount, whichever is less, will be paid.
6. When 70 percent of the original contract amount is paid under the contract, 100 percent of the amount bid for mobilization will be paid.

Nothing in the contract may be construed to limit or preclude partial payments provided in the contract. Payment will be full compensation for all work necessary to complete the item.

109.09.3 Payment (SMP Contracts)

An exception to Subsection 109.09.2 is:

- For state maintenance stockpile contracts (SMP contracts), mobilization will be paid for based on the percentage each stockpile site quantity bears in relation to the entire contract quantity, determined by the Department. The amount established as payment for mobilization for each site will be paid for in its entirety with the first estimate for each site.

109.10 OVERPAYMENTS

Overpayments on progress estimates will be deducted from subsequent progress estimate payments, or the Contractor may be notified of the overpayment. The Contractor has 30 days from the date of receipt of notification of overpayment to repay the money owed. If the money owed is not received by the Department before the 30-day period expires, interest will be charged on the overpayment beginning with the date of receipt of notification of overpayment. The interest rate charged will be the average Short Term Investment Pool (STIP) rate, determined by the Montana State Board of Investments, for the period in which the overpayment is not repaid.

109.11 FUEL PRICE ADJUSTMENT

Provide the Engineer a list of up to ten contract items that will be subject to fuel price adjustment at the Pre-construction Conference or by the Notice to Proceed Date, whichever comes first. Provide diesel fuel, propane fuel and gasoline fuel costs for the respective contract items. The accumulated diesel fuel, propane fuel and gasoline fuel costs may not exceed 20 percent of the contract unit price without justification acceptable to the Engineer. Items measured on a lump sum basis will not be eligible for fuel price adjustment.

Adjustments will be calculated using the increase or decrease between the base price and the monthly average price at the time the contract items are added to the progress estimate. The base price for the contract will be the average of the high and low price for the five days before the bid opening. The base price for propane fuel will be the base price for diesel fuel divided by the difference in BTU/hr for each fuel, or 1.5455 BTU/hr. The monthly average price will be the

average of the high and low prices on Wednesday of each week in the adjustment period taken from Platt's Oilgram Price Report for Billings, Montana for unleaded gasoline and low sulfur No. 2 diesel fuel. The average price for propane fuel will be the average monthly price for diesel fuel divided by 1.5455. The adjustment period for fuel price is from the Wednesday of the full week before the beginning of the estimate cycle to the Wednesday of the full week prior to the next estimate cycle. If the estimate cycle extends beyond the monthly estimate period, only the fuel prices from the month in which the item is added to the estimate will be used to generate the average price.

Adjustments will be made only when the monthly average price is 20 percent more or less than the base price. The adjustments will be for the amount exceeding 20 percent.

The price adjustment for each type of fuel will be the percent change from the base price (BP) to the monthly average price (AP) multiplied by the quantity (Q) of the item added to the progress estimate, multiplied by the fuel cost (FC).

Adjustments will be according to the following formulas:

$$\text{Increase} = \left(\frac{AP - BP}{BP} - 0.20 \right) * FC * Q$$

$$\text{Decrease} = - \left(\frac{BP - AP}{BP} - 0.20 \right) * FC * Q$$

Where:

AP = Monthly Average Price

BP = Base Price

FC = Fuel Cost

Q = Quantity

Adjustments will be calculated for each type as described without regard to the grade or amount of fuel actually used. The total of the fuel price adjustments will be added to, or subtracted from, the monthly progress estimate.

SECTION 201 CLEARING AND GRUBBING

201.01 DESCRIPTION

This work is the clearing, grubbing, removing, burning, burying, and disposing of vegetation and debris within the right-of-way limits and easement areas without damaging vegetation, adjacent property and other objects designated to remain in place.

Immediately stop work and notify the Engineer if evidence of aboriginal activity or occupation is encountered.

201.01.1 Clearing

Clearing is felling trees, disposing of stumps, brush, windfalls, logs, limbs, sticks, piles of sawdust, rubbish, debris, vegetation, and other matter within the clearing limits or other areas that interfere with the excavation and embankment limits.

201.01.2 Grubbing

Grubbing is removing and disposing of roots, stumps, stubs, duff, matted roots, and debris from the grubbing limits.

201.01.3 Clearing and Grubbing

Is performing both clearing and grubbing meeting Subsections 201.01.1 and 201.01.2.

201.01.4 Disposal

Disposal is removing, burning, and burying material generated from clearing, grubbing, or clearing and grubbing operations meeting all local, state and federal laws and regulations.

201.02 RESERVED

201.03 CONSTRUCTION REQUIREMENTS

201.03.1 General

Limit dragging, piling, disposing of debris, and other work to areas to be excavated or covered by embankment. Do not damage or destroy vegetation not designated to be removed.

Do not injure or damage vegetation adjacent to streams, ponds, or lakes unless designated for removal in the contract. Replace damaged or destroyed vegetation not to be disturbed at Contractor expense.

Coat cut or scarred surfaces of trees or shrubs to be preserved with an asphaltum base paint formulated for tree surgery.

Locate pioneer roads or work trails a minimum 20 feet (6.0 m) inside of the clearing limits. Protect live root systems adjacent to, but outside of, the clearing limits.

Close-cut and remove potential hazards, such as leaning trees (alive or dead), and snags within the right-of-way as directed by the Project Manager.

Coordinate clearing, grubbing, or clearing and grubbing with the grading work to meet the approved erosion control plan in Subsection 208.03.2. Backfill or grade depressions caused by grubbing to drain. Construct temporary settling basins where scour may occur.

The Project Manager will stake the construction limits for cuts, fills, channel changes, ditches, fence lines, utility relocation, roadside development areas, selective thinning for sight distance, grubbing, and similar areas to establish clearing and grubbing limits.

201.03.2 Clearing

Clear only within the staked construction limits.

Cut off trees, stumps, brush, shrubs, and other vegetation to within 6 inches (155 mm) of the ground. Fell trees without endangering traffic and injuring trees or objects not designated for removal.

Remove dead vegetation, logs, stumps, limbs, sticks, sawdust piles, rubbish, debris, and other undesirable matter from areas where live shrubbery, brush, or trees are to remain in place.

Merchantable timber is the property of the Contractor.

201.03.3 Grubbing

Grub only within the staked construction limits.

Remove all stumps, roots, logs, timber exceeding 3 inches (75 mm) in diameter, and all brush, matted roots, and other debris within the grubbing limits to at least 12 inches (305 mm) below the original ground surface.

Grubbing items that do not extend more than 6 inches (155 mm) above the ground line that are to be covered with at least 4 feet (1.2 m) of subgrade or slope embankment may remain.

201.03.4 Clearing and Grubbing

Clear and grub meeting Subsections 201.03.2 and 201.03.3 requirements.

201.03.5 Disposal

Dispose of all brush, stumps, windfalls, slash, timber having no commercial value, and all other debris from clearing, grubbing, clearing and grubbing, or other operations to meet all local, state and federal requirements at Contractor expense.

Furnish the Project Manager a written statement detailing where non-salvageable treated timber was disposed of.

A. Burning. Burn materials meeting the State of Montana Open Burning Regulations administered by the Air Quality Bureau of the Montana Department of Health and Environmental Sciences, and all other applicable local, state and federal rules and regulations. The general requirements of the Montana Open Burning Regulations regarding burning season and permits are described below.

- 1. Permits.** Obtain an open burning permit from the Air Quality Bureau during the open burning season when burning more than 100 acres (40.5 ha) of forest residue per year.

When burning near public lands during the fire season (May 1 through September 30, or as extended), obtain a burning permit from the local, state or federal fire protection agency having jurisdiction.

- 2. Open Burning Season.** The open burning season for forestry slash is from March 1 through November 30. Open burning is not allowed during December, January, or February. Burning from September 1 through November 30, on a day-to-day basis is subject to ventilation conditions available from the Air Quality Bureau, at 1-800-225-6779. Obtain the ventilation conditions daily before burning.
- 3. Burning Methods and Instructions.** Burning by the Air Curtain Destructor or Forced Air methods are encouraged.

Obtain the Project Manager's approval for burning pits located within the right-of-way limits. Dispose of all pits, ashes, and debris meeting Subsection 201.03.5(B). Locate burning pits at least 100 feet (30.5 m) from free-flowing water or areas where ditches are to be constructed. Locate pits and incinerators to prevent fire damage or hazard to surrounding vegetation or structures. Contact local fire protection agencies before the start of any burning.

Provide 24 hour monitoring of all burning.

B. Disposal of Other Material. Obtain the Project Manager's approval to incorporate non-hazardous solid material into the work for constructive use.

Dispose of material not incorporated into the work at Contractor expense.

201.04 METHOD OF MEASUREMENT

Measurement for clearing, grubbing, or clearing and grubbing is by either of the following methods.

201.04.1 Lump Sum Basis

Clearing, grubbing, and clearing and grubbing are measured by the lump sum. Disposal of the material is not measured for payment.

201.04.2 Area Basis

Measurement is by the acre (ha) for the area actually cleared, to the nearest 0.1 acre (0.1 ha) to the limits in the contract or as staked by the Project Manager. Disposal is not measured for payment.

201.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Clearing	Lump Sum or Acre (hectare)
Grubbing	Lump Sum or Acre (hectare)
Clearing and Grubbing	Lump Sum or Acre (hectare)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

201.05.1 Lump Sum Basis

Payments will be prorated for the percentage of completed work for each item listed as a lump sum item in the contract.

201.05.2 Area Basis

No payment is made or allowed for any areas not actually cleared (i.e. present traveled way, paved surfaces, etc.)

201.05.3 Reserved

201.05.4 Exclusion

When the contract does not contain a pay item for clearing, grubbing, or clearing and grubbing, the work is incidental to and included in payment for other items of work.

SECTION 202 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.01 DESCRIPTION

Remove and dispose of all structures and obstructions not designated to remain or to be removed and disposed of under other items of the contract.

202.02 RESERVED

202.03 CONSTRUCTION REQUIREMENTS

Raze, remove, and dispose of all buildings, foundations, structures, fences, debris, and other obstructions on the right-of-way, excluding utilities. Remove and transport specified salvage material designated to remain property of the Department, without damage, to the specified locations. Obtain the Project Manager's written permission to use any salvaged materials.

Dispose of unusable combustible material under Subsection 201.03.5(A). Dispose of unusable noncombustible material under Subsection 201.03.5(B). Backfill cavities caused by removing structures and obstructions level with the surrounding ground and compact the backfill under Subsection 203.03.3.

Install the necessary traffic control devices when removing and transporting structures to maintain traffic in the work area.

202.03.1 Removal of Bridges and Major Drainage Structures

- A. Removal of Superstructures.** Repair or replace all damaged or destroyed members, pins, nuts, and plates from steel or timber structures designated to be salvaged at Contractor expense.

Match-mark all members to be salvaged with paint before dismantling. Similarly mark all pins, nuts, and plates to indicate their location in the structure. Paint all pins, pin holes, and machined surfaces with a zinc-rich paint, and wire all loose parts to adjacent members or pack in clearly marked boxes showing the contents and index-numbered for identification.

- B. Removal of Substructures.** Remove substructures above the ground surface to 3 feet (915 mm) below the finished ground surface. Remove or cut off piles and substructures 1 foot (305 mm) below the streambed. Shape and contour removal areas to blend with the surrounding terrain.

Do not damage new work removing existing structures.

- C. Disposal of Materials Removed.**

1. **Structural Steel.** Store salvaged structure members and all steel beams above the ground on skids at the designated sites.
2. **Concrete and Masonry.** Use concrete and masonry removed from old structures in backfills or approach embankments under Section 203. Dispose of concrete or masonry not placed in backfills or embankments at Contractor expense. Remove all contract related concrete rubble from streams.
3. **Timber and Other Materials.** Store all salvageable timber or other salvaged materials above ground on skids at the designated sites.

- D. Disposal of Temporary Structures.** Remove and dispose of all temporary structures under 202.03.1(C).

202.03.2 Removal of Pipe Culverts and Minor Drainage Structures

Remove and salvage pipe culverts and minor drainage structures as specified in the contract. Replace lost or damaged salvaged material at Contractor expense.

202.03.3 Removal of Pavement, Sidewalks, Curbs, Etc.

Remove and dispose of all existing bituminous or portland cement concrete pavement, sidewalks, curbs, etc. to be removed unless otherwise specified. Process, handle and transport these materials to utilize them in embankments on the project, or crush, screen, mix and otherwise process for use as base or traffic gravel as approved or dispose of them as solid waste in conformance with applicable laws, rules, regulations and the Montana Solid Waste Management Act.

Existing pavement used for embankment or base gravel must meet the specifications for the particular item. Process the material to be used as embankment to a maximum 6-inch (150 mm) size in its largest dimension. Do not place the removed bituminous pavement in ephemeral drainage's nor within 100 feet (30 m) of standing water and groundwater wells.

Include all costs of this work in the unit price for the applicable contract item.

202.04 METHOD OF MEASUREMENT

202.04.1 Remove Structures and Obstructions

Remove structures and obstructions is measured by the lump sum or each and includes the removal and disposal of all structures and obstructions encountered within the right-of-way.

202.04.2 Pipe Culvert Removal or Remove and Relay

The pipe length is measured in feet (meter) to the nearest foot (305 mm), in place before removal.

202.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Remove Structures and Obstructions	Lump Sum or Each
Remove Pipe Culvert	Foot (meter)
Remove and Relay Pipe Culvert	Foot (meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

When the contract does not contain estimated quantities or lump sum items for removal and disposal of structures and obstructions, the work is incidental to and included in payment for other items of work.

**SECTION 203
EXCAVATION AND
EMBANKMENT**

203.01 DESCRIPTION

This work is the excavation, placing, compacting and disposal of material encountered within the construction limits necessary to construct the project.

203.01.1 Excavation

A. Unclassified Excavation. Unclassified excavation is excavating and disposing, when required, of material from the right-of-way or construction easement areas except borrow excavation and muck excavation as defined in Subsection 203.01.1.

B. Borrow Excavation.

1. Unclassified Borrow. Unclassified borrow for embankment construction is Contractor furnished excavation from outside the right-of-way or construction easement areas.

Use Department approved sources meeting current environmental and cultural resource preservation regulations.

Material from a Department-optional or Department-owned borrow source may be available at no cost. For Contractor-furnished sources, the haul distance is measured for payment under Subsection 206.04.

The applicable provisions of Subsections 102.06 and 106.02 apply to unclassified borrow.

2. Special Borrow. Special borrow is excavation from designated sources or from other approved sources.

Subsection 203.01.1(B)(1) and the applicable provisions of Subsection 106.02 apply to special borrow.

C. Unclassified Channel Excavation. Unclassified channel excavation is excavating and disposing of all materials from new watercourses or channels and the widening, deepening, or straightening of existing channels.

D. Street Excavation. Street excavation is excavating all material to the street template.

E. Muck Excavation. Muck excavation is removing and disposing of unstable material below subgrade elevation in cut sections or below the natural ground line in embankment sections.

Material is considered unstable if:

1. It contains saturated or unsaturated mixtures of soils and organic matter unsuitable for foundation material, regardless of moisture content; and
2. If it cannot be excavated using the same equipment and methods as for unclassified excavation.

If a grade line is adjusted, the difference between the staked or plan lines and adjusted grade lines is not muck excavation unless unstable material is encountered at or below the final grade line. Topsoil removed below the natural ground line in embankment sections is muck excavation if the material is determined unstable and cannot be excavated using the same equipment and methods for unclassified excavation.

Excavated unstable material areas will be cross-sectioned before they are backfilled.

Do not place fill over unstable foundation soils without the Project Manager's approval. Materials placed before approval may be ordered removed and replaced at Contractor expense.

- F. Sub-excavation.** Sub-excavation is removing unsuitable material from below the plan subgrade elevation as shown or directed.

203.01.2 Embankment

Place and compact excavation in roadway embankments, dikes, areas where unsuitable material is removed, holes, pits, and other roadway depressions. Prepare embankment foundations, obtain embankment material from the designated roadway, drainage, structure, culvert, or borrow excavation.

203.02 RESERVED

203.03 CONSTRUCTION REQUIREMENTS

203.03.1 Excavation

- A. General.** Do not begin excavation, grading, and embankment operations before the area is cleared of vegetation and obstructions under Sections 201 and 202 and erosion controls are placed as specified in the contract.

Excavate without disturbing material and vegetation outside of the slope limits.

Use all suitable material removed from the excavation in embankments, subgrade, shoulders, topsoiling, and other designated locations. Excavated material not used as specified or directed is not paid for.

Sequence excavation of backfill or road finishing material so it is placed into final position as soon as possible. Stockpile suitable material that is not immediately used.

Construct temporary fencing to restrict livestock and vehicular traffic from the work under Subsection 607.03.5.

Replace temporarily removed fence and repair damaged fence to a condition equal to the existing fence at Contractor expense. Confine livestock when fencing is disturbed.

If excavated material from the roadway prism is used outside the embankments, furnish and place at Contractor expense, an equal quantity of borrow to replace the material.

Compact the top 8 inches (205 mm) of the subgrade in cut sections under Subsection 203.03.3.

Place special borrow in layers immediately below the subgrade surface on embankments and through cuts as specified.

B. Rock Blasting.

- 1. General.** Use and store explosives under Subsection 107.09.

Use current technology in rock blasting to prevent slides, minimize overbreak, and provide smooth cut slope faces free of loose or fractured rock. Design the ignition sequence and blasting pattern with delays to produce maximum relief to the holes nearest the cut slope face.

Temporarily suspend blasting operations if the specified slopes are not produced, nearby residences, structures, utilities, or appurtenances are endangered, or the safety and convenience of the traveling public is jeopardized by fly rock, fragmentation, vibration, air blast, or overbreak.

- 2. Blasting Plan.** Submit the blasting plan before drilling and blasting operations begin and when there is a change in the proposed drilling and blasting methods. Submit the blasting plan on form CSN-55, available from the Project Manager, with the following information:

- a.** Station limits of proposed blast;

- b. Plan of proposed drill hole and delay pattern including free face, burden, and spacing; and
- c. Report of hole depth, diameter, burden, spacing, stemming, explosive types, powder factor, and delays.

The blasting plan is to reflect a blast design that provides for the proper drilling and blasting procedures to produce the specified results.

Revise the drilling and blasting methods as necessary to produce the specified results.

- 3. **Scaling.** Scale all loose or detached rock and soil masses that create a potentially dangerous situation to the work, workers, or the public. Remove the rock by barring, wedging, equipment, or using light explosive charges. Scale during or after each lift is completed. Scaling and disposing of the scaled materials is incidental to unclassified excavation.

- 4. **Pre-splitting Rock Slopes.**

- a. **General.** Pre-split rock cuts to a smooth plane using loaded, timed, and spaced drill holes.

Produce a continuous or semi-continuous fracture between drill holes and a stable rock cut by eliminating overbreak in the backslope during primary blasting. Detonate pre-split holes before detonating the production holes.

- b. **Drilling.** Use drills equipped with mechanical devices that accurately determine the angle the drill steel enters the rock. Do not drill if the devices are missing or inoperative.

Remove overburden soil and loose or decomposed rock along the top of the excavation to produce a smooth rock surface for drilling.

Use pre-split hole diameters that are between 2 1/2 inches (64 mm) and 3 inches (75 mm). Drill pre-split holes within 3 inches (75 mm) of the staked collar location. Holes drilled outside the 3-inch (75 mm) tolerance will be rejected and not measured for payment. Drill hole intervals may vary between 24 inches (610 mm) and 36 inches (915 mm). A 30-inch (765 mm) interval is used to estimate the measurement of pre-split contract quantities.

When the cut height exceeds 30 feet (10 m), an offset from the staked slope line, not to exceed 2 feet (610 mm) is allowed at the top of each lift after the top lift. The actual slope cannot deviate from the plan slope by more than 2 feet (610 mm).

Control the drilling operations to insure that no hole deviates from the slope plane by more than 9 inches (230 mm) parallel or normal to the slope. Pre-split holes exceeding these limits will not be paid for.

Drilling 2 feet (610 mm) below ditch bottom to aid removing the toe berm is permitted.

Extend pre-split holes a minimum of 30 feet (9.2 m) beyond the limits of the production holes or to the end of the cut.

Maintain the length of pre-split holes for any individual lift at no more than 30 feet (9.2 m). The Project Manager may approve a written request to increase the hole length to a maximum of 60 feet (18.3 m) if it is demonstrated that the above pre-split hole tolerances and a uniform slope can be obtained. If over five percent of the pre-split holes are misaligned in any one lift, reduce the lift heights until the 9-inch (230 mm) tolerance is met.

- c. Blasting.** Verify that the drill holes are free of obstructions for their entire depth before placing charges. Take precautions to prevent material from entering the drill holes while placing the charges.

Drill hole conditions may vary from dry to water filled. Use the type or types of explosives and blasting accessories for the conditions encountered following the manufacturer's recommendations.

Use explosives with a maximum diameter no more than one-half the diameter of the pre-split hole. Do not use bulk ammonium nitrate and fuel oil in the pre-split holes. Use only standard explosives manufactured specifically for pre-splitting.

If fractional portions of standard explosive cartridges are used, firmly affix them to the detonating cord to prevent the cartridges from slipping down the cord or bridging across the hole. Space fractional cartridges along the length of the detonating cord at maximum 30-inch (765 mm) centers and adjust spacing to produce the specified results.

Assemble and affix continuous column cartridge type explosives to the detonating cord following the explosive manufacturer's instructions. Furnish the Project Manager these instructions 24 hours before blasting begins.

The pre-split hole bottom charge may be larger than the line charges if it does not cause overbreak. Reduce the top charge of the pre-split hole and place it far enough below the collar to avoid overbreak and heaving.

Stem the upper 3 feet (915 mm) of all pre-split holes below the hole collar with sand or other dry, angular granular material passing a 3/8-inch (9.5 mm) sieve.

The Contractor may pre-split the slope face before production drilling or pre-split the slope face and production blast at the same time, if the pre-split drill holes are fired simultaneously at least 100 milliseconds before the production blast. Do not delay pre-split holes more than 25 milliseconds, hole to hole, to reduce noise and ground vibration.

Do not vary the pre-split slope face by more than 1 foot (305 mm), measured perpendicular to the slope, from a plane passing through adjacent drill holes unless otherwise directed.

- 5. Production Blasting.** Drill the row of production blast holes adjacent to the pre-split blast line on a plane parallel to and no closer than 6 feet (1.8 m) to the pre-split blast lines. Do not drill the production hole bottoms lower than the pre-split hole bottoms and with a diameter not greater than 6 inches (155 mm).

Detonate production holes on a delay sequence toward a free face.

Stem production holes a minimum of 3 feet (915 mm) or 0.7 times the burden distance, whichever is greater, with sand or other dry, angular granular material passing a 3/8-inch (9.5 mm) sieve.

Perform production blasting to minimize blast damage to the backslope.

Production blasting is incidental to and included in the measurement and payment for unclassified excavation.

- C. Rock Excavated Below Grade.** Excavate all un-yielding materials that require blasting or the use of rippers to at least 6-inches (155 mm) below subgrade within the roadbed limits. Backfill the excavation with specified or approved material. Remove or drain surface rock pockets that trap or pond water.

Rock, removed to a maximum depth of 6 inches (155 mm) below subgrade is measured and paid for as unclassified excavation. Rock removed or backfilling due to over excavating in excess of the 6 inches (155 mm) with approved backfill material is at Contractor expense.

- D. Removing Excess Moisture.** Rework materials from excavation or borrow areas exceeding two percent of optimum moisture to the specified optimum moisture before use in embankments or as backfill. Costs to remove excess moisture from the material is incidental to the embankment.

Remove excess moisture in the finished roadbed soil, introduced or caused by construction operations, for re-use in the work at Contractor expense. Excessively wet material, caused by the construction operations that cannot be properly compacted must be removed and replaced with suitable material at Contractor expense.

- E. Borrow Material.** Excluding special borrow, borrow material may be used only after the roadway excavation has been placed in the embankment. If excess borrow is placed creating a waste of excavation, the waste quantity will be deducted from the measured volume in the borrow area.

Provide the Project Manager five calendar days notice before excavating material from the borrow area so that cross sections may be taken. Do not excavate beyond the dimensions and elevations established for the borrow areas. Finish and shape all borrow areas to permit accurate measurements. Reclaim borrow areas meeting Subsection 106.02.5 requirements

- F. Step or Roughen Slopes.** Step or roughen slopes as directed. Horizontally step cutslopes, excluding rock slopes that cannot be excavated by ripping, approximately 1 foot to 2 feet (305 by 610 mm) wide by 1 foot to 2 feet (305 to 610 mm) in height. Extend the steps the continuous length of the slope, even if the slope decreases to less than 2:1.

Start the steps immediately below the backslope rounding. Cut each step opposite in direction of the preceding cut.

Leave loose material deposited on the steps during construction. Stepped slopes are not topsoiled. Seed the completed sections of the stepped slope daily.

203.03.2 Embankment

- A. General.** Do not place stumps, trees, logs, rubbish, vegetation, muck, frozen material, pockets of rock, or other deleterious materials in embankments.

Spread sod mixed with surface soil and soil containing excessive humus or other organic materials over the embankment slopes or incorporate it into the embankments outside of the shoulder lines.

Compact embankment, backfill, and embankment foundation areas under Subsection 203.03.3.

Leave the surface of completed embankments in a roughened condition.

- B. Embankment at Structures.** Do not place rocks, broken concrete, or other solid material in areas where piling is to be driven.

Do not place embankment against any backwall or abutment until the concrete has cured for 10 days or has reached 70 percent of the required strength. Furnish a certified laboratory test report showing the field-cured cylinders meet the required strengths.

The Project Manager may approve early embankment work at backwalls or abutments with beams or girders in place, or that are cantilevered from a fixed footing or cap if the strength requirement is met.

Do not place embankment against un-supported backwalls or U-shaped abutments rigidly connected to the deck until the deck is placed and cured meeting the applicable requirements of Section 552.

The Contractor may submit a method of supporting the structure to permit early placement of embankment against the structure. If approved, all costs of the alternate method are at Contractor expense.

Place embankment in 8-inch (205 mm) maximum layers loose thickness and compact adjacent to structures, around columns and similar structural supports, and on both sides of concrete walls, box type structures, and similar structures. Extend embankment material placed above the excavation limits or ground line a minimum 10 feet (3 m) from the structure or structural support.

Restore, repair, or replace structures or structural members moved or distorted by placing and compacting embankment at Contractor expense.

Compact embankment inaccessible to rollers by mechanical tampers to the density specified in Subsection 203.03.3.

Before placing and compacting backfill, compact at least the top 8 inches (205 mm) of the existing ground under Subsection 203.03.3.

C. Preparation of Embankment Foundations. Bench all embankments placed and compacted on hillsides, against existing embankments; built one-half width at a time, or on slopes 6:1 or steeper when measured at right angles to the roadway centerline. Construct benches in minimum 4-foot (1.2 m) width. Maintain the horizontal inclination within 5 percent of horizontal. Backfill and compact each bench in maximum 8-inch (205 mm) layers.

Excavate each bench as close to each other as the slope permits. Use approved material excavated from benches in the embankment.

In excavation to embankment transitions where the natural ground slope exceeds 6:1, construct the excavated benches so the natural ground surface is a minimum 12 inches (305 mm) from the top of the subgrade.

Remove frozen earth, snow and ice from the cut or embankment surface and place it outside the slope stakes at Contractor expense. Remove and dispose of this material at least 300 feet (91.5 m) ahead of the excavation and placing of the embankment.

Remove and waste frozen material, and provide the replacement borrow material at Contractor expense.

Clear the full width of the subgrade of sod and vegetative matter. Scarify the top 8 inches (205 mm) of the subgrade, water, and compact under Subsection 203.03.3 before constructing embankments 4 feet (1.2 m) high or less, or embankments placed on soils having less than 90 percent maximum density, determined by MT-210.

If lightly compacted soils are encountered that exceed 8 inches (205 mm) in depth, remove it to the depth directed. Compact the upper 8 inches (205 mm) of the ground under Subsection 203.03.3. Place the removed material in the embankment or use it for topsoil as directed. Material useable as topsoil may be placed alongside the roadway after compaction is completed.

Whenever a compacted road surface is within 3 feet (915 mm) of the subgrade, scarify the top 8 inches (205 mm) and re-compact under Subsection 203.03.3.

D. Earth Embankment. Place earth roadway embankment in uniform horizontal layers not exceeding 8 inches (205 mm) loose measurement and compact under Subsection 203.03.3. Continuously level, work, and maintain moisture to compact to the specified density. Uniformly work the entire surface of each layer.

Work each layer of earth embankment using a tandem type construction disk with a maximum disk spacing of 14 inches (355 mm) and a minimum worn disk diameter of 25 inches (635 mm). Larger disks may be used if the ratio of disk spacing to disk size is comparable to the above dimensions. Leave the embankment slopes in a roughened condition.

E. Rock Embankment. When the excavated material contains more than 25 percent rock by volume, 6 inches or larger (155 mm) in its greatest dimension, place the embankment

in layers 2 inches (50 mm) thicker than the maximum size rock in the material not to exceed 24 inches (610 mm) loose thickness.

Individual rocks and boulders larger than 24 inches (610 mm) in diameter may be placed in the embankment if the rocks do not exceed 48 inches (1.2 m) vertical height after placement, are evenly distributed, and are spaced to allow placing and compacting of the soil in horizontal layers.

Place and compact the upper 2 feet (610 mm) of the embankment in maximum 8-inch (205 mm) layers loose thickness as specified in Subsection 203.03.2(D).

Dump and work rock from excavations to the stream face when the embankments are adjacent to streams or channels. Prevent the rock from entering the stream. This work is incidental to unclassified excavation.

F. Embankment Over Swampy Areas. On low, swampy ground incapable of supporting haul equipment, construct the lower part of the embankment by dumping successive loads of uniformly distributed material in layers thick enough to support the equipment. Place subsequent layers under

G. Disposal of Unsuitable or Excess Material. Place excess or unsuitable excavated material, including rock and boulders, not useable in embankments in the side slopes of the nearest fill as directed. Dispose of excess or unsuitable material that cannot be incorporated into side slopes at Contractor expense. Slope and shape all disposal areas to blend into the surrounding terrain and meet the requirements of Subsections 106.02.5 and 107.11.

203.03.3 Moisture and Density Requirements

Compact each layer of material to the in-place density requirements of Table 203-1 for the method of moisture and density control used. The moisture and density control is the Proctor method or the Zero Air Voids method, determined by the Project Manager.

If proctors are used for density control, the Contractor may make a written request to the Engineer to compact the soils at a lower moisture content. Identify the soil class in the request.

The Engineer may approve the request provided a Department investigation ensures the lower moisture content is not detrimental to compaction of the soil class.

For A-1 material in embankments, MT 218 and MT 230 tests are used.

Compact safety slope embankments to a minimum 90 percent of maximum density with no optimum moisture requirement. The safety slope is the embankment placed from an existing shoulder to a catch point on the original ground not supporting any portion of the surfacing.

Compact rock embankments that cannot be tested by Montana Test Methods MT-212, MT-215, and MT-218 (Proctor Method) or MT-229 (Zero Air Voids Method) with compaction equipment and hauling and spreading equipment. Use grid rollers, pneumatic-tired rollers, vibrating rollers, vibrating compactors, or self-propelled tamping rollers. Do not use sheepfoot rollers unless approved. Use water as required.

**TABLE 203-1
COMPACTION REQUIREMENTS**

COMPACTION CONTROL METHOD		
Material Compacted	Proctor	Zero Air Voids
		Test Methods: MT-210 or AASHTO T99, MT-212, MT-215, MT-218
Earth Embankment Including All Backfills Top 8 Inches (205 mm) of Subgrade in Cut Sections Culvert Foundations	Minimum 95% of Maximum Density at Optimum Moisture \pm 2%	Less than 10% Air-filled Voids
Top 8 Inches (205 mm) of Embankment Foundations and Backfill Foundations	Minimum 90% of Maximum Density at Optimum Moisture \pm 2%	Less than 16% Air-filled Voids

203.03.4 Sloping and Finishing

A. Sloping. Finish and shape all cut slopes, ditches, embankments, and structure berms to a uniform, rough textured surface, except for stepped slopes. Scarify smooth slopes.

Conduct slope roughening in accordance with the plans and detailed drawings. Slope roughening is a part of slope construction and is not measured for payment.

Where roadway slopes are not completed to the planned or directed lines and the material from the backslope erodes, sloughs, or slides due to incomplete erosion control measures or the Contractor's operations, the removal of the material and restoration of the slope is at Contractor expense.

Where roadway slopes are completed to the plan or directed lines, all required erosion control devices are in place as specified, and the material from the completed slopes erodes, sloughs, or slides onto the roadway prism before final acceptance of the work, through no fault of the Contractor, the removing of the slide material, potential slide material, and the drainage excavation is paid for at an agreed unit price or on a force account basis under Subsection 109.04.

When directed, widen cuts and flatten slopes to obtain additional excavation for embankments or to increase slope stability. The Project Manager may steepen stable rock slopes. This work is measured and paid for as unclassified excavation unless it requires non-contract construction methods increasing costs that are considered extra work under Subsection 104.03.

B. Finishing. Finish the entire roadbed to the final elevations specified. Do not place organic, or other deleterious material in the top 4 inches (105 mm) of the roadbed surface. Remove and dispose of partly buried oversize material not passing a 4-inch (105 mm) square-mesh screen from the roadbed surface. Finish the grade so it does not deviate more than 0.1 foot (30 mm) at any point from the staked elevation, and so the sum of the deviations from the true grade of any two points not more than 30 feet (9.2 m) apart do not exceed 0.1 foot (30 mm).

203.03.5 Maintenance of Constructed Roadway

Maintain the roadway during construction so it is continuously well drained.

Prevent erosion damage to embankments and stream siltation under Section 208. Keep all drainage ditches and structures open and free from debris until final acceptance.

If grading work is suspended, blade smooth and grade the entire roadway area to prevent water from collecting or ponding on the roadway. Maintain the roadway during suspension periods to the specified grade and cross section at Contractor expense.

Maintain erosion and siltation control devices meeting the contract requirements at all times.

203.03.6 Topsoil - Salvaging and Placing

Remove sufficient amounts of topsoil from the excavation and embankment foundations to ensure replacement quantities are available to cover all disturbed areas with four inches (100 mm) of topsoil.

Place topsoil on the completed graded roadway to the lines, grades, and elevations specified.

Unless directed by the Project Manager, place topsoil on all slopes, excluding slopes 2:1 or steeper. Place topsoil to an average 4-inch (100 mm) loose depth on the base course surfacing inslope. Uniformly spread what is available over the remainder of the disturbed areas.

Stockpile topsoil at acceptable selected locations within the right-of-way. When construction operations do not permit stockpiling within the right-of-way, make arrangements for stockpile sites outside the right-of-way at no additional cost to the Department.

Construct stockpiles so drainage is maintained and topsoil is easily reclaimed. Provide erosion controls following best management practice.

In the event that construction sequencing prevents replacement of topsoil over all disturbed areas prior to final paving, reserve adequate quantities to cover the exposed base course surfacing inslope as shown in the Detailed Drawings.

203.04 METHOD OF MEASUREMENT

203.04.1 Excavation

The quantities of unclassified excavation, unclassified borrow excavation, special borrow, unclassified channel excavation, street excavation, subexcavation, and muck excavation for payment is the staked quantities calculated in cubic yards (cubic meters) under Subsection 109.01.

The Department will provide the initial measurement at no charge for the following specific work areas:

1. In slide areas determined by the Department not to be the fault of the Contractor;
2. In excavated areas authorized by the Project Manager, outside the staked lines and grades; and
3. In un-staked areas such as borrow areas, muck excavations, sub-excavations, and un-staked excavations authorized by the Project Manager.

These areas of excavation and borrow are measured in their original position under Subsection 109.01.

Either the Department or the Prime Contractor may request re-measurement of specific work areas, or the entire project, if there is disagreement over the accuracy of quantities computed from the staked lines and grades. The party requesting the re-measurement is responsible for all costs associated with the re-measurement. Department staff may perform the re-measurement, in which case, the rate for determining the costs for performing the work are based upon the original contract amount, and the daily charge established in Subsection 108.08, Table 108-1. An independent third party acceptable to the District Construction Engineer, and under the direction of a professional land surveyor registered in Montana, may also be used to perform the re-measurement.

Excavation requiring more than one handling before placement may be eligible for additional payment if approved by the Project Manager in advance of the second handling. The second handling of the material will be measured and paid for under the appropriate item of work.

Authorized excavation of rock, shale, muck, or unsuitable material below grade necessary to provide the designed thickness of backfill is measured for payment. If the designated bottom plane of the excavation falls within a layer of rock, the below-grade excavation to the bottom of the layer, not exceeding 6 inches (150 mm) below grade, is considered authorized and is measured for payment.

Rock excavation exceeding 6 inches (150 mm) below grade is not measured for payment. If the nature of the material, the thickness of the layers or strata, and method of operations make it practical to excavate only to the plan depth, any material removed below plan depth is not measured.

Measurements are made for unusable materials excavated and removed.

Useable material temporarily removed and replaced for Contractor convenience is not measured for payment.

Removal and disposal of unusable materials from borrow areas is not measured for payment. Special borrow removed from areas before staking is not measured for payment.

The actual quantities of plan and approved sub-excavation are measured and added to the quantities of unclassified excavation for payment.

Material authorized for removal that cannot be excavated by the methods used for the unclassified excavation is measured and paid for as muck excavation.

Muck excavation reworked under Subsection 203.03.1(D) is measured and paid for as unclassified excavation for the second handling.

Hauling muck excavation to the disposal areas is measured and paid for as haul under Section 206.

When the contract does not contain a bid item for muck excavation and an area is determined unstable under Subsection 203.01.1(E), the muck excavation quantity is measured and paid for at an agreed price or force account basis under Subsection 109.04. Measurement and payment for muck excavation at the agreed price includes all excavating and hauling, disposing of all stumps, logs, and other debris encountered in the excavation, all pumping and de-watering required, and finishing of the planned disposal areas.

Unclassified excavation allowed for pre-split drill equipment clearance is calculated from the area bounded by the plan slope and lines parallel to plan slope, offset 2 feet (610 mm) for each 50-foot (15.2 m) increment in vertical cut height. The quantity for drill equipment clearance where the cut slope height is less than 50 feet (15.2 m) is not measured for payment.

Excavation used as select or stockpiled select material is measured by the cubic meter in its original position.

Removed and placed stockpile material is measured using the volume in its original excavated position.

Where it is impractical to measure material by the cross-section method, alternate methods involving three-dimensional measurements may be used.

Channel excavation is measured and paid for as unclassified excavation.

Street excavation is measured and paid for as unclassified excavation unless the contract has street excavation as a bid item.

203.04.2 Drill Pre-splitting Holes

Drill pre-splitting holes are measured by the foot (meter). The measurement is made from the rock surface to the roadway grade or to a predetermined bench elevation. The quantity of drill pre-splitting holes shown in the contract is not guaranteed, and the Department reserves the right to increase or decrease this item with no adjustment in the contract unit price.

203.04.3 Embankment in Place

When the contract contains a bid item for Embankment in Place, all roadway excavation and construction of embankments is measured and paid for as embankment in place. The quantities measured in cubic yards (cubic meters) for payment as embankment in place include the following:

1. The actual quantities of roadway embankment measured, above the original ground line under Subsection 109.01, with no volume adjustments made for shrinkage, compaction, or subsidence.
2. The quantities of unsuitable or excess material used to flatten slopes, or otherwise disposed of, measured in its final position.
3. The topsoil replacement quantity, measured in the topsoil stockpiles.
4. Minor excavation and sub-excavation directed by the Project Manager in its original position.

203.04.4 Compaction

A. Volume Measurement Method. When roadbed compaction is specified in the contract, the quantity measured for payment is the quantity of excavation incorporated in the roadway, measured under Subsection 203.04.1, excluding wasted material.

Road approaches, turnouts, wyes, and other similar facilities are included as part of the roadway. Measurement includes compaction of the natural ground cut sections under Subsection 203.03.3.

Water to reach the specified moisture content and compactive effort is not measured for payment and is incidental to roadbed compaction.

Compactive effort to obtain the specified densities includes scarifying, watering, aeration, and any other work to produce the finished roadbed and embankments.

B. No Bid Item for Compaction. When the contract does not contain an item covering compaction, all work and materials to compact embankment material to the specified density is not measured for payment.

C. Structure Backfill. When there is no item for mechanical tamping, the compaction is not measured and paid for but is incidental to other items in this Section. Compaction of structure backfill and at the ends of major structures is measured for payment if mechanical tamping is specified. Mechanical tamping is measured by the cubic yard (cubic meter) of backfill material and includes compaction of the ground below the backfill to a depth of 8 inches (205 mm).

203.04.5 Topsoil

Excavation of topsoil material from its original position, loading, hauling, stockpiling, and removal from the stockpile and spreading on the designated areas is measured for payment by the cubic yard (cubic meter) in the stockpile before final placement.

Before measurement, shape and smooth each stockpile into the smallest practical area. Haul is not measured for payment.

Topsoil removed from cut areas is not deducted from the unclassified excavation, roadbed compaction, or haul quantities.

Measurement is made as if the topsoil had not been removed.

Topsoil removed from embankment areas and from borrow areas, excluding Contractor-optional under Section 106, is measured under the bid item Topsoil - Salvaging and Placing.

203.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Unclassified Excavation	Cubic Yard (cubic meter)
Unclassified Borrow Excavation	Cubic Yard (cubic meter)
Special Borrow	Cubic Yard (cubic meter)
Unclassified Channel Excavation	Cubic Yard (cubic meter)
Sub-excavation	Cubic Yard (cubic meter)
Muck Excavation	Cubic Yard (cubic meter)
Drill Pre-splitting Holes	Foot (meter)
Embankment in Place	Cubic Yard (cubic Meter)
Roadbed Compaction	Cubic Yard (cubic meter)
Mechanical Backfill Compaction	Cubic Yard (cubic meter)
Topsoil - Salvaging and Placement	Cubic Yard (cubic meter)
Street Excavation	Cubic Yard (cubic meter)

Payment at the contract unit prices is full compensation for all resources necessary to complete these items of work under the contract.

SECTION 204 EXISTING SURFACE PREPARATION

204.01 DESCRIPTION

Existing surface preparation is reshaping the typical section and truing the grade line of a previously completed earth subgrade or gravel or bituminous-surfaced roadbed for new surfacing construction.

204.02 RESERVED

204.03 CONSTRUCTION REQUIREMENTS

204.03.1 Subgrade

Excavate and remove all areas in the roadway subgrade not meeting moisture and density requirements. Backfill the excavations with approved material.

Grade the entire subgrade surface to the specified lines and grades and compact under Subsection 203.03.3.

Grade the roadway ditches to drain. True shoulder lines and shape and slope roadway inslopes uniformly.

Maintain the subgrade surface until the surfacing is placed.

204.03.2 Aggregate Surfaces

Excavate, backfill, and re-compact all existing aggregate surfaces not meeting moisture and density requirements to the typical cross section and profile grade.

Complete compaction and surface smoothness using equipment meeting Section 210 requirements and meeting compaction and smoothness requirements in Subsection 301.03.5.

204.03.3 Bituminous Surfaces

Dispose of existing bituminous surface, designated to be removed, under Subsection 202.03.3.

Re-work all existing bituminous surfaces designated to remain in place as specified.

Before placing the leveling course, clean the existing surface of dirt and loose, extraneous material. Apply a prime or tack coat of bituminous material to the cleaned surface as specified.

Correct dips, depressions, sags, excessive or nonexistent crown, and other surface irregularities using a premixed bituminous mixture. Spread the mixture in 2 inch (50 mm) compacted layers.

Correct surface irregularities exceeding 6 inches (155 mm) deep using untreated aggregate material before leveling with a bituminous mixture.

204.04 METHOD OF MEASUREMENT

Existing surface preparation is measured under the respective contract items used in the work.

The materials and equipment required for existing surface preparation include, but are not limited to, aggregates for the subgrade and aggregate surfacing courses, bituminous material for prime and tack coats, bituminous-mixed surfacing for the leveling material, and watering and rolling.

Materials and equipment used to complete existing surface preparation, not incidental to, or included with other bid items in the contract, are measured and paid for on a force account basis under Subsection 109.04.

204.05 BASIS OF PAYMENT

Existing surface preparation is paid for at the contract unit prices for the material and equipment required to complete the work and on a force account basis for those items required but not having bid items.

The contract unit price paid for plant mix bituminous material spread for leveling includes the spreading, leveling, and compaction of the material.

SECTION 206 HAUL

206.01 DESCRIPTION

Haul is transporting excavation or aggregate surfacing material from its original location to its final location in the work.

206.02 RESERVED

206.03 RESERVED

206.04 METHOD OF MEASUREMENT

206.04.1 Excavation Haul

The haul distance for excavation material moved from:

- A. Outside the roadway is measured along the shortest route determined by the Project Manager.
- B. Within the roadway and placed inside the roadway is measured along the centerline of the roadway.

Haul is computed by multiplying the number of cubic yards (cubic meters) of excavation removed from its original position by the mean distance it is hauled. The distance between the center of volume of the excavation and the center of volume of the embankment is the haul distance.

Excavation and embankment volumes for ramps, frontage roads, road approaches, driveways, and connections on either side of the roadway is considered concentrated at the centerline or at a line parallel with the main roadway under construction for computing haul quantities for payment.

The number of cubic yards (cubic meters) hauled is determined by measuring the materials in their original position with no allowances for swell occurring when the materials are excavated and loaded into the haul units.

206.04.2 Aggregate Haul

Aggregate haul is measured by the ton-mile (metric ton-kilometer) or mile-cubic yard (kilometer-cubic meter) for haul of aggregate over an approved route. The number of ton-miles (metric ton-kilometer) or mile-cubic yards (kilometer-cubic meter) is the product of miles (kilometer) times tons (metric ton) or cubic yards (cubic meters) of material hauled. The haul distance is measured to the nearest 0.1 mile (10 m) along the shortest practical route from the loading point to the point where placed.

206.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Excavation Haul	Mile-Cubic Yard (kilometer-cubic meter)
Aggregate Haul	Ton-Mile (metric ton-kilometer) or Mile-Cubic Yard (kilometer-cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

When not specified as contract pay item, haul is not measured or paid for but is incidental to and included in the payment for other items of work.

SECTION 207

CULVERT EXCAVATION AND TRENCH EXCAVATION

207.01 DESCRIPTION

This work is the excavation for placing or removing drainage and other appurtenant structures. It includes foundation preparation, backfilling, disposal of excavation material, bailing, drainage, sheeting, shoring and cribbing. Excavation classes are described below.

207.01.1. Culvert Excavation

Culvert excavation is all work under Subsection 207.01, where vertical walls are not required and the excavation width is not specified.

207.01.2. Trench Excavation

Trench excavation is the excavation for placing or removing storm drains, sanitary sewers, water lines, and other installations in the contract. Vertical trench walls, when required, must be shored or supported to meet the U.S. Department of Labor, OSHA, Safety and Health Regulations for Construction. Trench widths are specified in Subsection 207.03.3.

207.02 RESERVED

207.03 CONSTRUCTION REQUIREMENTS

207.03.1 General

Excavate to permit removal, jointing, and backfilling of pipe.

Construct and maintain the excavations to prevent personal injuries, damage to foundations, structures, pole lines, or other facilities.

Pile and maintain all excavated material to meet OSHA requirements and with a minimum of inconvenience to the public. Do not obstruct fire hydrants, water valves, meters, and the free flow of storm water in gutters, other conduits, and natural water courses.

Do not excavate below the specified depth, except as permitted in Subsection 207.03.6.

Remove all obstructions in the excavation at Contractor expense.

Backfill excavated areas to meet Subsection 603.03.4. Do not place backfill against newly constructed masonry or concrete structures for at least 14 days. Remove all sheeting and bracing before backfilling.

207.03.2 Culvert Excavation

When special foundation stabilization is specified, excavate the bedding trench walls vertically and the trench width to provide room for the bedding material.

207.03.3 Trench Excavation

Keep trench lengths to a minimum in paved roadways, sidewalks, or other improved areas, in advance of the pipe laying and not to exceed 200 feet (61 m). Keep trench backfilling and compaction to within 300 feet (91.5 m) of the installed pipe.

Cut the pavement full depth vertically along regular neat lines in paved roadways that require patching. Excavate the minimum trench width possible.

When vertical trench walls are specified, the maximum trench width is the external width of the pipe barrel plus 3 feet (915 mm). When a special foundation is specified, excavate the bedding trench walls vertically and the trench width as specified.

Do not exceed the specified trench width without the Project Manager's approval when vertical trench walls are specified.

Furnish any additional select backfill material and additional surface and subsurface improvements if the maximum trench width is exceeded at Contractor expense.

207.03.4 Excavation for Appurtenant Structures

Excavate for riprap, rubble masonry, retaining walls, cutoff walls, headwalls, manholes, drop inlets, catch basins, headgates, division boxes, and other structures appurtenant to culverts, sewers, drains, pipes, or tubing to meet the applicable requirements of Subsection 207.03.1.

207.03.5 Shoring

Provide and remove shoring or supports for the excavation walls that protect the work, existing property, utilities, pavement, and other existing facilities. Provide safe working conditions meeting OSHA, local and state safety codes.

Repair damage caused from excavation support failure or from failure to provide support at Contractor expense.

207.03.6 Foundation Preparation

Compact foundations for culverts, sewers, drains, pipes, tubing, and appurtenant structures to the moisture and density requirements of Subsection 203.03.3.

Remove unstable or unsuitable material encountered below the excavation floor elevation and replace with material meeting Subsection 701.04.2. Cover with bedding material meeting Subsection 701.04.1 as directed. The Project Manager will investigate unstable pipe installations requiring 4 feet (1.2 m) or more of foundation material.

Remove unyielding material below the staked elevation to at least 12 inches (305 mm) and replace with bedding material meeting Subsection 701.04.

Bed culverts larger than 12 inches (305 mm) as shown in the Detailed Drawings. Place bedding for 12-inch (305 mm) diameter and smaller culverts to uniformly support the culvert throughout its length. The bedding does not need to conform to the outside of the culvert.

Do not lay pipe until the foundations are approved by the Project Manager. Remove and relay pipe laid on unapproved foundations at Contractor expense.

207.04 METHOD OF MEASUREMENT

Culvert excavation, trench excavation and excavation for bedding and foundation material are not measured for payment.

207.05 BASIS OF PAYMENT

Payment for all costs associated with culvert and trench excavation, furnishing and installing culverts is included in the contract unit price per foot (meter) of pipe (type and size).

When bedding or foundation material is specified in the plans, payment for all costs associated with excavation required to place bedding and foundation material is included in the contract unit price per cubic yard (cubic meter) of bedding or foundation material.

SECTION 208

WATER POLLUTION CONTROL AND STREAM PRESERVATION

208.01 DESCRIPTION

Water pollution control is the planning, scheduling, installation, maintaining and removal of measures and devices to prevent pollution, and control sediment transport and soil erosion.

208.02 MATERIALS

Use materials meeting commercial grade standards approved by the Project Manager if permanent and temporary materials are not specified.

208.03 CONSTRUCTION REQUIREMENTS

208.03.1 General

Comply with the Department of Fish, Wildlife and Parks, Department of Environmental Quality, and all other state or federal laws or regulations for preventing or abatement of erosion, water pollution, and siltation.

Prevent pollution and sedimentation of adjacent property, lakes, streams, rivers, ponds, wetlands, or other surface water according to Montana Department of Environmental Quality's authorization to discharge under the Montana Pollutant Discharge Elimination System (MPDES) or the Environmental Protection Agency's authorization to discharge under the National Pollutant Discharge Elimination System (NPDES) and associated Water Quality Discharge Permits.

Utilize Best Management Practices (BMP's). The Department's "Erosion and Sediment Control Best Management Practices Field Manual" and "Erosion and Sediment Control Best Management Practices Reference Manual" are guides for devices and measures for erosion and sediment control and pollution prevention.

Use temporary and permanent water pollution controls to provide economical, effective, continuous erosion and sediment control, and prevent pollution during and after completion of construction activities.

Plan and install BMP's to preserve existing streambeds and stream banks.

Install temporary erosion and sediment control BMP's prior to disturbing soil associated with fill placement. Install temporary erosion and sediment control BMP's prior to, or concurrently with, other soil disturbance activities. When BMP installation is concurrent with the soil disturbance activity, limit the work to an area that can be protected by BMP's no later than the same day the work is performed. Failure to install BMP's within the same day will result in suspension of all work relating to those BMP's.

208.03.2 Water Pollution Control

Submit to the Department of Environmental Quality an erosion control plan covering all construction areas to be disturbed outside the highway right of way 30 working days before starting work. During construction, follow the plan to prevent polluting and silting of state waters. Prevent chemicals, fuels, lubricants, bitumens, raw sewage, and other wastes from entering state waters. Dispose of all wastes, refuse, and discarded materials meeting Subsection 107.11.

Control erosion, siltation, and water pollution during all work suspensions.

Contractor failure to provide erosion and water pollution controls is cause for the Project Manager to provide the work and deduct those costs from monies due or that may become due the Contractor.

A. Water Pollution Control Plan. Submit a water pollution control plan at the pre-construction conference or 30 working days before work starts. The Department has 30

days to review the plan. Incomplete or illegible plans will be returned for correction and the 30-day review time begins upon receipt of the corrected plan.

Include the schedule for incorporating the permanent erosion control work and all temporary controls proposed for use during the work in the plan. Do not begin work that disturbs the natural ground until the plan is approved. Revise and update the water pollution control plan whenever the required controls differ from the approved plan. Submit all changes for review and approval.

Meet the contract requirements and follow the approved pollution control plan.

B. Temporary Pollution Control Measures. Install temporary erosion control before each construction stage.

Maintain all temporary erosion control until it is no longer needed or conflicts with the work. If devices that conflict with the work are removed, replace these devices at the end of each shift.

Re-grade temporary sites to match the surrounding terrain after the devices are removed.

Repair or replace damaged, inadequate, or non-functioning devices.

Temporary pollution control measures required due to the Contractor's negligence, carelessness, or failure to install permanent controls are at Contractor expense.

C. Permanent Pollution Control Measures. Install permanent pollution controls concurrently or immediately following work that disturbs natural ground.

208.03.3 Limitations on Grading Operations

The maximum area allowed to be disturbed at one time within the highway right-of-way is 750,000 square feet (69,750 square meters) of clearing and grubbing and 750,000 square feet (69,750 square meter) of borrow, excavation and embankment.

The Engineer may modify the 750,000 square feet (69,750 square meter) restriction when soil characteristics, Contractor operations or both, indicate that a smaller or larger area is acceptable. For long or complex projects, the Contractor may have several separate grading operations working, where the Engineer may apply the limit to each individual operation, provided finishing, mulching, and seeding closely follow the rough grading operations at each location. Use the specified pollution controls at each individual location.

208.03.4 Stream Protection

A. General. Meet the following general provisions unless the plan approved by the Department of Fish, Wildlife, and Parks under Subsection 208.03.4(B) is more restrictive:

1. Clear and grub adjacent to streams or associated wetlands meeting Subsections 201.03.2 and 201.03.3.
2. Do not operate mechanized equipment in any stream.
3. Do not spill or dump material from equipment into streams or associated wetlands.
4. Do not permit wash water from cleaning concrete related equipment or wet concrete to enter streams, riparian areas, or wetlands.
5. Do not place fill or embankment material in streams, streambeds, wetlands, or riparian areas.
6. Locate staging or storage areas at least 50 feet (15.2 m) horizontally from the highest anticipated water level during the construction period.
7. Store and handle petroleum products, chemicals, cement and other deleterious materials to prevent their entering streams and associated wetlands.
8. Provide sediment controls for drainage from topsoil stockpiles, staging areas, access roads, channels changes, and instream excavations.

9. Reclaim streambeds and streambanks as close as possible to their pre-disturbed condition.

B. Temporary Construction Facilities. Plan temporary construction facilities to:

1. Minimize disturbance to streambank, streambank vegetation, streambed, and state waters;
2. Not restrict or impede fish passage in streams; and
3. Not restrict any water flow anticipated during use.

Install, maintain, operate, and remove temporary construction facilities meeting the approved work plans within or adjacent to streambeds and for crossing streams, streambeds or state waters.

Maintain constant progress once installation or removal work begins. Shape and contour areas disturbed by installation and removal to match adjacent undisturbed ground.

Furnish plans meeting the Department of Fish, Wildlife, and Parks requirements for approval for work bridges, haul bridges, bridge removal, detours, and other temporary construction facilities. Include the following in the plans:

- a. Details of stream and streambank features before installing temporary construction features and after they are removed;
- b. Location of facilities relative to permanent work and streambanks;
- c. Plan and elevation views of facilities showing stream section;
- d. Anticipated high water elevation during use of the facilities;
- e. Waterway openings and clearances;
- f. Type of bridge bent, pier, and superstructure construction (wood, steel, concrete, etc.);
- g. Written description for installing, operating, and removing facilities; and
- h. Estimated time facilities are to be in place.

Submit the plan to the Project Manager, who will forward two copies to the Department of Fish, Wildlife, and Parks for approval. Submit revised plans or modifications to approved plans. The Departments have 30 working days to review both the original and all plan modifications. Do not begin work on temporary construction facilities or modifications to approved plans until receiving written approval from the Department of Fish, Wildlife, and Parks.

Defend, indemnify, and hold harmless the Department from legal actions or fines resulting from violations of the Stream Protection Act, Section 87-5-501 to Section 87-5-509 MCA, because of any act, omission, neglect, or Contractor misconduct.

C. Existing Bridge Removal. Furnish a plan and written description detailing how the existing bridge(s) are to be removed. Include in the description what methods and equipment are to be used to remove the bridge deck, superstructure, piers, footings, and end bents.

Provide the anticipated start date of removal work and estimated time to complete the work.

Include details of erosion control measures used during end bent removal.

Remove all work debris from the waterway within 48 hours of completing the removal work.

Maintain constant progress on all in-stream work until completed.

208.03.5 Temporary Seeding

Temporarily seed all disturbed soil areas not to be re-disturbed for 21 days or more by the 14th day after the last disturbance. Areas not requiring further disturbance may be permanently

seeded. Re-seed permanently seeded areas that fail to establish a sustainable growth at Contractor expense.

208.03.6 Inspections

Conduct inspections of BMP's according to the MPDES/NPDES and the associated General Permit for Storm Water Discharges Associated with Construction Activity. Provide one copy of the signed inspection report to the Project Manager within three calendar days of the inspection. Failure to conduct BMP inspections and submit timely inspection reports renders the BMP's unacceptable and no payment will be made on the monthly progress estimate for BMP's installed until the inspection reports are completed and approved by the Project Manager.

208.04 METHOD OF MEASUREMENT

Erosion and sediment control devices are measured per each for the type installed. The contract quantities for erosion and sediment control devices are estimated and may vary from the actual quantities used or required for a specific project. Only those quantities approved for placement will be paid for.

The following items are not measured for payment:

1. Maintenance of BMP's; including BMP maintenance until the completion of the final work inspection;
2. Removal of BMP's no longer required;
3. Mobilization for maintenance and inspections required by the MPDES/NPDES and the contract;
4. Inspections, documentation and submittal costs required to comply with the MPDES/NPDES and the contract; and
5. Disturbance areas outside the State R/W associated with Contractor activities that are not included in the project specific NOI and SWPPP.

MPDES/NPDES authorization, fees, and BMP's outside the State R/W are the Contractor's responsibility and will not be paid for.

208.04.1 Temporary Erosion and Sediment Controls

Temporary Erosion and Sediment Control (TESC) devices are measured by the unit. A unit is the base value used for establishing the relative value of each type of TESC device. The relative value of each TESC device in units is shown in the "Erosion and Sediment Control Rate Schedule" included in the contract.

208.04.2 Temporary and Erosion Seeding

Temporary and erosion seeding is measured parallel to the ground line, and includes seedbed preparation, fertilizing and seeding.

208.04.3 Permanent Water Pollution, and Erosion and Sediment Control

Permanent water pollution, and erosion and sediment control items are measured and paid for under the respective bid items.

208.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities are made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Temporary Erosion Control	Unit

Temporary erosion and sediment controls are paid for at the contract unit price per temporary erosion control. The units of each type of temporary erosion control paid for will be

calculated by multiplying the measured quantity of each device by the assigned value per units shown in the "Erosion & Sediment Control Rate Schedule" included in the contract.

Normal maintenance of BMP's in accordance with the MPDES/NPDES and the contract is not paid for separately and is to be included in the contract unit price for temporary erosion control devices.

Maintenance includes:

- Removal of siltation and debris in front of and around BMP's;
- Repair and replacement of incorrectly installed devices;
- Mobilization and travel for inspections; and
- Maintenance until the completion of the final work inspection.

The replacement or addition of BMP's ordered by the Project Manager due to a precipitation occurrence that causes damage is paid for under the temporary erosion control item in the contract.

No additional compensation is made for the removal of BMP's no longer required.

Payment at the contract unit price is full compensation for all necessary resources to complete this item of work under the contract.

SECTION 209 STRUCTURE EXCAVATION

209.01 DESCRIPTION

Structure excavation is excavating bridge foundations and all other structure foundations. The item includes disposing of excess or unsuitable material from the excavations, backfilling to the original ground level, bailing, pumping, draining, sheeting, shoring and cribs.

209.01.1. Structure Excavation Type I

Structure excavation Type I is excavating, de-watering, shoring and cribbing, backfill and compaction for the excavation.

209.01.2 Structure Excavation Type II

Structure excavation Type II is excavating, de-watering, backfill, and compaction for the excavation, excluding shoring and cribbing.

209.01.3 Shoring and Cribs

This is constructing and removing all shoring and cribs, cofferdams or caissons, and for all material, labor, equipment, tools, and incidentals to complete the work.

209.02 RESERVED

209.03 CONSTRUCTION REQUIREMENTS

209.03.1 General

The plan excavation lines in the contract are estimated. Excavate all foundations to the plan elevations and dimensions.

Removing boulders, logs, and other obstructions found in the excavation is incidental to this work.

Remove timber, sheeting, and other material used in the excavation before backfilling.

Remove and stockpile all excavated material that is suitable for backfill.

209.03.2 Treatment of Foundation Materials

When the excavation reaches the designated depth, de-water, clean, and maintain the excavation until the foundation bed is inspected.

Clean and fill rock seams and crevices with concrete mortar.

Obtain the Project Manager's approval of the foundation before placing concrete on the foundation.

Place concrete without disturbing the bottom of the excavation.

Minimize disturbance of the natural ground outside the excavation pay limits except as required for constructing cofferdams.

209.03.3 Cofferdams

Submit drawings and calculations prepared by a registered engineer showing the proposed method of cofferdam construction and de-watering procedures before starting the work. The cofferdam must meet OSHA requirements.

Assure cofferdams or cribs for foundation construction are watertight to permit de-watering.

Provide clearance within the cofferdam for constructing forms, inspection of the form exteriors, and for pumping.

Re-align or enlarge the cofferdams or cribs that are tilted or moved laterally during the work to provide work clearance at Contractor expense.

Timber bracing may be left in cofferdams or cribs extending into the substructure masonry with the Engineer's written approval.

When weighted cribs are used to resist the hydrostatic pressure acting against the bottom of the foundation seal, use an anchorage to transfer the entire weight of the crib to the foundation seal.

When the foundation seal is placed, vent or port the cofferdam at the cofferdam design low-water level.

The foundation seal depths in the contract are based on the estimated, normal water-surface elevations or are consistent with those satisfactorily used on past projects.

The specified seal thickness is a minimum. The Contractor may request an increased seal depth. Submit the request in writing to the Engineer for approval. Any approved increase in seal depth and associated costs are at Contractor expense.

Repair or replace failed cofferdams, foundation seals or both at Contractor expense.

Pump out the cofferdam and place the remaining masonry or concrete in the dry after meeting the time limit in Subsection 209.03.4.

Remove all cofferdam or crib material after the substructure is complete without disturbing or marring the finished work.

209.03.4 Pumping Water from Cofferdams

Pump interior foundation enclosures without disturbing the in-place concrete. Do not pump for at least 24 hours after placing concrete unless pumping from a sump separated from the concrete work by a watertight wall.

209.03.5 Inspection

Place the footings as soon as practical after the excavation depth and the foundation material are approved.

Drill holes or drive rods in the excavation bottom to determine the materials quality when requested by the Project Manager.

Excavate the spread footings and take rod soundings at each individual substructure unit and submit rod soundings simultaneously for the footing elevation approval.

209.03.6 Backfilling

Once approved, backfill and compact all excavated areas without damaging adjacent structures, to match the existing ground line.

Place backfill to be covered by roadway embankment in maximum 8-inch (205 mm) loose thickness, continuous horizontal layers.

Compact each layer meeting Subsection 203.03.3.

Remove and dispose of backfill containing large or frozen lumps, wood, or other deleterious materials. Do not jet or pond the backfill.

Serrate or step the slope bounding the excavation for abutments and wingwalls.

Place coarse gravel or broken stone around drain holes in wingwalls or abutments as shown on the plans.

Backfill around piers and in front of abutments and wingwalls with material large enough to resist erosion. If acceptable material is not available, the Project Manager may order stone or lean concrete backfill, paid for as extra work.

Place backfill against masonry abutments, and wingwalls meeting Subsection 203.03.2(B). Allow culvert related concrete work to cure 14 days before backfilling.

Dispose of excess material.

209.04 METHOD OF MEASUREMENT

209.04.1 Structure Excavation Type I and Type II

Measurement in cubic yards (cubic meters) is based on the volume bounded on the sides by vertical planes 18 inches (460 mm) outside of the footing neat lines; on the top by the original undisturbed ground surface at the time excavation begins or by the lines in the contract; and on the bottom to the specified footing elevation or the elevation directed by the Engineer.

Calculations for tie beams, overhangs, or similar volumes extending beyond the footing lines are computed from lines 18 inches (460 mm) outside of and below neat lines. The computed structure excavation includes only those portions not contained in the volume of footing excavation.

209.04.2 Shoring and Cribs

Shoring and cribs used with structure excavation Type I are not measured for payment.

Shoring and cribs used with structure excavation Type II are measured by the lump sum.

209.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Structure Excavation Type I	Cubic Yard (cubic meter)
Structure Excavation Type II	Cubic Yard (cubic meter)
Shoring and Cribs	Lump Sum

Additional approved material for backfill provided from other sources is paid for as extra work. Payment includes the costs of obtaining the material, processing, handling, and transporting to the project. The cost of placing and compacting the additional material and disposing of unsuitable material is included in the contract unit price for structure excavation.

No payment is made for additional material placed outside structure excavation pay limits and slope lines to comply with safety regulations.

No payment is made for additional material to replace material removed from the excavation, rendered unsuitable by improper excavation, handling, or stockpiling methods.

Partial payments for structure excavation Type I or II will be made based on the total quantity as follows:

1. 85 percent when removed to plan elevation.
2. 95 percent when backfilled and compacted.
3. 100 percent when the area is cleaned up to the Project Manager's satisfaction.

Partial payments for shoring and cribs will be made based on the lump sum contract unit price as follows:

1. 65 percent when shoring and crib is in position.
2. 90 percent when driven to final elevation.
3. 100 percent when shoring and crib is removed and the area is cleaned up to the Project Manager's satisfaction.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 210 EQUIPMENT USE

210.01 DESCRIPTION

This describes the equipment to be used for the contract work.

210.02 RESERVED

210.03 CONSTRUCTION REQUIREMENTS

210.03.1 General Requirements

Provide equipment in good mechanical condition having sufficient power to perform the work. Repair or replace equipment not meeting these requirements.

210.03.2 Motor Graders

Use self-propelled motor graders either tandem or all-wheel drive equipped with pneumatic tires.

Equip the graders with a moldboard at least 12 feet (3.7 m) long with a cutting edge, a scarifier with nine or more teeth having minimum dimensions of 3 inch x 1 inch x 16 inch (75 mm x 25 mm x 405 mm), and power-operated controls.

The motor grader manufacturer's power rating must be at least 100 horsepower (75 kW).

210.03.3 Dozers

Use dozers of any standard type attached to a crawler tractor of at least 75 horsepower (56 kW) having power-operated controls.

Furnish dozers a minimum 90 inches wide (2.3 m). The dozer and tractor is considered a single unit.

210.03.4 Rollers

A. General. Provide rollers and compaction equipment of standard manufacture bearing the manufacturers identification label. Roller weight is the manufacturer's rating.

Use self-propelled rollers capable of reversing direction without backlash.

Keep rollers in good mechanical condition with positive, accurate steering control.

Use adequately powered trucks or tractors for pull-type rollers.

Other than traction units, operate rollers separate and distinct from other equipment.

Equip all rollers with self-cleaning devices that prevent material from adhering to the wheels or tamping surfaces.

B. Smooth-wheeled Rollers. Use smooth-wheeled, self-propelled rollers meeting one of the following:

1. Tandem-type weighing up to 10 tons (9 mt); or
2. Three-wheeled type weighing a minimum 10 tons (9 mt); or
3. Towed steel-drum rollers weighing a minimum 4 tons (3.6 mt).

C. Tamping Rollers. Use tamping rollers with grids, drums, or shells surrounded by metal studs, pads, or similar elements that compress small areas of material.

D. Pneumatic-tired Rollers. Use pneumatic-tired rollers meeting the following:

1. Two-axle type, straight or oscillating;
2. Rigid framed providing a platform or body for ballast loading;
3. Having an effective rolling width of at least 4 feet (1.2 m);
4. Having a minimum working weight capacity of 250 pounds (113.5 kg) per inch width of tire tread;

5. Smooth tires (no tread) equal in size and diameter;
6. Rear axle tires spaced to overlap the tread gap of the preceding two tires;
7. Uniform tire pressure not varying from each other by more than five psi (34.5 kPa);
and
8. Self-propelled or tractor or truck drawn (tractive power).
Operate the rollers, while turning, to prevent tearing or loosening of the material being rolled or the adjacent material.

Do not use wobble-wheeled pneumatic-tired rollers for bituminous surfacing work.

E. Vibratory Rollers. Use vibratory rollers capable of obtaining the required compaction.

210.03.5 Watering Equipment

Furnish and operate pneumatic-tired water equipment having spray bars capable of uniformly distributing water over the surface area. The control valves must be positive closing to prevent leakage.

210.03.6 Test Trailer, Transport, and Setup

Transport to the project site or provide electrical power service or both for State-owned test trailers. Supply electrical power 24 hours a day, 7 days a week. Transport, set up, and make the trailer operational at least two days before starting plant mix paving.

Paving operations will be suspended if power level requirements are not maintained.

Use a licensed carrier that complies with 49 CFR to transport the test trailer from a designated location to the project site and return it to a designated location as directed. Transporting includes blocking, leveling, re-blocking, re-leveling and unblocking the trailer. Contact the Engineer for details concerning the transport of the trailer at least 30 days before plant mix operations.

Purchase a minimum \$85,000.00 insurance for the trailer and its contents. Provide written proof of insurance to the Engineer before the trailer is moved. Verify that the Department has prepared the trailer and contents for transport.

Repair or replace all contents and trailer damage occurring in transport at Contractor expense. Do not move the trailer without the Engineer's permission.

Furnish and install a continuous 200-ampere, 220 to 230 volt, single phase, 60-hertz power supply to the trailer. Have the source connected by a Montana licensed electrician using a 4-wire conductor.

210.03.7 Test Trailer, Power, and Blocking

Provide a level parking area, the required blocking, and electrical power service for the test trailer. Locate and construct the parking area a minimum 200 feet (61 m) from the plant mix dryer drum, mixing plant, and storage silo unless otherwise directed, to accommodate the 12 foot x 32 foot (3.6 m x 9.8 m) trailer. Park, block, and level the trailer as directed.

Do not begin plant mix paving operations until the trailer is operational. Suspend paving work during power interruptions or periods of insufficient power to the trailer.

Furnish, install, and connect a commercial or generated power meeting Subsection 210.03.06 requirements.

Unblock the trailer and disconnect the power as directed. The Department will prepare the trailer for transport.

210.04 METHOD OF MEASUREMENT

210.04.1 Equipment Use

Equipment use, when specified as a bid item, is measured by the hour for the hours performing the work and includes furnishing the equipment, including operator, servicing, repairs.

Time in moving equipment from point to point on the project and for repair and servicing is not measured.

Equipment used in the work but not specified as a bid item is incidental to the work.

210.04.2 Test Trailer, Transport, and Setup

Test trailer, transport, and setup is measured by the mile (kilometer) for the actual miles (kilometers) moved. It includes insurance, transporting, blocking, unblocking, leveling, furnishing and installing electrical power and associated wiring, and all other necessary resources to complete the item of work. The mileage shown in the contract is an estimate only and may be adjusted by the Engineer.

210.04.3 Test Trailer, Power, and Blocking

Test trailer, power, and blocking is measured by the lump sum and includes constructing a level parking area, blocking, leveling trailer, furnish power and wiring, unblocking, and removing power and wiring.

Maintenance re-blocking and re-leveling is incidental to the work and not measured or paid for separately.

Additional blocking and leveling of the trailer for trailer moves directed by the Engineer are measured and paid for.

210.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Motor Grader	Hour
Dozer	Hour
Test Trailer Transport/Setup	Mile (kilometer)
Test Trailer Power/Blocking	Lump Sum

Partial payments for test trailer power/blocking will be made based on the lump sum contract unit price as follows:

1. 50 percent when the trailer is blocked, leveled, and power is supplied.
2. 100 percent when the trailer is unblocked and the power is disconnected.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 211
ROAD LEVELER OPERATIONS

211.01 DESCRIPTION

Road leveling is using a road leveler to final shape the top surfacing course.

211.02 RESERVED

211.03 CONSTRUCTION REQUIREMENTS

211.03.1 Equipment

Use either a self-propelled or tractor-powered unit designed for road leveling work.

A. Leveler Unit. Furnish a leveler unit:

1. Approximately 40 feet long (12.2 m);
2. With a minimum cutting blade width of 10 feet (3.0 m);
3. With pivot points, both in front and behind the center point of the machine;
4. Mounted on pneumatic tires or crawler-type treads; and
5. With hydraulic power fittings to control the cutting blade from the power traction unit.

Machines less than 40 feet (12.2 m) in length may be used if operated off an approved string line using electronic controls.

B. Tractor Power Unit. Use tractor-power units capable of operating the leveler up to 4 miles per hour (6.4 km/h).

Equip the unit with a two-way hydraulic system having controls for operating the leveler cutting blade.

211.03.2 Operation

Once the final surface course material is finished, bring the surface to the specified tolerance.

Apply water to the surface as required for leveling.

Operate the leveler longitudinally, starting from the crown of the roadway working toward the shoulder on successive passes with each pass overlapping.

Do not straddle the roadway crown with the leveler.

211.04 METHOD OF MEASUREMENT

Road leveler operation is measured by the hour for the actual hours used in the work.

211.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Road Leveler	Hour

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 212
OBLITERATE ROADWAY**

212.01 DESCRIPTION

Obliterate roadway is the blading, scarifying, dozing, shaping, seeding, and disposing of structures and guardrail not included for removal under other items of the contract on existing portions of abandoned roadways designated for obliteration.

212.02 RESERVED

212.03 CONSTRUCTION REQUIREMENTS

Grade and contour abandoned roadways to blend with the new roadway and existing terrain.

After the old roadway surfacing is removed, salvage the topsoil from areas to be graded and perform the rough grading. Grade and contour the obliterated roadway to blend with the new roadway and adjacent terrain. Spread the salvaged topsoil and seed the obliterated roadway area.

Work construction scars, sharp breaks, and steep slopes or cuts to blend with the terrain. Existing surface material may be used in the new work or to construct fills over old roadways when covered with 12 inches (305 mm) of soil capable of supporting plant growth.

Remove and dispose of old structures, guardrail, and other non-salvageable items not included in other contract items for removal at Contractor expense. Remove and neatly store all material designated as salvageable to prevent damage.

The species of seed, seed bed preparation, fertilizing, mulching, and application rate is specified in the contract or will be determined by the Department Agronomist.

212.04 METHOD OF MEASUREMENT

Roadway obliteration is measured in stations to the nearest whole station along the centerline of the roadway obliterated or by the cubic yard (cubic meter), as specified.

When not included in the contract as a pay item, roadway obliteration is measured by the cubic yard (cubic meter) under Subsection 203.04.

Topsoil is measured under Subsection 203.04.

Seeding is measured under Subsection 208.04

212.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Roadway Obliteration	Station or Cubic Yard (cubic meter)
Topsoil	Cubic Yard (cubic meter)
Seeding	Acre (hectare)

Material obtained from the obliterated roadway and used in the construction of the new roadway is measured and paid for as unclassified excavation and haul under Sections 203 and 206 respectively.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 301
AGGREGATE SURFACING**

301.01 DESCRIPTION

This work is producing and placing one or more courses of aggregate surfacing on a prepared surface or producing and stockpiling aggregate surfacing.

301.02 MATERIALS

301.02.1 Aggregates

Obtain aggregates from sources meeting Section 106 requirements to produce material meeting Subsection 701.02.1 and the following Subsection requirements:

Selected Surfacing.....	701.02.2
Sand Surfacing	701.02.3
Crushed Base Course	701.02.4 and 701.02.5
Crushed Top Surfacing.....	701.02.6 and 701.02.7
Crushed Cover Aggregate	701.02.8

301.02.2 Binder

Binder material, for binding and gradation requirements, is fine, natural soil particles or crusher dust, free from grass, roots, weeds, humus, or other deleterious matter.

Add and blend the binder material when required with the aggregate surfacing to provide material meeting the specifications.

301.02.3 Blending Material

Blending material is selected natural or crushed mineral aggregate combined with the produced aggregate to meet specifications.

Do not use pit stripping's, overburden, or other deleterious material as blending material.

Furnish and add blending material to aggregate surfacing materials when required to meet gradation requirements.

The blending material must not increase the liquid limit and plastic limit of the surfacing material.

301.03 CONSTRUCTION REQUIREMENTS

301.03.1 Sampling, Testing, and Acceptance

A. Production Control. Develop a quality control sampling and testing plan for production and be responsible for all sampling and testing for gradation and mechanical fracture control during aggregate production.

B. Acceptance Sampling and Testing. The Project Manager will randomly select samples taken by the Contractor and witnessed by an Inspector, for gradation, fracture, and cleanness value testing from processed material on the roadway under MT-201. Samples for other tests will be taken at the point of production.

The following acceptance tests are used:

Gradation	MT-202
Mechanical Fracture.....	MT-217
Cleanness Value	MT-228

The largest quantity represented by each sample is 2,500 tons (2500 mt), excluding cover material, which is 500 tons (500 mt). Additional samples may be taken and tested.

The quantity represented by five samples is a lot when production schedules and material continuity permit. The Project Manager may establish a lot consisting of a quantity represented by three to seven consecutive random samples when there are short production runs, significant material changes, or other unusual characteristics of the work.

- C. Acceptance.** Surfacing aggregates are evaluated for gradation, mechanical fracture, and cleanness value on a lot-by-lot basis. The upper and lower limits in the gradation tables in Section 701 are the upper and lower limits in the evaluation formulas. The specified minimum fracture and cleanness values are the lower limit.

Develop a proposed job mix target aggregate gradation for each grade of crushed base aggregate to be produced. Establish a single target value for each specified aggregate size within the job mix target limits shown in Table 701-8. The job mix tolerance will be applied to the approved target values. Submit two copies of a completed job mix target aggregate gradation form to the Project Manager prior to beginning placement of the second lot on the roadway. If multiple sources are used for production, a completed job mix target aggregate gradation form may be submitted for each source prior to beginning placement of the second lot from each respective source. The submitted target aggregate gradation will be applied retroactively to the first lot for assessment. When the quality incentive allowance is waived in accordance with Subsection 105.03.3, the allowed band for each sieve size is equivalent to the job mix target limit with the tolerance applied to the low and high limit.

Acceptance is made under Subsection 105.03.2.

301.03.2 Equipment

- A. Rollers.** Use rollers meeting Subsection 210.03.4 requirements.
- B. Watering Equipment.** Use watering equipment meeting Subsection 210.03.5 requirements.
- C. Scales.** Furnish scales meeting Subsection 109.01.1 or use certified permanently installed commercial scales. Furnish and have readily available at least ten 50-pound (22.7 kg) weights for testing Contractor furnished scales. Furnish housing for the scale recording devices. Scale accuracy must be one-half of one percent at any weight.

Alternate weigh methods or devices may be acceptable, if they produce the required accuracy. Platform and belt-conveyor scale requirements are as follows:

- 1. Platform Scales.** Use platform scales having the length to weigh an entire vehicle in an unbroken operation.

Truck-trailer combinations may be weighed separately if the scale approaches are:

- a. Compacted gravel or asphalt;
- b. Long enough and level with the scale platform to accommodate the entire truck-trailer units; and
- c. Continually maintained.

Release all brakes as the unit is weighed.

- 2. Belt-conveyor Scales.** Belt-conveyor scales may be used for non-asphaltic materials if the scale meets the general requirements for scales in Subsection 109.01.1 and the following:

- a. The scale meets the National Bureau of Standards requirements for belt-conveyor scales, except as modified below.
- b. A daily static-load test is made after approximately 1/2 hour of continuous belt conveyor operation and whenever the air temperature varies 15 °F (9 °C) or more.

Have a calibration test performed once daily and whenever the daily static-load test shows adjustments are required.

- c. Make calibration computations, calibration procedures and results, and related documents available for the Project Manager's review. Clearly mark test chains with calibration constants. Carry test chains and test weights in protective containers and make immediately available for belt-conveyor scale testing.
- d. Perform accuracy checks by checking the average of five or more sequential payloads of hauling units on approved platform scales. The acceptable accuracy is plus or minus 0.5 percent of the payload of the average hauling unit. If the recording odometer of the belt-conveyor scales in use is graduated to 0.1-ton (200 lb) (91 kg) increments and is a cumulative recording process, differences in readings and variations less than 0.1-ton (91 kg) may carry over from one hauling unit to another. Conveyor weight conformation is based on the tonnage obtained from readings taken from the sealed odometer at the beginning and end of each check period. The number of check loads will be increased should the test results fluctuate.

Furnish a lock to secure the recording tape, odometer, totalizer, calibration adjustment, and clock-time imprinter. The Project Manager will lock the equipment and retain the keys before materials are delivered to the roadway.

301.03.3 Reject

Dispose of reject material produced from Department sources as directed.

301.03.4 Crushed Aggregate Course

When crushed aggregate course is a bid item, construct the aggregate surfacing section to the specified typical cross section and profile grade.

Select one of the following two options to construct the aggregate section:

1. Full depth crushed base course.
2. Top 0.15 ft (45 mm) crushed top surfacing, remaining depth crushed base course.

Indicate the selected option and the grade of crushed base course (Type "A" Grade 5 or Type "A" Grade 6) before beginning aggregate production. Only one grade of crushed base course will be permitted. If option 2 is selected use Type "A" Grade 2 crushed top surfacing.

Quality assurance lot sizes, test intervals and material tolerances will be based upon the materials selected.

301.03.5 Aggregate Surfacing Construction

- A. **Surface Preparation.** Prepare the existing roadway surface meeting Section 204 immediately before placing surfacing material.

Do not place aggregate surfacing material on any of the following:

1. Any surface not meeting the dry density requirements for that surface;
2. A rutted or frozen subgrade or aggregate surface; or
3. Any surface not meeting grade or surface smoothness specifications.

- B. **Pugmill Mixing.** Pugmill mix all surfacing aggregates except crushed cover aggregate.

Uniformly mix aggregate surfacing and water in a central plant pugmill mixer.

Proportion all blending material, filler, and binder by weight to within plus or minus one-half of one percent of the specified quantity before mixing.

Add the water needed to reach the specified density.

Additional water may be added only once to the aggregate surfacing once its placed on the roadway to replace moisture lost to surface evaporation. If additional water is needed, pick up the mixture and remix it in the pugmill.

1. Placing. Transport, place, and spread aggregate surfacing on the roadway.

Spread in maximum 8-inch (205 mm) compacted layers to the required grade and typical section. Spot fill low areas by scarifying roadway, spreading aggregate and compacting to specified density.

C. Road Mixing. When specified, place, mix and spread the surfacing aggregates on approved surfaces at optimum moisture using motor graders or other approved equipment.

Water may be added to the aggregate to reach optimum moisture during or after crushing.

Once uniformly mixed, spread in maximum 8-inch (205mm) compacted layers to the required grade and typical cross section. Roller compact the spread layer.

Add binder only after it is approved for use.

Uniformly spread the binder over the loose spread surface course. Blend and mix binder uniformly into the surfacing material using approved methods and equipment.

For courses 3 inches (75 mm) thick or less, work the binder into the entire depth. For course depths exceeding 3 inches (75 mm), work the binder into the upper 3 inches (75 mm).

Correct or remove equipment from the work failing to maintain uniform gradation of the material for the entire width and thickness.

D. Compaction. Compact aggregate surfacing to 98 percent of the target density.

The initial target density is the average of the maximum density of at least two tests on samples representing the material to be compacted. Maximum density is determined by MT-230.

The Project Manager will take samples from the materials placed on the roadway. They will be tested and the results averaged with the previous tests to determine a new target density for the material remaining to be placed.

The Project Manager will establish a target density for each course, grade, and type of surfacing aggregate. A new target density will be established if the aggregate characteristics change.

The Department will test the lift(s) of surfacing aggregate in 2000-foot long (610 m) sections based on full typical section width. The in-place dry density of each lift is determined within each section at 10 randomly selected locations. The average of the 10 tests must be a minimum of 98 percent of the target with not more than 2 out of 10 tests being less than 98 percent of the target. The number of tests will be pro-rated for sections with partial lengths and widths. In pro-rated sections, the average of the tests must be a minimum of 98 percent of target density.

Be responsible for controlling compaction and all necessary control testing.

Notify the Project Manager once compaction is complete on a section so it may be tested.

Re-compact sections not meeting density requirements.

Re-compacted sections will be tested at 10 new random locations.

Compaction and testing will continue until the section meets density requirements.

Densities will be determined using MT-210, MT-212, MT-215, MT-218, and MT-230.

E. Trimming. Trim each course of compacted aggregate surfacing to the specified grade and section.

Use trimmings on the inslopes, on sections of uncompleted roadway or return to the pit area. When quantities are measured by the ton (metric ton), excess material returned to the pit is deducted from the pay quantities.

- F. Restrictions.** The Project Manager may restrict equipment speed and load weights to prevent damage to existing and new work, public thoroughfares or safety.
- G. Surface Smoothness.** Finish the aggregate surface to the specified grade within Table 301-1 tolerances.

**TABLE 301-1
SURFACE SMOOTHNESS**

AGGREGATE SIZE	TOLERANCE	DISTANCE
1-1/2 inch (40 mm) and larger	0.08 foot (24 mm)	30 feet (9.2 m)
1 inch (25 mm) and less	0.04 foot (12 mm)	60 feet (18.4 m)

301.03.6 Shoulder Gravel

Compact shoulder gravel to provide a firm, hard surface. Finish the slope to provide a smooth surface from the edge of pavement to the catch point.

Furnish gravel meeting Table 301-2 gradation requirements.

**TABLE 301-2
SHOULDER GRAVEL GRADATION REQUIREMENTS**

SIEVE SIZE	PERCENT PASSING
3/4 inch (19.0 mm)	100
No. 4 (4.75 mm)	25-85
No. 200 (0.075 mm)	5-20

Cold milled pavement is not required to meet the above gradation when used as shoulder gravel.

301.03.7 Traffic Gravel

Furnish traffic gravel meeting Subsection 701.02.4 or 701.02.6. Traffic gravel is not evaluated under Subsection 105.03.2.

Place traffic gravel in the locations and quantities directed by the Project Manager.

301.04 METHOD OF MEASUREMENT

301.04.1 Aggregate

Aggregate surfacing, blending material, fillers, binder, water, producing, handling, mixing, hauling, placing, spreading, compacting, trimming, use of trimmings, maintenance and all necessary incidentals to complete the work is measured by the cubic yard (cubic meter) or ton (metric ton), as specified.

When removing oversize surfacing material from the roadway, the oversize material is measured by the ton, (metric ton) returned to the aggregate source, and deducted from the total surfacing material placed on the roadway.

- A. Measurement by Weight.** Aggregate surfacing is measured by the ton (metric ton) under Subsection 301.03.2(C).

Excess material removed from the roadway and returned to the pit area is deducted from the pay quantities.

- B. Measurement by Volume.** Traffic gravel and shoulder gravel are measured by the cubic yard (cubic meter). Aggregate surfacing is measured by the cubic yard (cubic meter), under the applicable provisions in Subsection 109.01, from:

1. Plan dimensions; or
2. Haul vehicles; or
3. In-place roadway or stockpile volumes.

When measured in place, each course thickness of each grade of surfacing aggregate will be measured at random locations in a section. The section length and number of measurements is the Project Manager's discretion. The thickness measurements for each section are averaged and the average must equal or exceed the plan thickness. The minimum measured thickness at any location must be at least plan thickness less 1/2 the largest aggregate size permitted for the material.

Bring all sections of a completed course not meeting these specifications into compliance before placing the next course.

Aggregate surfacing for small or irregularly shaped areas ordered in writing by the Project Manager, are measured in the haul vehicle under Subsection 109.01.

Aggregate surfacing to fill in subgrade low areas or placed outside the lines and slopes shown in the plans or established by the Project Manager is not measured for payment.

301.04.2 Binder

Binder added at the crusher plant is included in the measurement for the aggregate material.

Binder added to the surfacing material once placed on the roadway is measured by the cubic yard (cubic meter) or ton (metric ton) under Subsection 301.04.1.

When specified as a contract item, haul on binder is measured by the mile-yard (kilometer-cubic meter) or ton-mile (ton-kilometer) under Subsection 206.04.2.

When not specified as a contract item, haul on binder is not measured for payment.

301.04.3 Existing Surface Preparation

When specified, existing surface preparation is measured under Subsection 204.04.

When existing surface preparation is not specified, it is incidental to and included in the aggregate surfacing.

301.04.4 Aggregate Haul

Aggregate haul is not measured for payment unless specified. If specified, it is measured under Subsection 206.04.2.

301.04.5 Compaction

Compaction is incidental to the aggregate surfacing.

301.04.6 Crushed Aggregate Course

The entire aggregate surfacing section will be measured as crushed aggregate course regardless of the construction option selected under 301.03.4.

301.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Aggregate	Cubic Yard (cubic meter) or Ton (metric ton)
Binder	Cubic Yard (cubic meter) or Ton (metric ton)
Binder Haul	Mile-Cubic Yard (kilometer-cubic meter) or Ton-Mile (metric ton-kilometer)
Existing Surface Preparation	See Subsection 204.05
Aggregate Haul	Ton-Mile (metric ton-kilometer) or Mile-Cubic Yard (kilometer-cubic meter)

Traffic Gravel	Cubic Yard (cubic meter)
Shoulder Gravel	Cubic Yard (cubic meter)
Crushed Aggregate Course	Cubic Yard (cubic meter) or Ton (metric ton)

Payment at the contract unit price for traffic gravel includes all costs necessary to furnish and place the gravel.

Sale of excess crushed traffic gravel meeting all specifications is the Contractor's option. Traffic gravel meeting all specifications that is crushed and stockpiled on the project, but not placed or sold, will be paid for at 35 percent of the contract unit price. Gravel from a commercial source or a source supplying multiple projects and not transported to the project is not measured for payment.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 302 BITUMINOUS PAVEMENT PULVERIZATION

302.01 DESCRIPTION

This work consists of processing the existing plant mix surfacing and adding crushed aggregate course material necessary to restore the roadway section.

302.02 MATERIALS

Furnish crushed aggregate course meeting the requirements of Subsection 701.02.1 and one of the following Subsections:

Crushed Aggregate Course Type "A" Grade 5701.02.4

Crushed Aggregate Course Type "A" Grade 6701.02.4

302.03 CONSTRUCTION REQUIREMENTS

302.03.1 Pulverization

Pulverize the bituminous surfacing to the full depth of the existing mat. Pulverize the existing bituminous material so that 100 percent by weight passes a 2-inch (50 mm) sieve.

302.03.2 Equipment

Equipment used to pulverize the existing surfacing must not reduce the aggregate size in the existing surfacing.

302.03.3 Mixing

Add crushed aggregate course as necessary to construct the roadway to the dimensions shown on the typical sections. Uniformly mix the pulverized material and crushed aggregate course by pugmilling or by using the pulverization equipment.

302.03.4 Compaction

Compact the pulverized mixture to 98 percent of the target density. The target density will be determined by one of the following methods:

A. Pugmill Mixing. MT-230 determines maximum density when the pulverized plant mix and crushed aggregate course are blended at a constant ratio by pugmill. The initial target density is the average of the maximum density of the at least two tests on samples representing the material to be compacted.

B. In-place Mixing. MT-219 determines maximum density when in-place pulverized plant mix and crushed aggregate course mixtures are combined at varying ratios.

The Project Manager will determine target densities and moisture corrections. A new target density will be established if the ratio of pulverized material and crushed aggregate course change by more than 20 percent or the Engineer determines the pulverized material characteristics or site conditions change.

302.03.5 Testing and Acceptance

Each lift of pulverized mixture material will be divided into 2000-foot long (610 meter) sections. The in-place dry density of each lift will be determined within each section at ten randomly selected locations. The average of the ten tests must exceed 98 percent of the target density with no more than two out of the ten tests being less than 98 percent of the target density.

Be responsible for controlling compaction and all necessary quality control testing.

Notify the Project Manager when compaction is complete on a section so it can be tested.

Re-compact sections not meeting density requirements. Re-compacted sections will be tested at ten new random locations.

Compaction and testing will continue until the section meets density requirements.

302.04 METHOD OF MEASUREMENT

302.04.1 Aggregate

Crushed aggregate course is measured by the ton (metric ton) under Subsection 301.03.2(C) or by the cubic yard (meter).

302.04.2 Pavement Pulverization

Pavement pulverization is measured by the square yard (square meter). If the average pavement depth varies by more than 0.10 foot (30 millimeters) from plan, the pulverization quantity will be adjusted by the ratio of the actual pavement depth in excess of 0.10 foot (30 mm) divided by the plan depth.

302.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Crushed Aggregate Course	Ton (metric ton) or Cubic Yard (cubic meter)
Pavement Pulverization	Square Yard (square meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 303
STOCKPILED SURFACING
AGGREGATE**

303.01 DESCRIPTION

This is stockpiling surfacing aggregates at the specified location.

303.02 MATERIALS

Furnish materials meeting Subsection 301.02 and the contract requirements.

303.03 AGGREGATE STOCKPILING METHODS

Clear stockpile sites of weeds, roots, stumps, rocks, and other contaminating matter. Dispose of this material under Subsection 201.03.5 or level as directed.

Make the stockpile floor firm, smooth, well drained, uniform in cross-section, and able to support the stockpile.

Place an aggregate bed on the floor to prevent stockpile contamination.

Construct stockpiles in at least three layers. Place each layer approximately 4 feet (1.2 m) high before starting the next layer. Prevent each layer from spilling down over the next lower tier.

Do not drop material stockpiled by conveyor more than 12 feet (3.7 m). Deposit the material in succeeding merging cone piles. Do not permit the piles to exceed 12 feet (3.7 m) in height. Level each completed layer to 4 feet (1.2 m) thick.

Operate stockpiling trucks to produce a stockpile width that exceeds the single dump trucks width. Do not dump over the stockpile sides.

Maintain separation between different gradation stockpiles to prevent aggregates from intermingling.

Use equipment and methods to prevent segregation, degradation, or contamination of the aggregate when constructing stockpiles or delivering materials.

Department sieve test samples are taken from the stockpile to determine degradation.

Re-mix and re-stockpile segregated stockpiles.

Bring stockpiled material failing specifications back within specifications at Contractor expense.

303.04 METHOD OF MEASUREMENT

303.04.1 Aggregate

Stockpile surfacing aggregate is measured at the stockpile site by the ton (metric ton) or cubic yard (cubic meter) under Subsection 301.04.1.

303.04.2 Haul

Haul is measured under Subsection 206.04.2.

303.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Aggregate	Ton (metric ton) or Cubic Yard (cubic meter)
Haul	Ton Mile (metric ton kilometer) or Mile Yard (kilometer cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 304
PORTLAND CEMENT TREATED
BASE

304.01 DESCRIPTION

This work is the construction of one or more courses of an aggregate, water, and portland cement mixture on a prepared surface.

304.02 MATERIALS

304.02.1 Portland Cement

Use portland cement meeting AASHTO M 85, Type I or Type II requirements.

304.02.2 Water

Use water meeting Subsection 713.01 requirements.

304.02.3 Aggregate

Use aggregate source(s) meeting Section 106 requirements.

Produce aggregates meeting Subsection 701.02.9 requirements.

Assure aggregate is available for sampling at least 60 days before mixing is to begin.

Stockpile the aggregates under Subsection 303.03.

304.02.4 Blending Material

Blending material, consisting of selected natural or crushed mineral aggregate may be combined with the produced aggregate and added to meet gradation requirements. Blending material is by and at Contractor expense. The liquid limit for that portion of the fine aggregate passing the No. 40 (0.425) sieve may not exceed 30, and the plasticity index may not exceed 7, tested under MT-208.

304.03 CONSTRUCTION REQUIREMENTS

304.03.1 Composition and Proportioning

A. Cement. Add portland cement at the job mix target rate set by the Engineer. The initial job mix target rate is the laboratory mix design value.

B. Water. Provide the water to reach plus or minus two percent of the optimum moisture content of the compacted mixture.

C. Aggregate. Establish a single value for each specified aggregate size within the job-mix target limits in Table 701-13 in Subsection 701.02.9 as the target aggregate gradations. Submit it to the Engineer for approval. The job mix tolerances will be applied to the approved target values for final acceptance.

Produce aggregates meeting the approved job-mix aggregate gradation.

304.03.2 Aggregate Production, Testing, and Acceptance

A. General. Perform all work to meet the approved job-mix target values within the specified tolerances.

Sample and test aggregates during production to control gradations.

B. Acceptance Sampling and Testing. The Department will sample the stockpiles for acceptance of the aggregates physical properties, excluding combined gradations. Aggregate gradation samples for acceptance testing are randomly taken at the last practical point before portland cement and water are added to the mixture.

The approximate quantity represented by each sample is 1500 tons (1500 mt). Additional samples will be taken as necessary.

Five samples will represent approximately 7500 tons (7500 mt) which constitutes a lot whenever production schedules and material continuity permit.

The Project Manager may establish a lot of the quantity represented by any number of consecutive random samples from three to seven inclusive when there are short production runs, significant material changes, or other unusual characteristics of the work.

C. Acceptance. Cement treated base is evaluated for gradation requirements on a lot-by-lot basis. Acceptance is made under Subsection 105.03.2

304.03.3 Weather Limitations

Do not mix or place cement treated base when the ambient temperature is below 40 °F (4 °C) or the ground temperature is below 35 °F (2 °C).

Do not incorporate frozen aggregate in the cement treated base or place on a frozen subgrade.

304.03.4 Subgrade Preparation

Prepare the subgrade meeting the applicable requirements of Section 203.

Place cement treated bases on constructed subgrades with existing surface preparation meeting Section 204 requirements.

Trim the subgrade to the thickness tolerances for cement treated base specified in Subsection 304.03.13.

304.03.5 Mixing and Placing

Mix the portland cement treated base in a central plant.

Proportion the aggregate and cement by weight. Water may be proportioned by weight or by volume.

Use weigh systems and meters that are accurate to within plus or minus 0.5 percent of the total quantity batched and are equipped to indicate the total quantity of each ingredient batched between one half to ten hours.

Calibrate the feed system before production mixing begins.

Mix ingredient proportions must be periodically verified from the weigh indicators.

Maintain the cement content to within plus or minus 1.0 percent of the job mix target at any periodic check and within plus or minus 0.3 percent for each day's production. Mixing will be suspended until corrections are made if the cement content is not maintained within the above tolerances.

Uniformly mix aggregate, cement, and water. Modify mix procedures when evidence of a non-uniform mix is identified.

Place cement treated base in equal lifts, with a maximum of 9 inches (230 mm) per lift. When constructing more than one lift, keep the surface of the cement treated base damp until the following lift is placed. Apply the curing seal to the top of the lift being placed if the following lift is not placed within 48 hours of the placement of the preceding lift.

304.03.6 Moisture - Density Test

The moisture and density relationship is determined by Montana Test Method MT-211 using samples taken from the aggregate stockpiles before starting mixing operations.

Once cement treated base production has begun, subsequent moisture - density tests will be made on samples taken from the roadway to verify the moisture - density relationship obtained from the stockpile samples.

The compacted minimum density is 96 percent of the maximum dry density as determined above.

304.03.7 Compaction

Select the compaction method and complete compaction within two hours after mixing.

Field density values are determined under MT-212. One density test is taken at a randomly selected site within a 500-foot (152 m) section being constructed. If the density is below that specified, two additional tests will be taken in that section and the results averaged. The average density for the three tests must be at least the specified density, with none of the three tests less than 93 percent of the maximum dry density.

If the densities do not meet the specified requirements, remove the mix and reconstruct the section at Contractor expense.

The removed mix may be re-processed as aggregate for producing cement treated base.

Remove and re-process any un-compacted sections where the weather has increased the average moisture content above optimum by more than two percent.

304.03.8 Finishing

Shape the compacted surface to the specified lines, grades, and cross sections.

Finish and compact to produce a smooth, dense surface free of compaction planes, cracks, irregularities, or loose material.

Complete the surface finishing within two hours of compaction.

Scarify and re-compact surface deformations in the base caused by equipment.

Do not permit the moisture content to fall below the specified optimum during finishing. Apply water in a uniform fog spray.

304.03.9 Construction Joints

Construct straight vertical-faced transverse joints at the end of each day's work by cutting back into the completed base. Assure the vertical face is free of loose material.

Repair all construction related damage to finished sections of the cement treated base at Contractor expense.

304.03.10 Protection and Curing

Once the cement treated base is finished, apply the specified bituminous curing seal at approximately 0.2 gallon per square yard (0.91 L per square meter).

Keep the cement treated base surface moist between the final compaction and application of the curing seal.

Before applying the curing seal, assure the base surface is tightly knit, free of all loose material, and has sufficient moisture to prevent asphalt penetration.

Apply the specified blotter material at approximately 15 pounds per square yard (8.2 kg per square meter) when directed.

The actual application rate of curing seal and blotter may be adjusted by the Project Manager.

Remove base areas that have absorbed the curing seal down to hard, clean base, within 24 hours of application. Re-moisten if requested and re-apply the curing seal as specified.

Apply the curing seal and blotter material meeting the applicable requirements of Section 409.

304.03.11 Curing Period

Do not perform any work on the cement treated base for at least three days after the curing seal is applied. Do not apply the wearing course until compressive strength reaches 70 percent of design strength. If the cement treated base does not meet 70 percent of the design strength in

seven days, core the material in the presence of a Department employee. The Department will have it tested by an independent certified laboratory at the Contractor's expense.

Immediately repair all curing seal damage through the cure period at Contractor expense.

304.03.12 Maintenance

Maintain the finished surface and seal before placing the wearing course. Make all repairs or patches the full depth of the base.

304.03.13 Surface Smoothness and Thickness Requirements

Finish the cement treated base meeting the requirements of 105.08.

304.03.14 Use of Trimmed Material

Cement treated base trimmings may be used for shoulder construction in lieu of aggregate, subject to the following:

- A. The shoulder subgrade is prepared as specified in Subsection 304.03.4.
- B. Hardened material is reworked to the maximum size specified for shoulder aggregate before spreading additional shoulder aggregate.
- C. The trim material used cannot exceed 25 percent of the contract aggregate shoulder depth per linear foot (305 mm) of shoulder. When trimmings exceed this limit, remove or place the excess in other shoulder areas, subject to the 25 percent limit.
- D. Uniformly distribute the trim material in the shoulder area before spreading additional shoulder aggregate.

304.04 METHOD OF MEASUREMENT

304.04.1 Cement Treated Base

Cement treated base is measured by the cubic yard (cubic meter) of completed volume.

Cement treated base placed outside the lines shown in the contract or established by the Project Manager is not measured for payment.

No measurement is made of the width required for forms or equipment operations.

Gravel used in trimmings and lateral support sections outside the planned typical section dimensions are not measured for payment.

304.04.2 Portland Cement

Portland cement is measured by the ton (metric ton) or by the hundredweight (kilogram) under Subsection 109.01.

Measurement includes the cement in trimmings used as shoulder gravel.

Additional cement required for the re-processing specified in Subsection 304.03.7 is not measured for payment.

The payment weight is the invoice weight, up to the job mix target quantity, plus 0.3 percent. Furnish copies of invoices showing weights from certified scales.

Deductions are made for waste and non-project use.

304.04.3 Curing Seal

Curing seal is measured by the gallon (liter) or by the ton (metric ton) under Subsection 409.04.1.

304.04.4 Blotter Material

Blotter material is measured by the ton (metric ton) or by the cubic yard (cubic meter) for the quantity applied and accepted in place.

304.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Cement Treated Base	Cubic Yard (cubic meter)
Portland Cement	Ton (metric ton) or Hundred-weight (kilogram)
Curing Seal	Gallon (liter) or Ton (metric ton)
Blotter Material	Ton (metric ton) or Cubic Yard (cubic meter)

No payment is made for cement treated base quantities that exceed plan volume plus 10 percent.

Existing surface preparation is measured and paid for under Subsections 204.04 and 204.05.

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

SECTION 401 PLANT MIX PAVEMENT

401.01 DESCRIPTION

This work is the production and placing of plant mix asphalt pavements.

Plant mix pavement is one or more courses of plant mixed aggregate, mineral filler or chemical additive when required, and bituminous material, constructed on a prepared foundation.

401.02 MATERIALS

401.02.1 Aggregate

Use aggregate sources meeting Section 106 requirements. Produce aggregate meeting Section 701 requirements.

401.02.2 Bitumen

Furnish bitumen meeting Section 702 and the contract requirements.

401.02.3 Blending Material

Blending material is selected natural or crushed mineral aggregate.

Do not use pit strippings, overburden, or other deleterious material as blending material.

Furnish blending material with a volume swell not exceeding 8 percent and not displaying cracking or disintegration when tested under MT-305.

401.02.4 Mineral Filler

Furnish mineral filler meeting Subsection 713.06 requirements.

The mineral filler quantity and type is determined by tests made with mineral fillers in the crushed aggregate for plant mix bituminous material.

401.02.5 Additives

A. Hydrated Lime. Furnish hydrated lime meeting Subsection 713.02 requirements.

Hydrated lime introduced into a paving mixture, in a blend box with asphalt cement, is a chemical additive and is not included in gradation test results.

B. Anti-stripping Additive. Furnish anti-stripping additives meeting the contract requirements.

The percentage of anti-stripping additive is determined by laboratory tests on samples of the aggregate proposed for use. The anti-stripping additive must be uniformly distributed throughout the bituminous material at the refinery.

The anti-stripping quantity may be increased or decreased by the Engineer.

401.03 CONSTRUCTION REQUIREMENTS

401.03.1 Composition of Mixtures

A. Job Mix Formula - Design. Develop and submit for approval, a proposed job mix target aggregate gradation for each grade of pavement mix to be produced. Establish a single target value for each specified aggregate size within the job mix target limits in Table 701-15 of Subsection 701.03. The job mix tolerances will be applied to the approved target values. Submit the proposed job mix formula on Form CB-30 QA before submitting the mix design samples.

Furnish aggregate samples, witnessed by the Department, representing total production at least 20 days before mixing operations. The Department will establish for

each mixture a design mix formula providing the approved job-mix aggregate gradation, a recommended asphalt content, and the types and quantities of additives, if required.

Produce aggregates meeting the approved job mix aggregate gradation.

This procedure is repeated if there is a change in the aggregate properties or a change in the materials source.

- B. Job Mix Formula - Field Established.** A job mix formula for each grade of bituminous mix is established in the field for each design mix formula.

The Engineer will establish a target asphalt content expressed as a percentage of the total mix weight. The target asphalt content is based on design and field Marshall mix test results. The target asphalt content may be adjusted to improve mix properties as measured by field Marshall tests. Maintain the actual asphalt content in the mix within plus or minus 0.3 percent of the target asphalt content.

Use the approved job mix aggregate gradation unless otherwise directed.

- C. Aggregate Sampling and Acceptance.** Aggregate is accepted in the stockpiles for physical properties, excluding combined gradation.

Take samples, witnessed by the Department, for aggregate gradation acceptance testing, just before the bitumen is added to the mix.

When aggregate gradation is controlled by a cold feed control system without plant screens, acceptance-testing samples may be taken from the cold feed. Cold feeds for batch plants will not be sampled for acceptance testing when plant screens are used.

401.03.2 Equipment

- A. All Mixing Plants.** Furnish bituminous mixing plants meeting the following requirements. Scale requirements apply only where proportioning by weight is required. Cold feed control requirements apply only where aggregate gradation is controlled by a cold feed control system.

- 1. General.** Use mixing plants of the weight-batching, continuous-flow, or dryer drum type.

Do not use mixing plants that cannot produce a uniform mix meeting the contract requirements.

- 2. Storage and Heating Equipment.** Use bitumen storage tanks that uniformly heat and maintain the tank contents at the required temperatures.

Do not allow fuel oil or other material to contaminate the bitumen.

Equip storage tanks with a gauge, calibrated rod, or float that accurately measures the contents.

- 3. Aggregate Feeder.** Equip plants with an accurate, mechanical aggregate feed system.

- 4. Bins.** Provide easy and safe access to bins and bin sampling areas. Provide separate, dry storage for the mineral filler.

- 5. Bituminous Control Unit.** Use weighing or metering devices to control the bituminous material introduced into the mix within the specified limits.

Measure the bitumen discharged into the mixer by a temperature-compensating meter with totalizer.

- 6. Thermometric Equipment.** Install an armored thermometer or other approved thermometric device in the bituminous material feed line near the charging valve at the mixer.

Use thermometric equipment having an accuracy of plus or minus 5 °F (3 °C), sensitive to a minimum temperature rate change of 10 °F (5.5 °C) per minute.

- 7. Emission Control.** Furnish emission control devices meeting the Department of Health and Environmental Sciences requirements.

Do not discharge wet scrubber effluent into a live stream, lake, or pond. Circulate the effluent through sludge pits or tanks. Contain and dispose of the sedimentation, and all other wastes produced by crushing and mixing operations under Subsection 106.02.5.

Do not return the material collected from air pollution control equipment (bag house fines) to the mix unless authorized in writing. Authorization may be terminated when test results indicate any mix property is outside the specified limits. When authorized, return bag house fines to the mix where the asphalt is introduced, using equipment to meter and uniformly add as a percentage of the total aggregate as established by the Engineer.

- 8. Scales for Hauling Units.** Furnish haul unit scales meeting Subsection 301.03.2(C) requirements.
- 9. Plant Scales.** Obtain the Engineer's approval for all weighing equipment. Use adjustable weigh equipment accurate to within 0.5 percent of the true weight throughout the use range.

Have available at least ten 50-pound (22.7 kg) weights for scale testing. Have scales inspected and sealed when requested.

Use beam scales with a telltale indicator for each size aggregate and a tare beam for balancing the hopper. The telltale indicator must begin moving when the weight is within 100 pounds (45.4 kg) of the desired weight. Poises must lock in any position and prevent unauthorized change.

Use vibration-free springless dial scales with dial numerals legible from a distance of at least 10 feet (3 m). The dial must be a compounding type with a full complement of index points and be in plain view of the operator. Pointers causing parallax errors cannot be used.

Replace scales failing to maintain positive adjustment.

10. Weigh System.

- a. Automatic Weighing.** Plant mix bituminous mixtures may be weighed with an automatic digital weigh system. Assure weigh accuracy to within plus or minus 0.5 percent of the true weight throughout the use range.

Include in the system an automatic printer that provides the following information:

- 1) Project No. (as shown on plans);
- 2) Item Name (as shown on detail estimate);
- 3) Date;
- 4) Time;
- 5) Ticket Number (consecutive);
- 6) Haul Unit No.;
- 7) Net tons (metric tons) in load, to nearest 0.05 ton (0.05 metric ton);
- 8) A subtotal of tons (metric tons) for each haul unit since the beginning of the shift; and
- 9) An accumulated total for all haul units since the beginning of the shift.

Use a pre-programmed printer or one equipped to prevent manual override of any weight information. Have the weigh system tested, certified, and sealed by the State Bureau of Weights and Measures after each plant move and before production for a project. Immediately stop production should the printer malfunction or breakdown and do not resume until corrected. Delivery of material

from storage or surge bins will be permitted only if the weight can be maintained within weigh specifications.

The Project Manager will randomly designate the re-weighing of loaded vehicles, at least 3 times per project, on an independent certified scale if one is within a 20 mile (32 km) round trip distance from either end of the project.

Re-test the plant weigh system any time the difference between the re-check and the plant system exceeds plus or minus 1 1/2 percent of the load. Any weight difference will be treated under Subsection 109.01.1.

- b. Manual Weighing.** The contractor may manual weigh and record weights instead of using an automatic digital weigh system. Manual weighing must include platform scales as specified in Subsection 301.03.2(C) and a competent weigh person and dump person.

Direct the weigh person to record, on Department furnished forms, weights to the nearest 100 pounds (45.4 kilograms) as well as other required information regarding delivery and placement.

Tabulate and furnish a machine tape for the total of the weighed material delivered and placed on the roadway each shift. Certify that weights and totals furnished are a true and correct record of materials delivered and placed in the work. Deliver the records and totals before 10:00 a.m. the next working day following the shift.

The Project Manager will randomly designate the re-weighing of loaded vehicles to verify the recorded weight at least once each day. Weight differences are treated under Subsection 109.01.1. Submit trucks weighing on platform scales for random taring at least twice each day.

- 11. Safety Requirements.** Install and maintain stairs, ladders, walkways, and all other plant facilities meeting state and federal safety requirements.

Provide access to the tops of truck bodies for taking samples and mix temperature data.

Maintain a safe and unobstructed route in and around the truck loading area.

- 12. Cold Feed Control.** Aggregate gradation may be controlled by a cold feed control system permitting hot mix plant operation without plant screens, excluding a scalping screen.

Feed each aggregate stockpile through a separate bin having a positive feed that can be accurately calibrated. Use a quick adjusting feed that maintains a constant, uniform flow throughout its calibration range.

Re-combine the aggregate in the mix design proportions in the cold feed process before it enters the dryer.

Batch and continuous flow plants operating without cold feed controls must have enough bins to store aggregate and permit recombining of the aggregate in the required proportions.

- 13. Burner Fuel Restrictions.** Approved fuels to heat and dry aggregates are as follows:

- Propane;
- Butane;
- Natural Gas;
- Fuel Oil (grades 1 and 2 only); and
- Coal.

EPA Specification - Used Oil Fuel (EPA-UOF) may be used instead of the approved burner fuels provided the Table 401-1 requirements are met.

**TABLE 401-1
EPA SPECIFICATION - USED OIL FUEL REQUIREMENTS**

PHYSICAL PROPERTIES	
Property	Range
API Gravity	20-28
Viscosity at 122 °F (60 °C) (Saybolt Flurol)	10-20
Pour Point °F (°C)	+10 (-12)
Flash Point, min. °F (°C)	100 (37.8)
Water by Distillation %	Under 1
Solids by Separation %	Under 1
Ash %	Under 0.4
Sulfur	Average 0.5%
Kinematic Viscosity at 100 °F (37.8 °C) (centistokes)	54-100
Kinematic Viscosity at 122 °F (60 °C) (centistokes)	15-75
CHEMICAL PROPERTIES	
Element or Compound	Permitted Level
Vanadium	Under 100 ppm (100 mg/L)
Cadmium	Under 2 ppm (2 mg/L)
Chromium	Under 10 ppm (10 mg/L)
Lead	Under 100 ppm (100 mg/L)
Arsenic	Under 5 ppm (5 mg/L)
Total Halogens	Under 1,000 ppm (1,000 mg/L)
PCB's	Under 2 ppm (2 mg/L)

Notify the engineer in writing at least 48 hours before using EPA-UOF. Furnish a copy of the most current tests certified by the supplier and showing compliance with physical and chemical requirements with the notice. Also certify that the plant burner is designed and equipped to properly preheat and burn EPA-UOF. The right to sample and test to verify certified test results is reserved.

Immediately stop using EPA-UOF fuel if burner flame-outs or other evidence of incomplete combustion or mix contamination are evident. Begin using one of the other approved fuels to complete the work. No claim for additional compensation will be considered or allowed.

B. Batching Plant.

- 1. Dryer.** Furnish plants having a dryer or dryers that continuously agitate the aggregate while heating and drying.

Equip the dryer with a mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument with a dial scale. Locate the thermometer at the dryer discharge chute so it automatically registers the heated aggregate temperature.

Fully enclose the material transfer or conveyance from the dryer to the mixer.

- 2. Screens.** Use plant screens that have a storage capacity exceeding the mixing units full capacity.
- 3. Bituminous Control.** Assure the bituminous measuring equipment is accurate to within plus or minus 0.3 percent of the true measure.

Equip the plant with a heated, quick-acting, no-drip charging valve located directly over the bituminous material bucket. The bucket must deliver the heated bitumen in a thin, uniform sheet or in multiple streams over the mixing units full width.

- 4. Mixer Unit.** Use a mixer capable of producing a uniform mixture within the job-mix tolerances.

Enclose or hood the mixer box to prevent dust loss.

Equip the mixer box with a lock-timing device that controls the mixing cycle.

- 5. Aggregate Sampling Device.** Provide a sampling device that samples dried aggregate when the plant is operated with plant screens.

When cold feed controls are used, provide a sampling device for taking a composite sample at a point just before the aggregate enters the dryer.

Maintain a constant aggregate feed rate when samples are taken.

Split the sampled material to the size specified in MT 202.

C. Continuous Mixing Plant.

- 1. Aggregate Control.** Assure the cutoff system automatically stops mixing when the minimum bin level is reached. Equip each bin with an overflow to control the top aggregate level.

Equip the plant with bypass gates for collecting individual box test samples for calibrating gate openings.

Provide a platform scale with a 500-pound (227 kg) capacity and containers for weighing test samples.

- 2. Dryer.** Furnish a dryer meeting Subsection 401.03.2(B)(1) requirements.
- 3. Screens.** Furnish screens meeting Subsection 401.03.2(B)(2) requirements.
- 4. Bituminous Control.** Use a rotating, positive-displacement volumetric proportioning bituminous metering pump with nozzles at the mixing unit. The pump operating capacity must be synchronized with the aggregate flow to the mixing unit by a positive, automatic, adjustable interlocking control. Provide equipment for accurately checking the bitumen flow rate into the mix.
- 5. Mixing Unit.** Equip the plant with a continuous mixer to produce a uniform mix within the job-mix tolerances.

The units paddles must be adjustable and reversible to retard the mix flow.

Assure the mixer has the manufacturer's plate stating the mixer's net volumetric content at the heights inscribed on a permanent gauge. Provide charts showing the aggregate feed rate per minute for the aggregate being used.

Equip the discharge hopper with dump gates that permit rapid and complete mix discharge.

- 6. Aggregate Sampling Device.** Furnish an aggregate sampling device meeting Subsection 401.03.2(B)(5) requirements.

D. Dryer Drum Mixing Plant.

- 1. Cold Feed Control.** Furnish a feed control meeting Subsection 401.03.2(A)(12) requirements.
- 2. Calibrated Cold Feed Proportioning.** Calibrate the cold feed to provide full mix gradation control.
- 3. Weight Measurement of Aggregate.** Positive weight measurement of the combined cold feed must regulate the feed gate and permit automatic correction for load variations.
- 4. Synchronization of Aggregate Feed and Bituminous Material Feed.** Synchronize the bituminous feed control with the total aggregate weight-measurement device to

provide a uniform asphalt percentage in the mix. It must automatically compensate for weight variations in the cold feed coupled with the aggregate moisture content.

5. **Aggregate Sampling Device.** Provide a sampling device that will take a composite sample just before the aggregate enters the dryer drum mixer.

Maintain the aggregate feed rate during sampling. Split the sampled material to between 30 (13.6 kg) and 50 pounds (22.7 kg).

6. **Hydrated Lime or Mineral Filler Feed System.** Introduce dry hydrated lime and mineral filler into drum dryer mixing plants just below the asphalt introduction point.

The system must provide positive, accurate material feed and be automatically synchronized to the aggregate feed. The system must indicate the weight entering the mixing unit on a time-coordinated basis.

Weigh using an automatic indicating electronic system. The lime or mineral filler may be weighed directly, or the storage container including lime or mineral filler may be weighed.

Provide a continuous digital readout showing the weight or rate of feed in tons (metric tons) per hour. Record the information using a production monitor/recorder system or by a de-cumulating balance ticket printing system. Record the information at minimum five-minute intervals or as directed.

Silo or storage container system weights will not be used for acceptance during filling or transfer. Limit filling or transfer periods to 1 hour per 3 hours of plant operation. Record and provide start and finish times for filling or transfer and the total quantity added.

Suspend mixing for erratic feeding or failure to feed hydrated lime or mineral filler to within 20 percent of the job mix formula. Do not resume until corrected or repaired.

7. **Flow Rate Meter.** Measure the asphalt cement discharged into the mixing unit using a flow rate meter with totalizer and temperature compensation.

The totalizer is to record 1,000,000 gallons (3,785,000 L) and be certified to a plus or minus 0.20 percent of the measured quantity.

Use a flow rate meter and totalizer that automatically corrects to a temperature of 60 °F (16 °C) with an operating range of +60 °F (16 °C) to +450 °F (232 °C).

Locate the totalizer readout in the plant control room so it is readily accessible to the Inspector.

The flow rate meter must automatically shut off any time asphalt is diverted or stops entering the mixing unit.

Calibrate the flow rate meter and totalizer before the start of the project and as necessary during production. The Project Manager will witness the calibration.

Provide the equipment and assistance for initial and subsequent calibration checks and furnish a copy of all calibration checks.

Use a calibration volume of at least 3,000 gallons (11,355 L). Use weigh scales that have been tested and certified.

Furnish a test report showing the asphalt's specific gravity.

Spot check failure will require re-testing and certification above. The Project Manager will establish the spot check interval.

8. **Production Monitor - Recorder.** Use recording equipment that automatically monitors and records on a time coordinated basis, the aggregate, lime or mineral filler, and asphalt weight entering the mixing unit. The records may be continuous (chart recorder) or digital printout.

Chart recorders must clearly record asphalt content changes of 0.1 percent or more and aggregate feed rate changes of 1.5 percent or more.

Digital printout equipment must record the day's total production at minimum five-minute intervals, or the interval directed by the Project Manager.

Digitally display the aggregate and asphalt rates in tons (metric tons) per hour and daily totals. Display lime or mineral filler by tons (metric tons) per hour or on a de-cumulating balance.

The monitor system must operate on unprocessed signals from measuring devices.

Provide continuous access to the recorder during production.

Submit the permanent record.

Failure to maintain asphalt content within the specified tolerance is grounds to suspend production until corrected. This provision does not apply to the first 15 minutes after each day's first start-up.

Operate the production/monitor recorder at all times during production. Stop production when the recorder is not operational.

E. Storage and Surge Bins.

- 1. General.** Hot bituminous mix storage or surge bins may be used for balancing production capacity with hauling and placing capacity.

Discontinue use of hot mix storage or surge bins that cause segregation, adverse mix heat loss, or adversely affect the bituminous mix quality.

Dispose of all rejected mix at Contractor expense.

- 2. Low-level Indicator.** Equip storage or surge bins with an automatic low-level indicator that signals when the mix level drops below the discharge cone or the minimum level specified by the manufacturer.

Mix discharge during low level indication is permitted for emptying the bin at the end of shifts.

- 3. Loading and Unloading.** Equip storage or surge bins with a batch hopper or rotating chute to reduce segregation during loading. The batch hopper gates must be interlocked with the mix discharge gates to keep the batch gates closed during mix discharge. Suspend production for equipment failure or improper operation.

- 4. Storage Time.** The Project Manager will establish the maximum bin storage time. Initially, a maximum bin storage time of two hours without discharge is permitted until data and experience is available to establish the maximum permissible storage time.

Empty all bins each day at the close of work.

F. Roadway Equipment.

- 1. Pavers.** Spread plant mix pavement, shape, and finish using one or more self-contained, self-propelled pavers operated without supplemental spreading, shaping, or finishing equipment to produce the specified work.

Equip pavers with an integral activated screed or strike-off assembly, heated if necessary.

Spread and finish the surfacing course to at least a full lane width and from 3/4 to 6 inches (19 mm to 150 mm) in depth.

Use extension and cut-off shoes in minimum 1-foot (305 mm) increments. Screed extensions must have an equal length of auger extension.

The screed or strike-off assembly must not tear, shove, or gouge the paved surface.

Equip pavers to automatically control the transverse slope and screed elevation using a sensing device at either side of the paver, receiving grade information from an independent grade-line control or the midpoint of a mobile grade reference.

Mount the sensing unit to receive grade information at 15 to 50 percent of the length of the leveling arm ahead of the screed. Furnish a commercially manufactured mobile grade reference recommended by the paver manufacturer.

Use a mobile grade reference device at least 40 feet (12.2 m) long to place the first lane or strip of each plant mix pavement lift. The remaining lanes or strips of each pavement lift may be placed with a mobile grade reference with an effective length of at least 10 feet (3 m), with an adjacent lane or pavement strip as the gradeline reference.

Maintain the transverse slope at all times and have controls to adjust the slope throughout super-elevated curves.

If the automatic controls fail, paving may be finished, not to exceed four hours, using manual controls, if the specifications can be met. Repair the automatic controls before starting the next paving shift. Automatic controls may be waived on irregular sections.

Provide an attachment for forming beveled edges on surfacing courses when required.

Pavers must be able to ascend a seven percent grade while pushing a loaded truck, have quick, positive steering and operate at speeds commensurate with the mix delivery rate to allow uniform placement and prevent interrupted paver operation.

The plant mix material may be dumped directly into the paver hopper or windrowed ahead of the paver.

The paver hopper capacity must permit the paver to maintain its speed while receiving loads.

2. **Trucks.** Truck haul beds must be tight, clean, smooth and free of cleaning agents before hauling material.

Do not use trucks that cause segregation, delays, or have oil leaks.

When directed, cover each load with canvas or other approved material to protect the mix.

3. **Rollers.** Furnish rollers equipped with drum cleaning devices and a watering system that evenly wets the roller surface.

Do not use steel rollers having flat spots, grooves, or projections that mar or injure the pavement surface.

Remove rollers that crush the paving aggregates.

401.03.3 Aggregate Production, Testing, and Acceptance

- A. **General.** Furnish aggregates meeting the approved job mix target values within tolerances at the point of bituminizing.

Be responsible for all sampling, testing and controlling aggregate gradations, mechanical fracture, and volume swell during aggregate production. Establish a quality control plan using generally recognized procedures.

- B. **Acceptance Sampling and Testing.** Acceptance sampling will be by Subsection 401.03.1(C).

1. **Mechanical Fracture and Volume Swell.** Mechanical fracture tests will be by MT-217. Volume swell tests will be by MT-305.

2. **Aggregate Gradation.** The Project Manager will randomly select gradation test samples.

The approximate quantity represented by each sample is 600 tons (600 mt). Additional samples may be selected and tested at the Project Manager's discretion.

The quantity represented by five samples or approximately 3000 tons (3000 mt) constitutes a lot whenever production schedules and material continuity permit. The Project Manager may establish a lot quantity represented by three to seven consecutive random samples when there are short production runs, significant material changes, or other unusual characteristics of the work.

Gradation tests are by MT-202.

C. Acceptance.

- 1. Fracture and Volume Swell Requirements.** The aggregate will be evaluated for mechanical fracture and volume swell requirements using the test results taken on samples selected by the Project Manager.

Results are acceptable if the average of all tests is within the specified limits and not more than one test out of any five consecutive tests is outside these limits.

Do not begin plant mix operations until stockpiled aggregates meet these requirements.

- 2. Gradation Requirements.** Plant mix pavement is evaluated for gradation requirements on a lot-by-lot basis. Acceptance is made under Subsection 105.03.2

401.03.4 Preparation of Aggregate

- A. General.** Have enough material stockpiled for at least one day of plant mix operations.

Do not charge the mixing plant with aggregates directly from crushing or screening plants or a combination of these plants.

Proportion and uniformly blend blending material (not mineral filler), when required, with the aggregate.

- B. Batch and Continuous Flow Plants.** Dry and heat aggregates in the dryer within the mix design temperature range.

The aggregate temperature, when introduced into the mixing unit, must not exceed 325 °F (163 °C).

Adjust flames for drying and heating to prevent aggregate damage and not leave visible unburned oil or carbon residue on the aggregate.

If the bituminized mixture shows excess moisture, such as foaming on the coarse aggregate, excessive mix slumping in the truck, condensed water dripping from the truck box, bubbles or blisters forming on the surface immediately behind the paver, or any other visual indications, make adjustments to lower the moisture content.

401.03.5 Preparation of Bituminous Mixture

- A. All Plants.** Store mineral filler or hydrated lime in a separate bin and feed directly into the mixing unit or weigh box. Use a uniform feed rate.

If mineral filler is not weighed with the other aggregates in the weigh box at the mixing plant, determine the mineral filler proportion on a weight basis, measured separately from the other aggregates. After the mineral filler proportions have been determined, the material may be added to the mix by volume or weight measurement.

Mix to produce a homogeneous mixture. Assure all aggregates are thoroughly and uniformly coated with bitumen.

Remove, dispose of, and replace any mix that is damaged by burning, improper mixing, or not meeting specifications at Contractor expense.

Maintain the bituminous mix discharge temperature between the specified lower mixing temperature and the greater of:

- 1** The upper mix design temperature; or
- 2.** 325 °F (163 °C).

The discharge temperature will be periodically checked and recorded. Maintain a discharge temperature within plus or minus 10 °F (5.5 °C) of the specified temperature.

The average of any three checks must be within the specified limits.

Suspend plant operations when mix temperatures exceed these limits.

B. Batch and Continuous Flow Plants.

1. **General.** Measure and convey the hot aggregate into the mixing unit meeting the specified gradation. Introduce the aggregate at a temperature:
 - a. Not to exceed 225 °F (107 °C) when cutback liquid asphalt is used; or
 - b. Not to exceed 325 °F (163 °C) when asphalt cement or slow-curing liquid asphalt is used.

Do not introduce asphalt into the mixing unit at 25 °F (14 °C) or more below the aggregate temperature.

Assure the bituminous mix is within the specified temperature range in the data on "temperature-viscosity", furnished for the bituminous material used.

2. **Mixing Time.** Mix for at least 25 seconds or the time specified by the Project Manager. Mixing time, in seconds, for continuous flow plants equals "pugmill dead capacity in pounds (kilograms)" divided by "pugmill output in pounds (kilograms) per second".

401.03.6 Surface Conditions, Weather Limitations, and Paving Dates

Stop plant mix paving when the surface temperature is less than 35 °F (2 °C), the surface is wet, the roadbed is unstable, or the Project Manager determines adverse weather conditions prevent the proper handling, finishing, or compacting of the mix. Suspend all paving work by November 1st.

Complete all sections of plant mix pavement, to be open to traffic during winter suspension, to the full plan width and thickness, excluding seal coating. Complete this work meeting the contract requirements before the November 1st paving cessation date.

The Project Manager will suspend time assessment between November 1st and November 16th when the next scheduled significant work item is paving and all grading, gravel and other operations affecting the safe and convenient use of the roadway by the traveling public are complete.

Submit a written request to the Engineer and obtain written approval to pave after November 1st.

Plant mix surfacing placed after November 1st and before April 15th is at the Contractor's risk and subject to the following conditions.

1. The surface temperature to be paved is at least 35 °F (2 °C), measured by the Project Manager.
2. All applicable specifications are met.
3. Make permanent repairs and restore partially completed pavement to the required profile, section, and condition at Contractor expense before placing any remaining lifts.
4. This is not a waiver by the Department of any other contract requirement regarding the work sequence or traffic operation.

If the paving operation causes transverse joints spaced at less than one half mile (805 m), suspend paving work until the next April 15.

No payment is made for the plant mix or asphalt on progress estimates between November 1st and April 15th for partial width or thickness. Promptly repair damage to all partial width or thickness of plant mix surfacing used by traffic during this period for any reason including suspension of work due to adverse weather.

Provide all required interim traffic striping and traffic control on partially completed pavement at Contractor expense.

Failure to promptly make repairs and provide interim striping and traffic control is cause for the Department to perform or have the work performed and deduct the cost from monies due or that may become due the Contractor.

Payment for partial width or thickness pavement in acceptable condition will be made on the estimates following the end of the period on the next April 15th.

These requirements apply when the Project Manager gives written approval to the Contractors request that a portion of the planned width or thickness be placed between November 1st and April 15th of the next year.

401.03.7 Existing Surface Preparation

Perform existing surface preparation meeting Section 204 requirements.

401.03.8 Prime and Tack Coat

Apply prime and tack coat meeting the applicable requirements of Sections 407 and 410 and the contract.

Apply prime coat as directed before placing the plant mix.

Allow the prime coat to cure at least 24 hours before placing the plant mix unless otherwise approved.

Do not place plant mix on any primed surface containing free moisture, as determined by the Project Manager.

Apply tack coat on existing pavement to be overlaid and between lifts when plant mix pavement is constructed in multiple lifts.

401.03.9 Protection of Traffic and Roadway Structures

A. Traffic Protection. Place traffic control devices meeting Section 618 requirements, and the approved traffic control plan.

At the end of each day's work, and when not in use, park all equipment at least 30 feet (9.2 m) from the outside edges of the traveled lane.

B. Protection of Roadway Structures. Protect roadway structures meeting Subsection 410.03.9 requirements.

401.03.10 Spreading and Finishing

Place and spread the mix to the widest practical width on the approved surface. Place shoulder-widening material with approved equipment.

Transport and place the bituminous mix with the least possible segregation. Remove and replace segregated pavement areas behind the paver with specification material before initial rolling begins. Correct all segregated areas at Contractor expense.

Place plant mix surfacing in compacted lifts not exceeding 0.20 feet (60 mm) thick; plant mix bituminous base in compacted lifts not exceeding 0.35 feet (110 mm); and plant mix base riding course not exceeding 0.25 feet (75 mm) thick.

Establish and maintain horizontal line control for paving. The Engineer will furnish the Contractor the necessary survey notes to establish these controls. Maintain the paving control line tolerance within 0.25 foot (75 millimeters) of a true line from the existing reference points using standard surveying practices.

Failure to maintain the paver control line within the specified tolerance is cause for corrective action or pavement removal and replacement, as directed by the Engineer, at Contractor expense.

Include the cost of furnishing horizontal line control in the plant mix pavement bid item.

Set a string line using the alignment control to establish one edge of the first lane of each surfacing lift. Remove all string line used for the final lift after use.

On small or irregular areas, approaches, turnouts, around manholes, inlets, walls, and on other areas not readily accessible to a paver, plant mix material may be spread to the specified thickness by special pavers or other approved methods. Compact these areas as directed.

Place plant mix pavement at bridge ends using wire line grade control meeting the applicable requirements of Subsection 411.03.5.

Non-Interstate two lane plant mix pavements may be opened to traffic or to haul units when the mat is compacted and cooled.

Four lane routes may be opened to traffic and haul units when the mat is compacted and the surface cools to 140 °F (60 °C).

401.03.11 Constructing Joints

Continuously place each lift and provide at least a 6-inch (150 mm) offset between longitudinal joints in successive lifts. Offset transverse joints in successive lifts by at least 6 feet (1.8 m).

Correct joints not meeting the surface tolerance requirements to Subsection 401.03.14 requirements.

Uniformly coat the exposed face of all joints, excluding those formed by echelon paving, with SS-1 emulsified asphalt or other approved bitumen just before placing the abutting course.

Construct longitudinal joints in the top lift of plant mix at the centerline or lane line. If these locations are not practical, construct the joint outside the wheel paths.

Construct a vertical transverse joint the full lift depth if the mix cools below 175 °F (80 °C) before placing additional mix. Remove loose material, brush the joint face with asphalt, and compact the fresh mix against the joint face when paving is resumed.

Bevel the paving lift ends on roadways under traffic at a 20:1 ratio. When paving of the lift resumes, construct transverse joints.

When the compacted thickness exceeds 3/4-inch (19 mm), taper longitudinal joints with a 5:1 slope or flatter. Do not permit an exposed longitudinal joint length to exceed one day's paving run. Compact the joint to a minimum 95 percent of Marshall density.

Sign the new pavement end at the close of work each day meeting the traffic control plan and contract.

Construct joints at bridge ends or other rigid structures after the existing base is prepared and compacted. Apply a coat of SS-1 emulsified asphalt to portions of structures abutting the plant mix pavement.

401.03.12 Compaction, Compaction Control Testing, and Acceptance Testing

A. Compaction. Once the plant mix is spread, struck off, and surface irregularities are corrected, compact the plant mix to at least 95 percent of the established target density. Compact and finish without displacing, over-compacting, cracking, or shoving.

Complete compaction rolling before the mat temperature falls below 175 °F (80 °C). Compaction rolling after the temperature is below 175 °F (80 °C) is cause to suspend paving operations. Compaction rolling is rolling in the vibratory mode. The Project Manager may increase the minimum 175 °F (80 °C) temperature when compaction rolling damages the new pavement.

Begin finish rolling immediately after compaction rolling and continue until roller marks are eliminated. Complete finish rolling the same day the mix is placed.

Correct any pavement displaced due to roller direction changes or other causes before final compaction.

Remove and replace any mix that is segregated, loose and broken, mixed with dirt, or is defective with fresh hot mix and compact at Contractor expense.

- B. Leveling, Patching, and Thin Lifts.** Subsection 401.03.12(A) does not apply to initial plant mix lifts used for leveling ruts, sags, or other existing surface defects that are less than 0.10 foot (30 mm) thick.

Perform initial rolling using oscillating-axle pneumatic-tired rollers with a minimum 20 ton (18 mt) operating weight and not less than 250 pounds (113.5 kg) per inch (25 mm) width of tire tread. Perform finish rolling meeting the requirements of Subsection 401.03.12(A). Compact the material to the density specified by the Project Manager.

- C. Compaction Control Testing.** Perform all necessary density testing to control compaction.
- D. Acceptance Testing.** The pavement density is determined at randomly selected locations after all rolling is complete and before the roadway is open to traffic. The density is determined using MT-212 and MT-313. The core correlation is added to all nuclear density test results.

The density is divided by the Field Marshall Target density currently in effect to arrive at a percentage. The Field Marshall Target density for the mix is established by the Project Manager from the test results using MT-311.

The Project Manager will select the test locations using random selection based on the tons (metric tons) of mix placed. Areas within 1 foot (305 mm) of a free edge or where the nominal thickness is less than 0.10 foot (30 mm) are excluded from testing.

The approximate mix quantity represented by each test is 600 tons (600 mt). Additional tests may be made at the Project Manager's discretion. The quantity represented by five tests or approximately 3,000 tons (3000 mt) of mix constitutes a lot whenever production schedules and material continuity permit. The Project Manager will establish a lot represented by three to seven consecutive random samples when there are short production runs, significant material changes, or other unusual characteristics of the work.

- E. Acceptance.** Plant mix surfacing is evaluated for density on a lot-by-lot basis under Subsection 105.03.2, except as noted in Subsection 401.03.12(B).

401.03.13 Pavement Repair

Cut out the defective pavement to a minimum 1-inch (25 mm) depth. Clean the sides and bottom of the hole and apply approved bitumen to the surfaces. Fill the hole with fresh mix, level, and compact to the specified density and surface smoothness.

401.03.14 Surface Tolerances

Finish the surface of each final lift to the specified grade and cross section. Table 401-2 values specify the maximum allowable variance and divergence from the mean constructed grade:

TABLE 401-2
MAXIMUM ALLOWABLE VARIANCE AND DIVERGENCE

SURFACE	TOTAL VARIATION	RATE
New Plant Mix Bituminous Surfacing	0.02 foot (6 mm)	0.20%
Plant Mix Overlays (2 or more planned lifts)	0.03 foot (9 mm)	0.30%
Plant Mix Overlays (less than 2 planned lifts)	0.03 foot (9 mm)	No rate

The rate is applicable only to the longitudinal direction.

New plant mix bituminous surfacing includes the plant mix seal.

The mean constructed grade for each section is the planned grade or a grade parallel to plan grade, acceptable to the Engineer.

Surfaces will be checked for compliance at joints, bridge ends, and other sections where ride characteristics or other evidence indicates surface tolerance is outside the specifications.

Surface smoothness is measured longitudinally in 100-foot (30.5 m) sections at 10-foot (3 m) intervals, and transversely at 4-foot (1.2 m) intervals. Correct out of specification plant mix bituminous surfacing by any method approved by the Engineer, including cold milling at least 0.12 foot (38 mm) deep, the full width of the defect but not less than the paver width and for 50 feet (15.2 m) each side of the defective pavement. Fill the milled area with like material and compact to the specified density.

The corrected pavement and adjoining surface must meet the smoothness specifications.

The Contractor will be notified of sections to be corrected within three working days after the surface was placed or the final day of paving. Perform all corrective work at Contractor expense.

Transverse joints in lifts of plant mix surfacing or other lifts to be used by traffic for 15 days or more must not vary more than 3/8-inch (10 mm) from any point on a taut 25-foot (7.6 m) string line placed parallel to centerline. Plant mix seal courses must not vary by more than 3/16-inch (5 mm).

New surfaces will be checked for a minimum of 100 feet (30.5 m) by placing the string line in half-length increments along the roadway in traffic lanes.

Corrected areas including new joints will be checked for meeting the surface tolerances.

401.03.15 Rumble Strips

Cut the rumble strips into the finished plant mix pavement. Use a machine equipped with a rotary type cutting head capable of making the cuts to the dimensions and pattern shown in the Detailed Drawings.

Establish a control line and locate the rumble strips on the shoulder 6-inches from the outside edge of the travel lane. The offset may be adjusted to avoid longitudinal pavement joints. Do not place rumble strips where concrete median barrier rail or other roadside features prevent placement as specified.

Apply a fog seal to the finished rumble strips. Use SS-1 or CSS-1 emulsion for the fog seal. Dilute the emulsion with water at a 1:1 ratio and apply at 0.05 to 0.15 gallons per square yard (0.20 to 0.60 liters per square meter).

Keep traffic off the fog seal until the emulsion has cured to no-track.

Apply the fog seal to the rumble strip for each lane in the direction of travel for that lane.

Produce the rumble strips without tearing and snagging the pavement.

Remove and dispose of the waste material meeting all applicable local, state, and federal regulations.

401.04 METHOD OF MEASUREMENT

401.04.1 Plant Mix Pavement

Plant mix pavement is measured by the ton (metric ton) on approved scales after complete mixing of all ingredients. The pay weight includes the bituminous material and any mineral filler or hydrated lime in the mixture.

401.04.2 Bituminous Material

Bituminous material is measured by the U.S. gallon (Liter) or the ton (metric ton), as specified, under Subsection 402.04, excluding anti-stripping additive.

401.04.3 Mineral Filler

Mineral filler is measured by the ton (metric ton) under Subsection 109.01.

401.04.4 Hydrated Lime

Hydrated lime is measured by the ton (metric ton) under Subsection 109.01.

401.04.5 Anti-stripping Additive

Anti-stripping additive is measured for payment based on invoice prices.

401.04.6 Rumble Strips

Rumble strips are measured by the mile (kilometer) to the nearest tenth of a mile (tenth of a kilometer) along the centerline of the roadway, less all gaps in the rumble strips due to ramp terminals, objects, etc. Each individual line of rumble strips is measured separately.

Fog seal for rumble strips is measured by the undiluted gallon of SS-1. The quantity shown in the contract is an estimate of undiluted SS-1 needed to complete the work and is calculated using an application rate of 0.05 gallons per square yard (0.20 liters per square meter) and an applied width of 24 inches (600 millimeters).

401.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Plant Mix Pavement	Ton (metric ton)
Bituminous Material	Gallon (liter) or Ton (metric ton)
Mineral Filler	Ton (metric ton)
Hydrated Lime	Ton (metric ton)
Anti-stripping Additive	Ton (metric ton)
Rumble Strip	Mile (kilometer)
Emulsified Asphalt SS-1	Gallon (liter)

Payment will not be made for any claim for rejecting any batch or load of mix containing bituminous material varying more than 0.3 percent from the established percentage in the job mix formula. The contract unit price for rumble strips will be adjusted as shown in Table 401-3:

**TABLE 401-3
PRICE ADJUSTMENTS DUE TO LINE DEVIATIONS**

LINE DEVIATION FROM THE TRUE LINE	PRICE ADJUSTMENT
0.0 feet to 0.15 feet (0 to 50 mm) in 500 feet (152 m)	None
0.15 feet to 0.25 feet (50 mm to 75 mm) in 500 feet (152 m)	50% price reduction
Greater than 0.25 feet (75mm) in 500 feet (152 m)	Correct as directed

Mineral filler and hydrated lime used in the work but not specified in the contract is paid for at an agreed price under Subsection 109.04.

Furnish certified copies of invoices to support the prices for mineral filler, hydrated lime, and anti-stripping additives.

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

SECTION 402 BITUMINOUS MATERIALS

402.01 DESCRIPTION

This work is the furnishing and applying bituminous materials, on bases and surfacing.

402.02 MATERIALS

Furnish bituminous materials meeting Section 702 and the contract requirements.

402.03 CONSTRUCTION REQUIREMENTS

Mix and apply bituminous material meeting the applicable requirements in Sections 401, 406, 407, 409, and 410.

402.03.1 Materials Source

Obtain the Engineer's approval of the bituminous source before delivering the material to the project. Do not change the source of supply once work is started, without the Engineer's written approval.

402.03.2 Sampling

- A. General.** Take bitumen samples, other than products accepted under quality assurance, at the point of delivery on the project.

The Contractor or designated representative is responsible for sampling the bituminous materials on the project using MT-302.

Drain off and discard at least 1 gallon (3.8 L) of the bituminous material before drawing samples.

Draw two one-quart (0.9 L) samples from each shipment, witnessed by the Project Manager. Forward one sample for testing and retain the second sample for use as specified in Subsection 702.02.

Equip all transport vehicles with a spigot or gate valve in the unloading line, or in the tanker at the centerline of the tank, or in the pressure line from the unloading pump, or at another approved location. The spigot or gate valve diameter must be between 3/8-inch (9.5 mm) and 3/4-inch (19 mm). Locate the spigot or valve to prevent plant dust or other sample contamination.

- B. Asphalt Sampling (Quality Assurance Sampling).** Sample asphalt cement for plant mix surfacing and base and plant mix seal course using a sampling device located in the line between the storage facilities and the mixing plant.

Provide a sample of the asphalt cement entering the mixing plant. One approved in-line sampling device is shown in ASTM D 140.

Place the samples in Department furnished containers. Give the samples to the Project Manager immediately after sampling.

The Project Manager will randomly designate the time of sampling based on the tons (metric tons) of completed mix produced. The approximate quantity of mix represented by each sample is 500 tons (500 mt). The Project Manager may require additional samples and testing.

Six samples represent approximately 3000 tons (3000 mt) of mix and constitute a lot whenever production schedules or material continuity permit. The Project Manager may establish a lot consisting of the quantity represented by any number of consecutive random samples, from three to seven inclusive, when necessary to represent short production runs, significant material changes, or other unusual characteristics of the work.

402.03.3 Shipping

Ship the bituminous material in clean, uncontaminated, fully insulated cars or trucks, sealed by the supplier after loading.

402.03.4 Testing

Bituminous materials are accepted on the test results of samples selected and tested under Subsection 702.02 by the Department or its authorized representative.

402.03.5 Acceptance

- A. General.** Provide the Project Manager a copy of the original bill of lading and a copy of the certificate of compliance, with each shipment. Assure the certificate is signed by the supplier's representative and attests that the bituminous material meets the Department's specifications for the type and grade of material provided and that the shipping container was inspected and found free of contamination. The certificate of compliance is the basis for tentative material acceptance and use.
- B. Asphalt Cement Penetration (Quality Assurance).** Asphalt cement for bituminous plant mix surfacing and base, and plant mix seal course is tested for penetration on a lot-by-lot basis. Acceptance is by Subsection 105.03.2. Asphalt cement with an anti-stripping additive is not evaluated under this provision.

The asphalt cement quantity in a lot, used for calculating the amount of price reduction, is based on the job mix target value of asphalt for that lot and the total tons (metric tons) of completed mix in the lot.

- C. Failures Other than Asphalt Cement Penetration (Non-quality Assurance).** If a shipment of bituminous material fails to meet any of the specifications, other than penetration, after the tolerances in Subsection 702.02 are applied, the material may be accepted at a 10% price reduction of the bituminous material cost.

If a shipment fails to meet any one of the specifications after twice the allowable tolerances have been applied, the price reduction will be 25 percent of the bituminous material cost.

If a shipment fails to meet any one of the specifications after triple the allowable tolerances have been applied, the Engineer may reject the material and require its removal from the work, or the Engineer may accept the material at a 50 percent price reduction of the cost of the bituminous material.

The cost of the bituminous material for calculating price reductions is the material's contract unit price.

If a shipment fails more than one of the specifications, the failure causing the largest percentage price reduction is assessed.

402.03.6 Loading and Application Temperatures

The Project Manager will designate the recommended application temperature ranges using Table 402-1.

Do not heat bituminous mix any higher than is necessary for proper hauling and placing.

Do not introduce aggregate into a mixer higher than 25 °F (14 °C) above the bituminous material temperature.

Furnish the Project Manager with data on the temperature-viscosity relationship of each asphalt to be used on the project. The data must cover the recommended temperature range and viscosities at which the asphalt may be used. The Project Manager will use this data to specify the temperature at which the material will be used.

**TABLE 402-1
RECOMMENDED APPLICATION TEMPERATURES
FOR BITUMINOUS MATERIALS**

LIQUID ASPHALTS - RC, MC and SC				
Grade	Loading Temp. Max.¹ °F (°C)	Spraying Temperature	Mixing Temp. of Aggregates for MC & SC Liquid Asphalts	
			Min. °F (°C)	Max. °F (°C)
70	195 (91)	As required to achieve viscosity of 50-200 centistokes (25-100 Sec. Saybolt Furol) ²	90 (32)	155 (68)
250	245 (118)		125 (52)	200 (93)
800	275 (135)		160 (71)	225 (107)
3000	310 (154)		200 (93)	260 (127)

EMULSIFIED ASPHALTS				
Grade	Mixing Temperature		Spraying Temperature	
	Min. °F (°C)	Max. °F (°C)	Min. °F (°C)	Max. °F (°C)
Slow and Medium Setting	50 (10)	130 (54)	50 (10)	130 (54)
Rapid Setting	125 (52)	185 (85)	120 (49)	160 (71)

ASPHALT CEMENTS		
Grade	Mixing Temperature	Spraying Temperature
		Max. °F (°C)
All Penetration Grades	Established by Project Manager	350 (177)

Notes:

1. Line Temperatures
2. See Temperature - Viscosity Charts (MT-308)

402.03.7 Alternate Type or Grade of Bituminous Materials

The Engineer may change or substitute, in writing, the type and grade of bituminous material specified.

Payment for the changed or substituted bituminous material is the contract unit price for the type and grade of bituminous material plus or minus the difference in Contractor's cost at the refinery between the specified and substitute type and grade.

402.03.8 Performance Graded Asphalt Binder (PGAB)

Furnish Performance Graded Asphalt Binder (PGAB) meeting Table 702-9 requirements for the binder specified in the contract. PG 64-28, PG 64-34 and PG 70-28 binders, after aging in the rolling thin film oven, and testing under AASHTO T-51 must meet the following:

- Pull Rate: 2 inches per minute (5 cm per minute);
- Sample Temperature: 77 °F (25 °C); and
- Ductility: 1 foot (30 cm) minimum.

Notify the Project Manager in writing before making changes to the PGAB components.

- A. Test Results.** Provide current test results for all PGAB requirements for material furnished.

Furnish the PGAB test data with the first delivery and for each 2,000 tons (2000 mt) delivered to the project.

- B. PGAB Shipping, Handling, and Storage.** Ship, handle, and store the PGAB following the supplier's requirements. Furnish a copy of the requirements before delivering the PGAB to the project. Ensure that the supplier's requirements are consistent with the material manufacturers. PGAB exhibiting separation, crusting, or foaming during delivery or in storage tanks will be rejected.

- C. Sampling.** Sample the PGAB meeting subsection 402.03.2(B). A sample is two one-pint (two 500 ml) containers of PGAB.

- D. Acceptance.** The Department will grade samples representing each lot using the PGAB grading system, and Table 702-9, with duplicate containers retained for testing in case of dispute. PGAB is accepted under Subsection 105.03.2 using an 'F' factor of 4. The "P" value is determined for the high temperature components of the resulting grade (i.e. 64, 58, etc.) using the formula:

$$P = (TL + aR - Xn) \times F$$

The "P" value is determined for the low temperature component of the resulting grade (i.e. -34, -28, etc.) using the formula:

$$P = (Xn + aR - Tu) \times F$$

Positive 'P' value is added to determine the lot's total price reduction. No disincentive will be assessed for 'P' values less than 13, based upon MDT's initial grading. This disincentive exclusion in 'P' value will not be applied to averaged results described below.

If the calculation results in a price reduction ('P' value of 13 or greater), the Contractor may make a written request for an independent laboratory to grade the duplicates for the lot in question. Ensure the Department receives the written request within 30 calendar days of the notification of price reduction. The Contractor and the Department will agree upon the choice of independent laboratory before release of the duplicate samples for testing. The independent laboratory results will be averaged with the results provided by the Department. The averaged results are binding on both parties for acceptance and payment of the material in question. The 'P' value will be calculated based upon the averaged results, with no exclusion allowed for results less than 13. Pay the cost of the duplicate testing, on a per lot basis, if the price reduction is confirmed or increased. The Department will pay the cost of the duplicate testing, on a per lot basis, if the price reduction is reduced.

The ductility requirement has no tolerance. Immediately stop paving if the binder fails the ductility requirement. Do not start paving until binder meeting the specifications is furnished.

402.04 METHOD OF MEASUREMENT

Bituminous material is measured by the gallon (liter) or the ton (metric ton), as specified in the contract.

If measured by the gallon (liter), the volume of bituminous material is determined at a temperature of 60 °F (15.6 °C) or corrected to this using the appropriate group table designated in the ASTM D 1250 volume correction tables. Transport bituminous materials measured by the gallon (liter) in tanks certified as to capacity. Provide a measuring rod and calibration card with

each tank. Railroad tank cars must have available inage and outage tables and dome capacity charts.

When measured by the ton (metric ton), the bituminous material weight is measured on scales furnished by the supplier or on public scales close to the source. Weigh each transporting vehicle for bituminous materials, other than railroad tank cars, empty and loaded. The weight difference is used for computing the tonnage (metric tonnage). Furnish an approved scale that can weigh the transporting unit in an unbroken operation. Test and seal the scales at Contractor expense when directed.

For plant mix operations, the bituminous material may be weighed by the plant scales, if approved.

If railroad tank cars transport the bituminous materials, the railroad car weights may be used for computing the weight of bituminous material, if the loaded cars are weighed over track scales. The stenciled tare on the car used for determining the net weight is subject to verification.

Use flow rate meters under Subsection 401.03.2(D)(7), to measure the material. Document meter readings by invoices. The Project Manager may take tank stabs for verification purposes.

402.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Bituminous Material	Gallon (liter) or Ton (metric ton)

Payment includes all costs to furnish, deliver, heat, haul, and apply the bituminous material.

For plant mix operations, the maximum volume of bituminous material eligible for payment on a shift basis is the target bituminous content plus 0.3 percent.

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract

**SECTION 403
CRACK SEALING**

403.01 DESCRIPTION

This work consists of routing, cleaning and sealing the transverse and specified longitudinal cracks meeting the dimensions specified under 403.03.1 in the roadway surface with the specified sealant.

403.02 MATERIALS

A. Crack Sealant. Use sealant meeting the ASTM D 5167 specifications in Table 403-1:

**TABLE 403-1
CRACK SEALANT SPECIFICATIONS**

PROPERTY	REQUIREMENT
Cone Penetration, 77 °F (25 °C), dmm (ASTM D5329)	100-150
Cone Penetration, 0 °F (-18 °C), dmm (ASTM D5329 modified)	25 min.
Flow, 140 °F (60 °C), 5h (ASTM D5329)	0.4 inch (10mm) max.
Resilience, 77 °F (25 °C), (ASTM D5329)	30% to 60%
Bond, -20 °F (-29 °C), 200% ext. (ASTM D5329)	Pass 3 cycles
Recommended Pour Temperature	380 °F (193 °C)
Safe Heating Temperature	410 °F (210 °C)
Asphalt Compatibility (ASTM D5329)	Pass

Submit a 30 lb (13.6 kg) sample for the first lot of the sealer proposed for project use to the Helena Materials Bureau for testing at least 20 calendar days before its intended application. Submit the sample in its original packaging with the batch number legible.

Do not use the first lot of sealant before it is approved.

The Department will take one random sample from each additional lot for testing.

B. Backer Rod. Furnish backer rod meeting ASTM D-5249, Type 1, sized for cracks meeting 403.03.3.

C. Blotter Material. Use toilet paper for blotter material.

403.03 CONSTRUCTION REQUIREMENTS

403.03.1 General

Work one-half of the roadway at a time.

Limit routing and crack sealing work to one maximum 2.0-mile (three-kilometer) work area.

403.03.2 Routing

Rout all existing cracks that are between 1/8 inch (3 mm) and 1 inch (25 mm) wide.

Rout all longitudinal cracks to produce straight 3/4-inch (19 mm) vertical walls and a 3/4 inch (19 mm) wide flat bottom reservoir.

Rout the transverse cracks to produce straight 1/2-inch (13 mm) vertical walls and a 1 1/2 inch (40 mm) wide flat bottom reservoir.

Rout when the roadway is dry.

Remove and dispose of the routed material from the roadway before opening the roadway to traffic.

403.03.3 Cleaning

The reservoir and crack must be dry and free of dust, dirt and loose materials immediately before placing the backer rod, if applicable, and applying the sealant.

403.03.4 Sealing

Install backer rod in cracks 1 1/2-inch (40 mm) wide and larger.

Place sealant material within 72 hours of routing.

Follow the sealant manufacturer's handling, mixing and application temperature requirements:

- Apply sealant filling the reservoir flush to the top using a pressure type applicator;
- Open the completed work to traffic once the sealant does not track; and
- Repair or replace all seal work damaged by traffic at Contractor expense.

All cracks sealed require blotter material.

403.03.5 Temperature Limitations

Do not rout when the mat temperature is below 35 °F (1.67 °C).

Apply the sealant when the roadway surface temperature is between 35 °F (1.67 °C) and 120 °F (49 °C).

403.04 METHOD OF MEASUREMENT

Crack sealing is measured by the pound (kg) of material placed.

Blotter material is not measured separately.

403.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Crack Sealing	Pound (kilogram)

Blotter material is included in the contract unit price and is not paid for separately.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 406
ROAD MIX BITUMINOUS
PAVEMENT

406.01 DESCRIPTION

This work is the construction of one or more courses of a mixture of aggregate and bituminous material, mixed and processed on the roadway.

406.02 MATERIALS

406.02.1 Bituminous Material

Furnish the type and grade of bituminous material specified in the contract meeting the requirements of Sections 402 and 702.

406.02.2 Aggregate

Furnish the aggregate specified in the contract meeting the applicable Section 701 requirements.

406.03 CONSTRUCTION REQUIREMENTS

406.03.1 Prosecution of Work

Furnish the resources to complete at least 1/2 mile (0.80 km) of continuous road mix bituminous pavement each day on projects 5 miles (8 km) or more in length.

On projects less than 5 miles (8 km) in length, complete the work within 10 working days.

Do not open up more than 2 miles (3.2 km) of work to any one phase of construction. Do not perform bituminous construction on more than 3 contiguous miles (4.8 km) of roadway.

406.03.2 Equipment

A. Bituminous Distributor. Maintain on the project at least one bituminous distributor meeting Subsection 410.03.1(A) requirements.

B. Motor Graders. Use motor graders meeting Subsection 210.03.2 requirements.

C. Road Plants and Machines. Use equipment capable of producing the specified work.

Do not damage the existing surface. Remove any equipment that damages the roadway or does not produce the specified work.

D. Stationary Plants. A stationary plant may be used for mixing the new aggregate and bituminous material, if approved. Mixing and aeration of the material, if not completed in the plant, must be completed on the roadway meeting these specifications.

The Project Manager may permit mixing, spreading, and compacting the materials under Section 401.

E. Rollers. Furnish rollers meeting Subsection 210.03.4 requirements.

406.03.3 Limitations and Conditions

A. Weather, Season, and Time. Perform road mix bituminous paving when the roadway surface is dry, the temperature is above 50 °F (10 °C) and during daylight hours.

B. Stockpiling. Windrow stockpile the aggregate on the roadway only for mixing operations that can be completed without interruption.

The Contractor may produce and stockpile the aggregate off the roadway at its own expense. Stockpile aggregate meeting Subsection 303.03 requirements.

C. Moisture Content. Do not allow the aggregate moisture content to exceed three percent by weight before applying the bituminous material.

When emulsified asphalt is specified, the maximum moisture content of the aggregate is specified in the contract or directed by the Engineer.

Cease work during periods of rain and immediately windrow the material. Maintain drainage away from the windrows.

Dry the treated material and the base before resuming work. Mixing is permitted to aid drying. Place the bituminized mixture on the roadbed, once approved by the Project Manager. Do not place the mixture if the moisture content in the upper 6-inches (150 mm) of the base exceeds 3 1/2 percent.

406.03.4 Traffic Control and Protection of Highway Structures

Place traffic control meeting the contract requirements and the approved traffic control plan. Protect highway structures meeting the requirements of Subsection 410.03.9.

Park all equipment at least 30 feet (9.2 m) from the edge of the traveled way or place it a minimum 10 feet (3 m) behind guardrail when work is suspended and traffic has use of the roadway.

Leave all material in a uniform windrow without interfering with traffic, signed and delineated as specified or directed. Leave the roadway in a safe condition for the traveling public.

406.03.5 Prime or Tack Coat

Apply the prime or tack coat under Section 407.

406.03.6 Aggregate

Where aggregate is recycled from the existing roadway, scarify the surface to produce the material quantity required for the compacted thickness of bituminous surfacing shown in the plans. Do not disturb the base surface below the depth required to produce the necessary quantity of material. Break all clods and windrow the loose material. Shape and compact the base surface to the typical section.

Uniformly mix recycled and new material before applying the bituminous material.

When only new aggregate is to be used, shape and compact the existing roadway surface to the specified sections. Apply prime coat as specified before placing the new aggregate. Uniformly windrow the new aggregate on one side of the roadway. Make the windrow uniform in size throughout its entire length.

406.03.7 Application of Bituminous Material

Apply bituminous material at the rates, temperature, and manner specified. Assure all aggregate is uniformly coated with bituminous material.

When applying bituminous material with distributors or mixing machines equipped with applicators, spread the windrowed aggregate in successive layers at least 8 feet (2.4 m) wide. Uniformly apply the bituminous material to the full width of each layer. Make at least three layers of aggregate and bituminous material.

406.03.8 Processing

Blade all surfacing material into a windrow after the last application of bituminous material and partial mixing. Move the windrow from side to side of the roadway a minimum of eight times working the aggregate until it is uniformly coated with bituminous material and is aerated for spreading and compacting.

A move is moving the entire mass from one edge of the roadway section to the other. If necessary, make additional moves to produce the desired mix uniformity. Prevent segregation of material or loss of mineral filler from the mixture.

Once mixing is completed, the Project Manager will inspect the mixture for acceptance. If excessive bituminous material was applied, add additional aggregate to the mixture and

thoroughly blend by blade mixing. If more bituminous material is required, spread the mixed material needing more bitumen on one side of the roadway, add the required additional bituminous material and resume mixing until the mix is uniform.

Remove oversize material in the mixture during mixing.

406.03.9 Spreading and Compacting

Spread the mixed material to the specified thickness using a pneumatic-tired motor grader.

Compact the material with a self-propelled pneumatic-tired roller that provides at least 60-psi (414 kPa) pressure on the mat.

Continue rolling until the mat is uniformly and thoroughly compacted leaving no roller marks. Begin rolling on the low side of the paving lane and roll lengthwise and parallel to the high side, each pass overlapping the preceding pass by at least 6 inches (150 mm).

Final roll using a metal-wheeled roller operated at speeds between 3 miles per hour and 8 miles per hour (5 km/h and 13 km/h). Correct roller speed if the roller displaces the material.

Do not use kerosene or diesel fuel to prevent pickup on the finishing roller. Correct all defects before opening the road to traffic.

The finished surface must be free of ruts, depressions or other surface defects exceeding 3/8-inch (10 mm), as measured with a 10-foot (3 m) straightedge paralleling the roadway center. Make corrections by scarifying and relaying the mixture at Contractor expense.

406.03.10 Seal Coat

Apply seal coat when specified under Section 409.

406.04 METHOD OF MEASUREMENT

406.04.1 Bituminous Material

Bituminous material is measured by the gallon (liter) or ton (metric ton) under Subsection 402.04.

406.04.2 Aggregate

New or additional aggregate for the bituminous surfacing course and the shoulders is measured by the cubic yard (cubic meter) or ton (metric ton) under Subsection 301.04.1.

406.04.3 Processing

Processing of all bituminous surfacing materials is measured by the mile (km) along the centerline of the roadway or by the square yard (square meter).

406.04.4 Rolling

Rolling is incidental to and included in payment for other items of the work.

406.04.5 Reserved

406.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

Pay Item

Bituminous Material
Aggregate
Processing

Pay Unit

Gallon (liter) or Ton (metric ton)
Cubic Yard (cubic meter) or Ton (metric ton)
Mile (kilometer) or
Square Yard (square meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

When emulsified asphalt is specified, the cost of additional water required during mixing is included in the contract unit price for emulsified asphalt.

The grade of bituminous material may be changed one step by the Engineer with no adjustment in price.

When stationary plants are used for mixing, the weight of bituminous materials and mixing water are deducted from the total mix weight.

SECTION 407 BITUMINOUS PRIME AND TACK COAT

407.01 DESCRIPTION

This work is the furnishing and applying a bituminous material, and a blotter material if required, to an existing surface.

Prime coat is applying a bituminous material to a prepared aggregate or soil-surface roadway before placing bituminous surfacing.

Tack coat is applying a bituminous material to a constructed bituminous or concrete surface before placing a bituminous surfacing.

407.02 MATERIALS

407.02.1 Bituminous Material

Furnish bituminous material meeting Section 702 requirements for the type and grade specified.

The Project Manager may change or substitute the type and grade of bituminous material to be used under Subsection 402.03.7.

A one step change in grade will not change the contract unit price.

The Contractor may substitute CSS-1 emulsified asphalt for SS-1 emulsified asphalt for tack coat.

407.02.2 Blotter Material

Blotter material is material with 100 percent passing the 1/2-inch (12.5 mm) screen and having a PI of 6 or less.

407.03 CONSTRUCTION REQUIREMENTS

407.03.1 Weather Limitations

Apply prime and tack coat to a dry surface during daylight hours.

Apply prime when the ambient temperature is 50 °F (10 °C) or higher.

Apply the tack coat when the ambient temperature is 50 °F (10 °C) or higher, or when the surface temperature is 35 °F (2 °C) and rising.

Do not place plant mix on any surface with a tack coat until the tack coat has cured (breaks) as determined by the Project Manager.

Apply the prime and tack coat after the Project Manager has approved the surface to receive the bituminous material.

Apply tack coat subject to the surface conditions and weather limitations in Subsection 401.03.6.

407.03.2 Equipment

Use equipment meeting Subsection 410.03.1 requirements.

407.03.3 Application of Bituminous Materials

Apply bituminous material as specified in Subsection 410.03.4, except as modified or supplemented by this Subsection.

The 3 percent moisture requirement in Subsection 410.03.2 is not applicable.

The Project Manager will establish the bituminous material application rate.

Apply water as directed to the aggregate base surface before the surface is primed.

Treat only one-half of the roadway width in one application.

Do not exceed the specified quantity of bituminous material at spread junctions. Correct excess or deficient coated areas to the specified application rate.

Apply emulsified asphalt for tack coat as specified by the Project Manager up to a maximum rate of 0.1 gallon per square yard (0.45 L per square meter). Maintain from 1 to 3 parts of water to 1 part of emulsified asphalt. The Project Manager will determine the exact proportions.

407.03.4 Application of Blotter Material

Spread, and compact if required, blotter material over primed surfaces as directed.

Sweep or blow excess blotter material onto the shoulders and in-slopes before placing subsequent bituminous surfacing courses. Remove and dispose of all excess material on adjoining curbs and gutters.

407.03.5 Maintenance of Surface

Maintain the prime or tack coated surface until covering with subsequent surfacing.

Repair all defects, deterioration or disintegration of the underlying surfacing course or courses as directed.

407.03.6 Traffic Control and Protection of Highway Structures

Furnish traffic control meeting the approved traffic control plan and Section 618.

Furnish highway structure protection as specified in Subsection 410.03.9.

407.04 METHOD OF MEASUREMENT

407.04.1 Bituminous Material

Bituminous material is measured by the gallon (Liter) or the ton (metric ton), as specified, under Subsection 402.04.

407.04.2 Blotter Material

Blotter material is measured by the ton (metric ton) or cubic yard (cubic meter).

407.04.3 Surface Repair

The surface repairs in Subsection 407.03.5 are not measured for payment except as follows:

The Project Manager may direct priming the surface before a winter shutdown. All traffic related damage areas during the shutdown period that are repaired are measured for payment at the appropriate contract unit prices, including additional materials.

407.04.4 Miscellaneous

Water for diluting emulsified asphalt used in the work is not measured for payment.

407.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Bituminous Material	Gallon (liter) or Ton (metric ton)
Blotter Material	Ton (metric ton) or Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

The blotter and bituminous material quantities in the contract are estimated and may be increased or decreased with no adjustment of the contract unit prices.

Surfacing aggregates are evaluated for gradation and mechanical fracture, on a lot-by-lot basis. The upper and lower limits in the gradation table, Table 701-12 are the upper and lower limits in the evaluation formulas. The specified minimum fracture values are the lower limit. Acceptance is made under Subsection 105.03.2.

409.03.2 Aggregate and Bituminous Material Application Rates

Determine the application rates for aggregate and bituminous material used to complete a test section and the project. Submit the following for informational purposes:

1. Aggregate and bituminous material application rates;
2. Bituminous materials supplier's recommended ambient and pavement surface temperatures;
3. Bituminous material supplier's recommended application temperature range; and
4. Elapsed time between the application of the bituminous material and the cover aggregate.

Before starting full production, complete a test section at least 2000 feet (0.6 km) long to verify the following:

1. Optimum bituminous material and aggregate application rates;
2. Time frame to complete each phase of the seal coat operation to meet the requirements for opening the roadway to traffic; and
3. Roller type, number of passes and pattern of rolling operations.

Do not begin production seal coat work until the test section has been placed and approved by the Project Manager.

409.03.3 Seasonal and Weather Limitations

The following conditions govern seal coat work:

1. Perform seal coat operations between May 1 and August 31.
2. Do not perform seal coat work during the 48-hour period immediately preceding a holiday or a holiday weekend except for pilot car operation as specified in Subsection 618.03.11.
3. Perform seal coat work when both the ambient and pavement surface temperatures meet the bituminous material supplier's recommended temperatures.
4. Stop seal coat work at least 1/2 hour before sunset, to include equipment off of the roadway and placement of traffic control devices for non-construction activities.

The following are weather related recommendations for seal coat work:

1. Do not perform seal coat work if the weather forecast for the project site includes a predicted temperature lower than 45 °F (7 °C) within 12 hours after the intended close of work for the day.
2. Do not perform seal coat work if the weather forecast for the project site includes a probability of precipitation greater than 45 percent within the intended schedule of operations for the day.
3. Stop seal coat work if the wind velocity affects the distributor spray pattern or current weather conditions prevent producing the specified results.
4. Do not apply bituminous material to damp or wet roadway surfaces.

409.03.4 Protection of Traffic and Highway Structures

Provide traffic control meeting Section 618 and the approved traffic control plan. Provide highway structure protection meeting Subsection 410.03.9(B). Provide dust control during sweeping and brooming.

409.03.5 Surface Preparation

Do not apply bituminous material unless the roadway surface is free of all dust, dirt, and foreign material.

409.03.6 Application of Fog Seal

The Contractor may, at their option, apply a fog seal using SS-1 or CSS-1 emulsions meeting subsection 402.03.6 requirements, on Grade S plant mix surfaces prior to application of seal coat materials. Notify the Project Manager in writing two days prior to application of fog seal. Specify the emulsion type and the application rate in the notification. For each completed section, as described in Subsection 618.03.11, the Department will pay for all pilot cars, flaggers, signs and necessary traffic control devices used for up to 12 hours. Traffic Control beyond 12 hours, unless ordered by the Project Manager, is at Contractor expense.

409.03.7 Application of Seal Coat Materials

Apply bituminous material at the rate established by the test section. Apply the bituminous material within the bituminous material supplier's recommended temperature range.

Ensure that transverse and longitudinal joints are smooth and match the adjacent surfaces. Keep meet lines to a minimum. Locate longitudinal joints outside the wheel paths.

For requests to apply full roadway width bituminous and aggregate applications in a single, continuous operation, provide the Project Manager two copies of a sequencing plan that ensures the least traffic impact for approval, at least five working days before the planned operation.

Uniformly apply the cover aggregate on the bituminous material at the rate established by the test section. When constructing longitudinal joints, one recommended method is to cover the joint with aggregate and sweep the aggregate back before applying adjacent bituminous material. When longitudinal joints are covered to permit vehicle cross over, sweep back the cover aggregate to expose the joint before applying adjacent bituminous material.

409.03.8 Warranty

If the seal coat experiences chip loss, tracking, flushing or bleeding, at any time, within 60 calendar days of seal coat completion, perform repairs to the seal coat at no additional cost to the Department. When repairs are deemed necessary, reference is made to the "MDT Seal Coat Warranty Administration Guide." Submit a detailed repair plan for approval. Make warranty repairs in accordance with the provisions of this specification. When performing warranty work, furnish traffic control meeting Section 618 requirements at no additional cost to the Department.

409.03.9 Application of Blotter Material

Monitor the finished seal coat and apply blotter material on live oil areas throughout the specified warranty period. Live oil is defined as bituminous materials that have not fully set or bonded to cover material particles. Live oil has a glossy appearance and is present in tracking, flushing and bleeding conditions. Failure to apply blotter material within 24 hours of written notification by the Project Manager will be cause for the Department to have the work performed. Costs incurred by the Department associated with application of blotter material will be deducted from subsequent progress estimates.

409.04 METHOD OF MEASUREMENT**409.04.1 Bituminous Material**

Bituminous material used for seal coat work is measured by the gallon (Liter) or by the ton (metric ton) under Subsection 402.04.

409.04.2 Cover Aggregate

Aggregate for "Cover - Type I" and aggregate for "Cover - Type II" is measured by the square yard (square meter), based on the length and width of seal coat placed and accepted.

409.04.3 Fog Seal

Bituminous material used for fog seal is measured by the gallon (liter) or by the ton (metric ton) under Subsection 402.04

409.04.4 Traffic Control

Traffic control is measured under Subsection 618.04.

409.04.5 Rolling

Rolling is not measured for payment.

409.04.6 Sweeping and Brooming

Sweeping and brooming and the disposal of excess material are not measured for payment.

409.04.7 Water

Water used for dust control or wetting chips is not measured for payment.

409.04.8 Blotter Material

Blotter material is not measured for payment.

409.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

Pay Item

Bituminous Material
Cover - Type I
Cover - Type II
Traffic Control

Pay Unit

Gallon (liter) or Ton (metric ton)
Square Yard (square meter)
Square Yard (square meter)
See Subsection 618.05

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

409.05.1 Excess Crushed Cover Aggregate

Sale of excess crushed cover aggregate is the Contractor's option. The Contractor cannot sell material from Department-owned or Department-optioned sources without a written agreement establishing and providing royalty refunds to the Department.

The Department may purchase acceptable unused crushed cover aggregate remaining in the stockpile, if the quantity exceeds 100 tons (100 metric tons). The conditions of purchase are described in Subsection 109.07.

Haul from the stockpile site to the site selected by the Project Manager will be by the most practical route as determined by the Project Manager. Payment for haul is 15 cents per ton-mile (0.907 mt per 1.6 km) for distances exceeding 2,000 feet (610 m).

SECTION 410 BITUMINOUS SURFACE TREATMENT

410.01 DESCRIPTION

This work is applying one or more coats of bituminous material on a prepared aggregate roadway surface, covering each application with aggregate surfacing material.

410.02 MATERIALS

410.02.1 Bituminous Material

Furnish the specified bituminous material under Section 702.

410.02.2 Aggregate

Furnish the specified aggregate under Section 701.

410.03 CONSTRUCTION REQUIREMENTS

410.03.1 Equipment

Maintain the following equipment on the project throughout the work.

A. Distributor. One pressure distributor for bituminous material with a minimum 1,000-gallon (3785 L) capacity insulated tank, internally heated.

Equip the distributor with a full-circulating spray bar:

1. At least 9-feet (2.8 m) long;
2. Capable of 1-foot (305 mm) incremental length adjustments up to 16 feet (4.9 m);
3. Having vertical nozzle adjustment that conforms to the roadway crown;
4. Capable of lateral shifting of the entire spray bar while operating; and
5. With vertical height adjustment capable of maintaining a preset height above the road surface.

Use spray bars and flat-slotted nozzles designed to not clog during intermittent operation and provide positive cutoff of the bituminous material. Use positive-acting flow control valves to produce a uniform, unbroken spread of bituminous material.

Remove or repair distributors not uniformly distributing the bituminous material.

Assure the distributor has devices and charts to provide for accurate, rapid determination and quantity control of the bituminous material application.

Equip the distributor with a pressure pump, pressure gauge, thermometer well, thermometer, and a calibrated fluid content gauge.

Use pneumatic-tired distributors meeting legal load requirements.

B. Rollers. Furnish pneumatic tired rollers under Subsection 210.03.4(D).

C. Aggregate Spreader. Provide one self-propelled aggregate spreader:

1. Equipped with at least four pneumatic tired wheels on two axles;
2. Capable of uniformly spreading the material over the full width of the bituminous material; and
3. The spreader application rate being independent of motive power.

D. Cleaning Equipment. Use power brooms, blowers, or hand brooms.

E. Watering Stockpiles. Provide equipment for wetting the cover aggregate stockpiles, when required.

F. Watering Equipment. Furnish water-distributing equipment meeting the applicable requirements of Subsection 210.03.5.

G. Scales. Furnish scales under Subsection 301.03.2(C).

410.03.2 Existing Surface Preparation

Unless surface preparation is included in the contract surfacing item, perform the work under Section 204, as modified or supplemented below.

When required, apply a light, uniform water application to the roadway surface just before applying the bituminous material. Do not exceed 3 percent moisture by weight in the top 2 inches (50 mm) of the aggregate course.

When required, apply a prime coat of bituminous material at the rate directed before the initial application of bituminous surface treatment. Apply the prime coat under Section 407.

410.03.3 Sweeping

Clean the roadway surface of all dust, dirt, and foreign material before applying the bituminous material.

410.03.4 Application of Bituminous Material

Apply the bituminous material with a maximum allowable variation of 0.02 gallon per square yard (0.4 L per square meter) from the specified application rate.

Apply bituminous material only with the Project Manager's approval. Apply the material when the surface temperature is at or above 60 °F (16 °C).

Do not work when rain, wind, or temperatures would prevent obtaining the specified results.

Uniformly apply the bituminous material at the temperature and rate specified. Provide uniform surface cover and true lines.

Assure high viscosity bituminous materials are covered with aggregate within 5 minutes.

Apply bituminous material to produce smooth and consistent transverse and longitudinal joints in successive applications with the adjacent completed surfaces.

Longitudinal joints may be from 6 to 10 inches (150 to 255 mm) wide but not overlap at the application ends. Prevent lapping at transverse joints by inserting a drip pan under the nozzles if necessary. Before continuing the application, spread protective sheets over the treated surface on the cover aggregate to provide bituminous coverage at the joint.

Apply the material to keep meet lines to a minimum.

The Project Manager may approve full width application of bituminous material and cover aggregate in a single, continuous operation.

Re-apply bituminous material at joints where the uncovered bituminous material has set and does not bond the aggregate at Contractor expense.

410.03.5 Application of Cover Aggregate

When directed, water the stockpiled cover aggregate before spreading it on the bituminous material.

Cover the first bituminous material application within 60 minutes. Uniformly cover all bituminous material with cover aggregate at the specified rate. When directed, use brooms to uniformly distribute the cover aggregate. Avoid displacement or loosening of the cover aggregate.

Do not permit haul trucks and traffic to drive on any uncovered bituminous material. Furnish traffic control for fresh spread cover aggregate areas as specified in the traffic control plan.

Before applying the adjacent bituminous material, broom all joints the full width to remove loose aggregate.

410.03.6 Rolling

Roll the cover aggregate immediately after spreading within 30 minutes of spreading.

Use self-propelled pneumatic-tired rollers with a ground contact pressure of between 50 psi (345 kPa) and 95 psi (656 kPa). Provide two rollers for each aggregate spreader used.

Roll parallel to the centerline, starting on the low side of the lane and working towards the crown or high side. Overlap roller passes at least 6 inches (155 mm).

Continue rolling until a smooth, compacted surface is produced.

Avoid displacing or loosening the cover material while rolling.

410.03.7 Curing and Cleaning

When the rolling is completed on each surface course and the surface is accepted, it may be opened to traffic.

Allow the surface to cure for at least five days.

Repair all surface defects in the treated surface immediately with the specified bituminous material or use a pre-mix bituminous aggregate at Contractor expense.

Cover areas of excess bituminous material with aggregate and roll at Contractor expense.

When the Project Manager determines the first course of bituminous material and cover aggregate has cured and set, all repairs have been accepted, all excess cover aggregate is removed, clean the surface of dirt, dust, and foreign materials.

Begin construction of the succeeding course on the cleaned surface.

410.03.8 Completion

When the final course is complete, open the surface to traffic for three days, using the specified traffic control. During this time, broom and roll the surface as required.

Repair all surface defects under Subsection 410.03.7.

Cover all areas exhibiting excess bituminous material with aggregate and roll it.

410.03.9 Protection of Traffic and Highway Structures

A. Traffic Control. Furnish traffic control meeting the contract requirements and Section 618.

B. Structure Protection. Cover exposed bridge elements, culverts, curbs, gutters, guard fences, road signs, and other roadside structures to protect them from splash or spray when applying bituminous material.

Clean these same items of all bituminous material, dirt, or other material caused by the Contractor's operations.

Repair all Contractor caused damage to the highway or structures at Contractor expense.

410.04 METHOD OF MEASUREMENT

410.04.1 Bituminous Material

Bituminous material is measured by the gallon (Liter) or the ton (metric ton) under Subsection 402.04.

410.04.2 Cover Aggregate

Cover aggregate is measured by the ton (metric ton) or the cubic yard (cubic meter) measured in the vehicle at the point of delivery on the roadway, as specified in the contract and under Subsection 301.04.1.

410.04.3 Traffic Control

Traffic control is measured under Subsection 618.04.

410.04.4 Existing Surface Preparation

Where base construction is a part of the contract with bituminous surface treatment, the items of work for existing surface preparation are incidental to and included in payment for the base construction.

Where bituminous surface treatment is applied to an existing aggregate surface, the work for existing surface preparation is measured for payment under Subsection 204.04.

410.04.5 Rolling and Watering

Rolling and watering are incidental to other items of the contract and not measured for payment.

410.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Bituminous Material	Gallon (liter) or Ton (metric ton)
Cover Aggregate	Cubic Yard (cubic meter) or Ton (metric ton)
Traffic Control	See Subsection 618.05

Surface sweeping or cleaning, watering of aggregate stockpiles and the roadway surface, repairing damaged surfaces or surfaces with excess bituminous material, and protection and repair of structures specified in Subsection 410.03.9 are incidental to and included in payment for other items of the contract.

410.05.1 Existing Surface Preparation

Existing surface preparation, when specified, is paid for under Subsection 204.05.

When not specified in the contract, the existing surface preparation work is incidental to and included in the payment for the base construction.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 411 COLD MILLING

411.01 DESCRIPTION

This work is the removal of existing bituminous pavement at the locations specified in the contract or designated by the Engineer.

411.02 RESERVED

411.03 CONSTRUCTION REQUIREMENTS

411.03.1 Equipment

Use a power-operated cold milling machine equipped to control cross slope and to establish profile grade from the existing pavement or an external reference.

Use cold milling machines having a minimum single pass cutting width of 12 feet (3.7 m) where one or more full lanes are designated for removal except for the following conditions:

1. Cattle guards and bridge ends; or
2. Two-lane two-way roads 40 feet (12.2 m) in width or less where the total removal is less than 25,000 square yards (20,900 square meters).

Equip the milling machine to capture milling related dust.

411.03.2 General

Do not start cold milling until the plant mix material is available.

Remove all thin delaminated or loose layers of existing pavement left after cold milling.

Replace the milled pavement at bridge ends and cattle guards with new bituminous surfacing the same day leaving no transverse joints in the milled areas.

If new surfacing cannot be placed on the milled area the same day of the milling, taper the edges at structures and cattle guards at 50:1 with hot mix. Remove and dispose of the tapers immediately before placing the planned overlay on the milled area.

Replace all other areas designated for milling with new plant mix surfacing within 24 hours after the milling is performed.

Replacing existing pavement is a separate operation from any succeeding overlay or lift.

411.03.3 Milling

A. Bridge and Cattle Guard Approaches and Bridge Decks. Mill the existing bituminous surfacing from bridge decks, bridge approaches, and cattle guards at the locations specified in the contract.

Mill to the plan depth from the bridge ends out to a maximum 50 feet (15.3 m) from the bridge end. Taper the mill depth from that point to the level of the existing pavement surface from a minimum 10 feet (3 m) to a maximum 150 feet (45.8 m), as directed.

At cattle guards, the full depth milling distance varies from 0 to 40 feet (12.2 m), and the taper milling distance varies from 10 feet to 80 feet (3 m to 24.4 m), as directed.

Bridge deck mill depth is shown in the contract.

B. Milling at Other Designated Areas. Mill the existing pavement at the locations, widths and depths specified. Depths specified are minimums. The depth is measured below the existing pavement plane projected from points on un-distorted pavement near the centerline and the edge of the driving lane.

C. Cold Milling for Seal and Cover. Meet the following requirements when seal and cover goes directly on the cold mill surface:

1. Use a cold milling cutting head having a maximum 1/4-inch (6 mm) tooth spacing.

2. Equip the milling machine with automatic controls and sensors on both sides to maintain the specified grade and transverse slope.
3. Do not operate the milling machine in excess of 75 feet/minute (23 meters/minute) unless it can be demonstrated to the Project Manager that the milled surface can meet the plant mix overlay surface tolerance specified in Subsection 401.03.14.
4. Do not begin placing the seal and cover until all cold millwork is complete.

411.03.4 Salvage of Pavement Millings

Salvage, haul, and stockpile the milled pavement to the specified site.

Milled pavement is the Contractor's property when specified and must be removed from the project.

411.03.5 Replacing Removed Pavement

Pave all milled areas in the contract with the specified bituminous mixture, placed to the specified depth.

Grades will be provided at 50-foot (15.3 m) intervals for placing the new pavement for 250 feet (76.3 m) from each bridge end and 100 feet (30.5 m) from cattle guards. Set a wire line for grade control with intermediate supports to prevent wire deflection exceeding 0.015 feet (5 mm). Stop paving if the deflection exceeds 0.015 feet (5 mm) and make appropriate corrections.

Apply a tack coat on all milled areas before paving.

411.03.6 Traffic Control

Furnish traffic control under Section 618.

411.04 METHOD OF MEASUREMENT

Cold milling is measured by the square yard (square meter) of pavement removed to the specified depth.

411.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Cold Milling	Square Yard (square meter)

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

The contract unit price may be adjusted if the Project Manager issues a written order to increase or decrease the milling depth.

**SECTION 501
PORTLAND CEMENT
CONCRETE PAVEMENT**

501.01 DESCRIPTION

This work is the construction of portland cement concrete pavement on a prepared subgrade or base course.

501.02 MATERIALS

501.02.1 Concrete

Furnish concrete meeting Section 551 requirements for Class "AP" or "DP" concrete.

A. Cement. Furnish Type I or II portland cement meeting ASTM 150 or AASHTO M 85 requirements and the applicable requirements of Subsection 551.02.1.

B. Air-entraining Admixtures. Furnish air-entraining admixtures meeting Subsection 551.02.2 requirements.

C. Fine Aggregates. Furnish fine aggregate meeting Subsection 701.01.1 requirements.

D. Coarse Aggregates. Furnish coarse aggregate meeting Subsection 701.01.2 requirements.

E. Water. Furnish water for concrete meeting Subsection 713.01 requirements.

501.02.2 Reinforcing Steel

Steel-wire fabric and steel bar mat sizes and dimensions are specified in the contract.

Furnish steel-wire fabric reinforcement in flat sheets.

Furnish bar mats and bars of structural or intermediate grade, as specified in the contract.

Furnish all reinforcing steel meeting Subsection 711.01 requirements.

501.02.3 Dowel Bars and Sleeves

Furnish Grade 40 plain round dowel bars meeting AASHTO M 31 requirements.

Bar dimensions and placement in the pavement are specified in the contract.

Do not use bars having burrs or other deformation that restrict slipping in the concrete.

Before delivery to the project, coat one-half the length of each dowel bar with one coat of zinc or tar paint. Furnish sleeves for dowel bars meeting the contract requirements.

501.02.4 Tie Bars

Furnish ASTM A 615, Grade 40 deformed steel bars. The length, size, and spacing of the bars are specified in the contract.

501.02.5 Expansion Joint Filler and Joint Sealing Material

Furnish expansion joint filler and joint sealing material meeting Subsection 707.01 requirements.

501.02.6 Curing Compound

Furnish AASHTO M 148 Type 2, white-pigmented, membrane-forming curing compound.

501.03 CONSTRUCTION REQUIREMENTS

501.03.1 Equipment

A. General. Do not begin paving operations until all equipment and tools for the pavement construction are available at the site.

Assure the equipment is in good mechanical condition, adjustment, design, and capacity.

Adjust, repair, or replace equipment failing to produce the specified work.

Use handling, batching, mixing, and concrete transporting equipment meeting the applicable requirements of Section 551 and the following.

Use batch plants for projects having 300 cubic yards (229.5 cubic meters) or more portland cement concrete pavement that proportion aggregates and cement by weight using automatic and interlocked proportioning devices.

Use non-agitating hauling equipment with smooth, mortar-tight metal bodies that completely discharge the concrete at a uniform rate without segregation. Provide covers when necessary to prevent the concrete from drying out or being exposed to weather-related moisture.

Use belly-dump trucks only with the Project Manager's written approval.

Remove and dispose of concrete remaining in haul units before reloading with fresh concrete.

B. Stationary Side Forms. Use metal side forms strong enough to resist displacement from concrete and mechanical equipment pressures.

Use flexible or curved forms for curves with 100-foot (30.5 m) radii or less.

Forms must:

1. Hold abutting sections in alignment;
2. Be adjustable for vertical and horizontal curvature;
3. Have a minimum depth equal to the specified concrete edge thickness;
4. Not have horizontal joints;
5. Have a base width greater than or equal to the depth;
6. Have at least three staking points for each 10 feet (3 m) of length that securely lock to the form stake; and
7. Have flange braces and staking pockets that extend outward on the base at least two-thirds the height of the form.

Use wooden forms only with the Project Manager's written approval. Include in the request to use wooden forms complete details showing they meet the requirements for steel forms regarding strength, lines, grades, and depth.

Do not use forms in poor condition in the work. Repaired forms must be inspected and approved before use.

C. Placing, Consolidating, and Finishing Equipment. Place, consolidate, and finish concrete meeting the contract requirements.

Operate only rubber-tired equipment on adjacent pavement. Pad crawler units to prevent pavement damage.

Keep the adjacent pavement and form tops clean to provide good contact with tires or crawler units.

1. Slip-form Pavers. Use slip-form pavers having automatic controls for longitudinal and transverse grade from continuous wire control lines.

Maintain the control wire tension, support interval, and sensor operating pressure to prevent control wire deflection in excess of 3/16-inch (5 mm) below supports at mid-span. Immediately stop paving operations when deflection exceeds 3/16-inch (5 mm) and resume once corrected.

Use self-propelled slip-form pavers to place and finish the concrete that are capable of negotiating all grades without external tractive force.

Equip the slip-form paver with an auger or other approved strike-off device to distribute the concrete to a uniform depth ahead of the screed.

Use sliding forms that are laterally rigid to prevent spreading.

Use slip-form pavers that consolidate the plastic concrete by internally vibrating the full paving width and depth. Use transverse vibrating units that do not project outside the specified paving section thickness and are positioned ahead of the screed a minimum distance equal to the pavement thickness. A series of longitudinal vibrating units may be used as an alternate. Vibrators may be the immersed tube type or a series of equally spaced longitudinal vibrating units.

The maximum spacing of each unit in a series of longitudinal units is 24 inches (610 mm) measured center-to-center of the units.

Each vibratory unit must provide at least 7000 vibrations per minute with the amplitude visibly perceptible on the concrete surface within 1 foot (305 mm) of the entire length of the vibrating unit. Equip the paver with a tachometer or other approved device for measuring the actual vibration frequency.

2. **Auxiliary Finishing Equipment.** Use finishing equipment behind the slip-form paver that automatically maintains alignment from an external reference.

Provide hand floats, edging tools, and other hand-finishing equipment to finish the surface as specified.

3. **Stationary Side Form Method.** Submit details for all equipment proposed for spreading, strike-off, consolidating, screeding, and floating before use.
4. **Roadbed Planers.** Equip the roadbed planer with adjustable steel cutting edges mounted in a rigid frame to trim the roadbed to the specified elevation and crown under all operating conditions. The planer wheels must ride on the forms or adjacent pavement.
5. **Concrete Spreaders.** Use a self-propelled spreader that uniformly spreads the concrete between forms and has an adjustable blade or head for striking off the concrete to the required height and crown.
6. **Vibrators.** Use full-width concrete slab vibrators of the surface pan type or the internal type with immersed tube or multiple spuds.

The vibrators may be mounted on the spreader, the finishing machine, or on a separate carriage.

Do not allow the vibrators to come in contact with the joint load transfer devices, the subgrade, or side forms.

Use vibrators meeting the following:

- Surface vibrators having a minimum frequency of at least 3,500 impulses per minute.
- Tube vibrators with a minimum frequency of at least 5,000 impulses per minute.
- Spud vibrators with a minimum frequency of 7,000 impulses per minute.
- Hand-operated or machine-mounted spud-type internal vibrators next to forms having a minimum frequency of 3,500 impulses per minute.

7. **Bridge Deck Finishing Machines.** Use transverse-finishing rotating drum bridge deck finishing machines when stationary side forms are allowed.
8. **Mechanical Floats.** Use mechanical floats that produce a surface true to the required crown and smoothness, free from honeycomb or excessive mortar.

Assure the float makes accurate incremental adjustments to the required crown without interrupting the float operation.

The mechanical float may be self-propelled or attached to the rear of the transverse finishing machine.

501.03.2 Pre-paving Conference

Attend a pre-paving conference, conducted by the Department, to be held at least 24 hours before paving starts.

The conference topics will include equipment, construction methods, specification requirements, and lines of communication.

The conference must include the foreman, other Contractor personnel that will supervise the concrete paving operations and key Department inspection personnel.

501.03.3 Aggregate Sampling and Testing

Furnish aggregates that meet the gradation requirements, fineness modulus, and deleterious material limits specified in Subsection 701.01. Provide all sampling and testing to meet these requirements during aggregate production.

501.03.4 Aggregate Production

Produce aggregate meeting the applicable requirements of Section 551.

Produce and stockpile at least one-third of the quantity of each size aggregate necessary to produce the plan quantity of portland cement concrete pavement before paving operations begin.

501.03.5 Acceptance of Aggregate

A. Sampling and Testing. The Project Manager will determine when samples are taken and will test the aggregate for acceptance.

Furnish and operate the aggregate sampling devices, witnessed by the Project Manager. Take samples at a point immediately before the aggregates are combined and enter the mixer, witnessed by the Project Manager. Samples may be split to a minimum 50 pounds (23 kg). Furnish the samples to the Project Manager immediately after sampling.

Acceptance samples will be randomly selected.

The approximate quantity represented by each sample is specified in MT-601.

Additional samples may be selected and tested.

B. Lot Size. The concrete quantity in each day's production constitutes a lot whenever production schedules and material continuity permit.

The Project Manager may establish a lot consisting of the quantity represented by any number of consecutive random samples from three to seven inclusive if the Project Manager determines it is necessary due to production runs, significant material changes, or other unusual characteristics of the work.

C. Acceptance. Portland cement concrete pavement is evaluated for price adjustment on a lot-by-lot basis under Subsection 105.03.2, when deviation from specified aggregate gradation limits, fineness modulus limits for fine aggregate, or percent passing the number 200 sieve (0.075 mm) for coarse aggregate occurs on one or more tests for a lot.

Payment for a lot where a price reduction applies under the acceptance provisions in Subsection 105.03.2 is calculated using the following formula:

$$\text{Price Reduction} = \text{Contract Unit Price} \times 0.40 \times P/100 \times \text{Lot Quantity}$$

Where:

P = the percent reduction in contract unit price as defined in Subsection 105.03.2.

Lot Quantity = the plan quantity in cubic yards (cubic meters) or square yards (square meters) of the pavement section where the lot was placed.

501.03.6 Mixing

Mix concrete meeting Subsection 551.03.3 requirements.

501.03.7 Transporting Concrete

Transport concrete in equipment meeting Subsections 501.03.1 and 551.03.4 requirements.

501.03.8 Placing and Finishing Concrete

Place all portland cement concrete pavement for projects of 20,000 square yards (16,720 square meters) or more, or bridge approach slabs, ramp tapers, and other small, restricted, or irregular areas, by the slip-form method.

Construct projects with 20,000 square yards (16,720 square meters) or less pavement using the slip-form method or by stationary side-form method using bridge deck finishing equipment.

Submit the proposed procedures and equipment details for the side-form method for approval before paving.

Place the fresh concrete on the prepared roadbed as close as possible in front of the paving machine to minimize concrete handling. Do not routinely use front-end loaders or other equipment at the paver for moving the fresh concrete once its placed on the roadbed.

Place concrete hauled in non-agitating equipment within 45 minutes from when the ingredients were charged into the mixer. Dispose of concrete that does not meet slump requirements at Contractor expense.

Place concrete hauled in agitator trucks within the time limits in Subsection 551.03.4(A).

Distribute the concrete to the specified slab thickness, with the finished surface at the specified grade, once the concrete is consolidated and finished.

Do not use vibrators to distribute concrete.

Place concrete only after the foundation course or subgrade has been approved by the Project Manager.

Prepare the foundation course ahead of the paving operation equal to the anticipated daily production.

Place concrete around manholes or other structures once the structures are brought up to the required grade and alignment.

Dampen the base or subgrade with a fine water mist immediately before placing concrete. Do not permit free-standing water to puddle on the surface.

If concrete placing is delayed or stopped in excess of one hour, construct an emergency transverse construction joint as directed.

Except for emergency transverse joints, do not construct a joint at any location other than as directed or specified.

Construct the pavement in full lane widths in a single operation.

Construct longitudinal joints between lanes or sections meeting Subsection 501.03.13(F) requirements.

Do not place concrete in longitudinal sections until the adjacent slab is 14 days old or has reached a minimum compressive strength of 2,000 psi (13,800 kPa), determined by testing the standard cylinders cured under the same environmental conditions as the slab.

A. Slip-form Method.

- 1. General.** Place the concrete with a slip-form paver meeting Subsection 501.03.1(C) requirements that spreads, consolidates, screeds, and float-finishes the fresh placed concrete in one pass.

Operate the slip-form paver to maintain a continuous, forward movement. Assure all concrete mixing, delivering, and spreading provides uniform progress without

stopping and starting the paver. If it is necessary to stop the paver, immediately stop the vibrators and tamping.

Maintain a uniform consistency in the concrete with a slump of 1-inch to 2-inch (25 mm to 50 mm).

The paver may be set to form a 3-inch (75 mm) or less battered edge while maintaining the top riding surface at the specified width.

Apply additional hand vibration at construction joints as required for consolidation.

2. Finishing. Finish the concrete surface to meet Subsection 501.03.14.

Correct any pavement edge slump, excluding specified edging, exceeding 1/4 inch (6 mm) before the concrete has hardened.

If the edge slump on any 1-foot (305 mm) or longer length of hardened concrete exceeds 1-inch (25 mm), remove and replace the entire panel between the transverse and longitudinal joints.

Before the initial concrete set, round the pavement edges on each side of the transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints to the required radius. Construct a well-defined, smooth, dense mortar finish radius.

Hand finishing is permitted only for finishing sections with narrow irregular dimensions and to finish any concrete already deposited on the grade should a machinery breakdown occur.

Grind high spots exceeding 1/4 inch (6 mm) using approved methods. Fill low spots exceeding 1/4 inch (6 mm) with an approved epoxy-bonded grout as directed.

B. Stationary Side Form Method.

1. Preparation of Subgrade or Foundation Course. Once the roadbed is finished and compacted under Section 203, trim, shape, and compact the subgrade or foundation course meeting Section 301 to the specified lines, grades, and cross sections.

Extend the finished subgrade 2 feet (610 mm) beyond each side of the planned pavement width.

Once the forms are set, re-shape and re-compact all disturbed subgrade or foundation course using rollers or compactors working between the fine grading equipment and the paver.

Test the subgrade or foundation course in advance of the paver for section and grade using an approved template. Mount the template on visible rollers with the tooth edge conforming to the required shape of the subgrade when riding vertically on the forms. Remove excess material and fill low areas to the finish elevation with subgrade or foundation material and compact to the specified density.

Maintain the finished subgrade or foundation course in a smooth, compacted, undisturbed condition until the pavement is placed.

Moisten the subgrade or foundation course as specified in Subsection 501.03.8 when placing the concrete.

2. Form Setting. Do not permit the forms to deviate more than 1/8-inch (3 mm) from the true plane of the form face or top. Do not permit the forms to warp, bend, or kink. Clean and oil forms before each use.

Cut the compacted foundation course or the subgrade to grade providing firm contact for each form for its entire length at the specified grade. Fill low areas to grade in 1/2-inch (13 mm) lifts or less for 18 inches (460 mm) on each side of the base of the form and compact to the specified density. Settlement or springing of forms under the finishing machine is not allowed.

The forms will be checked for alignment and grade. Make any corrections before placing the concrete.

Correct unstable or disturbed forms or foundation courses and re-check the forms.

Prepare the foundation course and forms ahead of the paving operation equal to the average daily production.

Leave the forms in place at least 12 hours after the concrete has been placed unless earlier removal is necessary to permit sawing of transverse weakened plane joints.

Exercise care in removing forms to avoid damage to the pavement edges.

3. **Strike-off and Consolidation.** Strike-off, screed, and consolidate the concrete with mechanical equipment to the specified crown and cross section providing a uniform surface texture. Avoid prolonged work over any area.

Maintain a uniform ridge of concrete ahead of the front screed of the finishing machine except when making construction joints.

4. **Floating.** Following strike-off and consolidation, finish the concrete surface with a mechanical float under Subsection 501.03.1(C)(8).

5. **Finishing.** Finish the concrete surface to meet Subsection 501.03.14(A) or (B).

- C. **Final Surface Finish.** Hand-float the surface only as needed to produce a uniform surface and sharp corners. Do not use excess mortar to build up slab edges or round the slab corners. Before the concrete's initial set, work the pavement edges along each side of transverse isolation joints, transverse construction joints, and fixed forms to produce a 1/4-inch (6-mm) continuous radius and a smooth, dense mortar finish. Check the surface of the fresh concrete with a long-handled straightedge that is 10 feet (3 m) or longer. Remove high areas indicated by the straightedge.

- D. **Texturing.** After surface finishing, texture all concrete surfaces within the travel lanes. Use either hand operated or mechanical tools to produce a uniform texture that conforms to the dimensions shown on the plans.

For artificial carpet and burlap drag, furnish carpet or burlap that is long and wide enough to cover the entire pavement width and that produces a uniform texture. Clean drag periodically to remove encrusted mortar or replace with new burlap or carpet.

Meet an average surface texture of 0.040 inch (1 mm) to 0.060 inch (1.5 mm), as measured by MT-113 (sand patch test).

If repair of high spots or low spots results in surface texture loss, repair the affected area to the specified texture at the Contractor's expense.

1. **Design Speed Greater than 50 MPH (80 km/h).** Produce the final surface finish with transverse tining, followed by longitudinal artificial carpet or burlap drag.

Space transverse tines randomly as follows:

- Minimum spacing 1/2 inch (10 mm);
- Maximum spacing 1 1/2 inch (40 mm); and
- No more than 50 percent of the tines apart by more than 1 inch (25mm).

Use tines that are 1/8-inch (3 mm) wide, with a tolerance of ± 0.02 inch (± 0.5 mm) and apply them to a depth of 1/8-inch to 1/4-inch (3 mm to 6 mm) (provided minimum dislodging of the aggregate particles result).

2. **Design Speed Less than 50 MPH (80 km/h).** Produce the final surface finish by broom texturing, followed by a longitudinal artificial carpet or burlap drag.

Produce a uniform texture with corrugations 1/16 inch (1.5 mm) deep.

501.03.9 Protection of Concrete From Rain

Maintain materials at the project site to protect all un-hardened concrete surfaces from rain.

When rain appears imminent, stop paving operations and cover all surfaces of the un-hardened concrete with the protective covering.

501.03.10 Evaluation and Repair of Rain-damaged Concrete

Follow *The American Concrete Paving Association Technical Bulletin No. 17* for the evaluation of and acceptable repair methods for rain-damaged concrete.

All protective, remedial, and corrective work to produce acceptable pavement is at Contractor expense.

501.03.11 Curing

A. Membrane. After the concrete is finished and the free water has left the surface, seal the entire surface area by machine spraying a uniform application of curing compound meeting Subsection 501.02.6 requirements.

Apply the curing compound following the manufacturer's recommendations before surface hair checking develops.

Do not apply curing compound to the inside faces of joints to be sealed.

If the groove coverage is not complete after the first application, apply a second coverage in the opposite direction from the first. Apply the second application within 30 minutes of the first application.

Assure the equipment controls the curing compound application rate and uniformity. Use the coverage rate of 1 gallon per 150 square feet (0.27 L per square meter) or follow the manufacturer's recommendations.

Re-apply membrane curing compound to areas protected for less than 72 hours and that are damaged by sawing, rain, or other causes.

B. Other Methods. The Contractor may submit for approval, other curing methods.

501.03.12 Handling and Placing Reinforcement

Keep reinforcing steel clean, rust free, straight and distortion free, placed and held in position as specified.

Store reinforcing steel out of the weather, distributing only the steel needed for immediate placing along the work.

Assemble and place reinforcement for bar mats as specified. Maintain bar mat placement during concreting operations. Tie all intersections. Lap all adjacent ends at least 40 bar diameters.

501.03.13 Joints

A. Transverse Expansion Joints. Construct transverse expansion joints as specified in the contract.

B. Expansion Joints at Structures. Construct and seal joints between concrete approach slabs and structures or concrete pavement as specified.

C. Transverse Construction Joints. Make transverse construction joints as detailed in the contract, at the end of each day's run, or where concrete work is interrupted for more than one hour.

Form the joint using a clean plank cut to the plan cross section with an attached beveled strip to form a key-way. Remove the header and clean excess concrete on the subgrade and joint face before placing fresh concrete against the joint.

D. Transverse Contraction Joints. Saw transverse contraction joints to the specified width, depth, and spacing using a power-driven gang saw with at least four separate blades.

Saw initial or "control" transverse contraction joints at 54 foot (16.5 m) intervals or another multiple of the specified joint spacing that reduces uncontrolled cracking with the least number of initial contraction joints. Saw initial contraction joints as soon as possible after the concrete is placed. Do not permit the saw to tear or ravel the adjacent concrete. Saw the remaining contraction joints typically within 24 to 48 hours after concrete is placed.

Be responsible for determining joint-sawing methods, sequences, and timing to prevent random cracking. Immediately revise methods that cause random cracking. Repair or replace concrete defects resulting from errors in the work methods at Contractor expense.

Repair or replace broken slabs, random cracks, nonworking contraction joints near cracks, and spalls along joints and cracks under Subsection 501.03.15.

Protect saw cuts in concrete 60 hours old or less from rapid drying using twisted paper, fiber or rope cords, waterproof covering, or other approved methods.

Have at least one stand-by saw in good condition and additional saw blades at the job site during sawing operations.

Cut curbs and gutters to the required depth to prevent erratic cracking.

Immediately after the joints are sawed, flush the groove with pressurized water and blow the groove out with compressed air to remove all dust, water, and slurry. Clean the groove using compressed air just before filling with joint filler.

Place hot-poured joint sealer in sawed joints to within 1/4-inch (6 mm) to 3/16-inch (5 mm) of the pavement surface when the pavement temperature is at least + 40 °F (4 °C).

Do not use polyethylene strips to form transverse contraction joints.

- E. Longitudinal Joints.** Saw longitudinal joints to the specified width and depth within three days of placing the concrete.

Do not use plastic tape as a joint sealer.

Saw and apply hot-poured joint sealer meeting Subsection 501.03.13(D) requirements.

Assure the finished joint alignment is parallel to the centerline of the pavement and does not have irregularities exceeding 0.04 foot (12 mm), measured by a 12 foot (3.6 m) straightedge, except for normal centerline curvature.

- F. Key-way Longitudinal Joints.** Construct key-way joints as specified when adjacent pavement slabs are constructed separately.

501.03.14 Surface Test

Test pavement surfaces exceeding 300 feet (91.5 m) long under (A) Profilograph. Test surfaces 300 feet (91.5 m) and shorter under (B) Straightedge.

- A. Profilograph.** Furnish a 25 foot (7.6 m) wheel base California type profilograph and a competent operator to measure the surface smoothness before joint sealing. Do not exceed a maximum 3 mph (4.8 km/h) operational speed. Calibrate, adjust, and operate the profilograph following the manufacturers instructions and California Test Method 526. Provide the Project Manager 24 hours advance notice before using the profilograph. The Project Manager will witness all profilograph recordings. The profilogram must record a scale of 1 inch (25 mm) to 25 feet (7.6 m) longitudinally and 1 inch (25 mm) to 1 inch (25 mm) vertically. Take a profile on a line parallel to and 3 feet (0.9 m) inside the outside edge of each traffic lane. Run the profilograph parallel to the pavement edge at all times. Additional profiles may be taken to define the limits of an out-of-tolerance surface. End the profiles 50 feet (15.2 m) from existing pavements, bridge ends, and intersections. The

acceptable lane section profile is an average profile index of 12 inches (305 mm) per mile (1.6 km) or less with each lane section being 0.1 mile (161 m) long. The Project Manager will determine the profile index using California Test Method 526. Remove all high points in excess of 0.3-inch (8 mm) in 25 feet (7.6 m) or less within each 0.1 mile (161 m) section using a method approved by the Project Manager. Re-profile corrected sections. Acceptable sections are those having an average profile index not exceeding 15 inches (380mm) per mile (1.61km). Re-profile corrected areas to determine if the section has an average profile index of 15.

Contract unit price adjustments are made following Table 501-1. The Contractor may elect to perform corrective work to reduce the average profile index when it is less than the corrective index but greater than the incentive index. Incentive will not be paid on sections with an initial index exceeding 15.

**TABLE 501-1
CONTRACT UNIT PRICE ADJUSTMENTS**

ENGLISH	
Lane Average Profile Index (Inches per Mile-per 0.1 Mile)	Contract Unit Price Adjustment
Less than 6	\$0.50 per square yard incentive pay
6 to 10	Contract Unit Price
10 to 15	\$1.00 per square yard deduction
Over 15	Corrective work required
METRIC	
Lane Average profile Index (mm per 1.6 km-per 161 m)	Contract Unit Price Adjustment
Less than 150 mm	\$0.60 per 1 square meter incentive pay
150 mm to 255 mm	Contract Unit Price
255 mm to 380 mm	\$1.20 per 1 square meter deduction
Over 380 mm	Corrective work required

The price adjustment applies to the entire area of concrete for the 0.1-mile (161 m) lane segment. The area is computed using plan width for the 0.1-mile (161 m) lane segments. Sections of pavement less than 0.1 miles (161 m) are added to subsequent paving to provide a 0.1-mile (161 m) section.

No payment is made for any section with an average profile index exceeding 15 until it is re-worked and re-profiled to an average profile index of 15 or less. Re-work all areas not profilographed (50 feet (15.2 m) from bridge ends and intersections) with high points exceeding 0.3-inch (8 mm) in 25 feet (7.6 m) to 0.3-inch (8 mm) or less per 25 feet (7.6 m).

Complete all corrective work before measuring the pavement thickness.

Include all profilographing costs in the contract unit price for portland cement concrete pavement.

- B. Straightedge.** Use straightedge tests for sections of pavement less than 300 feet (91.5 m) in length. Once the concrete has hardened, test the pavement surface with a 10 foot (3 m) straightedge placed parallel to the pavement centerline.

Span each low spot and touch each high spot with the testing edge revealing all irregularities.

Correct all pavement showing a variation from the testing edge exceeding 1/16-inch per foot (2 mm per 305 mm) from the nearest contact point with the testing edge or showing a total variation exceeding 1/4-inch (6 mm) from the 10 foot (3 m) straightedge by grinding until the areas are within the above limits.

Where the grinding methods would result in an unsatisfactory surface or in a slab thickness less than specified, the affected pavement may require an adjustment in the contract unit price or removal and replacement under Subsection 501.03.20.

Perform all pavement corrections including removing and replacing of pavement at Contractor expense.

501.03.15 Correcting Spall and Cracks

Remove and replace pavement slabs cracked through the full depth into three or more parts.

Repair pavement slabs containing a single diagonal crack intersecting the transverse and longitudinal joints within 1/3 of the width and length of the slab from the corner by removing and replacing the smaller portion of the slab. Repair broken slabs as directed.

Groove and seal random cracks that penetrate the full depth of the pavement. Groove the top of the crack to 3/4-inch (19 mm) minimum depth and a width between 3/8-inch (10 mm) to 5/8-inch (16 mm) using an approved grooving machine. Use a vertical rotary-cutting machine that can follow the crack path and widen the top of the crack to the required section without spalling or damaging the concrete. Remove all loose and fractured concrete, and thoroughly clean and seal the groove with the sealant specified in the contract.

The Project Manager will determine what random cracks are tight, don't penetrate the full depth of the pavement and will be left undisturbed. When requested by the Project Manager, determine the crack depth penetration by drilling and inspecting cores at Contractor expense.

When a transverse random crack terminates in or crosses a transverse contraction joint, fill the un-cracked portion of the joint with epoxy-resin mortar or grout, and route and seal the crack.

When a transverse random crack nearly parallels the planned contraction joint and is within 5 feet (1.5 m) from a contraction joint, route, seal, and fill the crack with epoxy-resin grout or mortar.

When a transverse random crack is more than 5 feet (1.5 m) from the nearest contraction joint in the pavement, seal both the joint and the crack. Thoroughly clean the joints before filling with epoxy-resin mortar or grout.

Repair spalls by making a saw cut at least 1 inch (25 mm) outside the spalled area and to a minimum depth of 2 inches (50 mm). When the spalled area abuts a joint, make a saw-cut 2 inches (50 mm) deep or 1/6 the slab thickness, whichever is greater. Chip out the concrete between the saw cut and the joint or primary crack to solid concrete. Thoroughly clean the resulting cavity of all loose material. Apply a prime coat of epoxy-resin binder to the dry, cleaned surface of all cavity sides, except the working joint faces to be retained. Apply the prime coat by scrubbing it into the surface with a stiff bristle brush. Place portland cement concrete or epoxy-resin concrete or mortar immediately following the prime coat application.

For spalled areas abutting working joints or working cracks penetrating full depth, place an insert or other bond breaker to maintain the joint or crack during the patch repair.

501.03.16 Opening to Traffic

Do not permit traffic or Contractor equipment, excluding joint sawing and sealing equipment, on the concrete until flex beam test results indicate the concrete has developed a minimum 350 psi (2,415 kPa) modulus of rupture.

Prepare the concrete flex beams meeting AASHTO T-23 and test for modulus of rupture using AASHTO T-97.

One test set consists of three beams. Take the concrete for the test beams from different concrete batches for each 2,500 square yards (2,100 square meters) of concrete pavement and make at least two sets per day. Test the beam sets for modulus of rupture. Cure the test beams under the same environmental conditions as the pavement they represent. The pavement, represented by the beams, may be opened to traffic when the average modulus of rupture of the set exceeds 350 psi (2,415 kPa) and no individual beam's modulus of rupture is less than 300 psi (2,070 kPa).

The Contractor may select the time for testing the beams. Test the flex beams on or near the project, using Contractor furnished equipment and with a Department Inspector witnessing the tests.

Include all costs to make, cure and test the flex beams in the contract unit price for portland cement concrete pavement.

Opening to traffic does not constitute a final acceptance of the pavement. The pavement is accepted upon confirmation of the 28-day flexural strength. Repair all concrete damaged prior to the final acceptance at Contractor expense.

501.03.17 Integral Curb

Construct the curb monolithically with the pavement.

Construct the inside face of the curb true to the lines and grades in the contract using the finish specified for the concrete pavement, including longitudinal floating and burlap drag finishing.

Test the surface for longitudinal trueness with a straightedge while the concrete is still plastic. Meet the same surface requirements specified for the concrete pavement.

Continue concrete pavement joints through the integral curb at the same locations, of the same type, and constructed in the same manner.

Cure the integral curb as specified for concrete pavement.

501.03.18 Weather and Night Limitations

Place concrete at night only with the Project Manager's written approval.

Stop concrete work when the ambient temperature falls below 40 °F (4 °C) and do not resume until the ambient air temperature reaches 35 °F (2 °C) and is rising.

Do not place concrete on a frozen foundation course or subgrade.

Remove and replace all concrete damaged by frost at Contractor expense.

501.03.19 Protection of Concrete

Cover the concrete with an approved commercial insulating blanket, covering all pavement if the ambient temperature falls below 35 °F (2 °C) during the cure period. Leave in place for seven days.

The Project Manager may direct the leaving the blanketing in place beyond the seven-day curing period.

501.03.20 Pavement Thickness

Construct concrete pavement to the specified thickness. Tolerances allowed for subgrade construction and specifications that may affect thickness do not modify the thickness requirements.

A primary unit of pavement is the pavement area placed in each day's paving operations. Within a primary unit of pavement, there may be an area or areas that are determined to be a secondary unit or units of pavement, as specified in part (B), Thickness Deficiency Exceeding 0.07 Feet (21 mm). The primary unit area is reduced by the secondary unit area.

Thickness measurements are made in each primary unit of pavement with a minimum one measurement for each 1,000 feet (305 m) of traffic lane, or fraction thereof, of pavement placed. The number of thickness measurements within each primary unit, both longitudinally and transversely, are determined by the Project Manager.

Thickness measurement locations are determined by random sampling under MT-416. Thickness measurements are made using MT-106 to the nearest 0.01 foot (3 mm).

Pavement thickness variation is determined by comparing the actual thickness measured with the specified thickness. The variation is determined to the nearest 0.01 (3 mm) foot as either excess or deficient variation.

Secondary thickness measurements are made under part (B).

When portland cement concrete pavement is placed using wire-line control over a base course constructed under a previous contract, pavement thickness variation measurements are made from a taut string line placed transversely across the pavement between grade points for the wire-line controls. Measurements are made from the string line to the pavement surface at three points across the section. Deviations from the planned cross section are computed for each point. The deviations for the three points are averaged and represent the thickness variation for that section. Three random sections are measured for each 1,000 feet (305 m) of traffic lane, or fraction thereof, and are averaged to represent that portion of a primary unit.

These measurements are the thickness deviations for applying the requirements of parts (A) and (B) below.

Fill all remaining holes in the concrete pavement after the thickness measurements are made with concrete of the same quality as that used to construct the pavement, at Contractor expense.

A. Thickness Deficiency Not Exceeding 0.07 Feet (21 mm). If all of the deficient thickness variations in a primary unit do not exceed 0.07 feet (21 mm), the thickness variations in the unit are averaged algebraically to determine the average thickness deficiency. For determining the average thickness deficiency, an excess thickness variation of more than 0.03 feet (9 mm) greater than the thickness specified is considered to be 0.03 feet (9 mm) greater than the specified thickness.

For each primary unit of pavement that is deficient in average thickness, pay to the Department, or the Department will deduct from any monies due or that may become due the Contractor under the contract, a sum computed by applying the deficiency adjustment from Table 501-2 to the quantity of the unit.

**TABLE 501-2
CONCRETE PAVEMENT THICKNESS DEFICIENCY**

AVERAGE THICKNESS DEFICIENCY		PROPORTIONAL PART OF CONTRACT UNIT PRICE
Feet	mm	Percent Allowed
0.02	6	100
0.03	9	80
0.04	12	68
0.06	18	57
0.07	21	50

For average thickness deficiencies of less than 0.02 feet (6 mm), no deficiency adjustment is made.

Average thickness deficiencies greater than 0.02 feet (6 mm) are rounded to the nearest 0.01 foot (3 mm) and the deficiency adjustment made using Table 501-2.

- B. Thickness Deficiency Exceeding 0.07 Feet (21 mm).** For each deficiency variation in a primary unit exceeding 0.07 feet (21 mm), the Project Manager will determine from secondary thickness measurements the dimensions of the secondary unit area where the apparent thickness deficiency exceeds 0.07 feet (21 mm).

The determination of the limits of the secondary unit area are made by making one randomly located secondary thickness measurement in each pavement panel adjacent to the panel in which the original measurement in the primary unit was made. This method continues until the secondary unit area is bounded by panels in which the secondary measurement is deficient in thickness by 0.07 feet (21 mm) or less.

The secondary unit area is made up of entire panels only. Panels are the areas bounded by longitudinal and transverse joints and pavement edges.

If a transverse weakened plane joint has been omitted at the location where a volunteer crack exists, the volunteer crack is considered a transverse joint only if the adjacent pavement is not to be removed and replaced.

The Project Manager will determine within the limits of the secondary unit area, which panels will require replacement and which panels may remain in place using procedures (1) and (2) below:

1. At Contractor expense, remove and replace the deficient concrete pavement panels with new concrete meeting all contract requirements. If the area to be removed is not bounded by longitudinal or transverse joints, saw the weakened plane joints at Contractor expense at the locations designated by the Project Manager. Lower the subgrade or base to meet the full thickness requirements. Replaced pavement will be tested for thickness requirements using additional secondary measurements and is subject to all of the contract requirements.
2. The Contractor may leave deficient pavement panels in place if the panels meet all of the other contract requirements and pay to the Department 50 percent of the contract unit price per square yard (square meter) or cubic yard (cubic meter) for those pavement panels left in place, or the Department may deduct that amount from any monies due or that may become due the Contractor under the contract. The decision to leave a deficient panel in place will be by contract modification under Subsection 105.03.

The cost of all secondary thickness measurements made under this Subsection will be deducted from any monies due or that may become due the Contractor under the contract.

After eliminating the secondary unit area or areas and thickness measurements from consideration, the average thickness deficiency of the remainder of primary unit areas will be determined under Subsection 501.03.20(A). Secondary thickness measurements made outside of a secondary unit area will be used to determine average thickness variation in the remaining primary unit area in which the measurements are taken.

The Contractor is not entitled to any additional compensation or time extension due to these requirements.

If the Contractor believes that the number of thickness measurements made in primary unit areas by the Project Manager are insufficient to indicate the actual pavement thickness placed, the Contractor may request the Project Manager to take additional thickness measurements. The additional calculated variations will be averaged with the original variations to determine the average thickness variation.

The Project Manager will randomly select the location of all additional thickness measurements.

The cost of all additional measurements made will be deducted from any monies due or that may become due the Contractor under the contract.

501.04 METHOD OF MEASUREMENT

501.04.1 Area Measurement

Portland cement concrete pavement is measured by the square yard (square meter) to the nearest 0.1 square yard (0.1 square meter).

The measured width is from outside to outside of completed pavement, not exceeding the specified width or the width ordered by the Project Manager.

The length is measured along the centerline of the pavement surface.

Fillets for widened sections or at drainage structures and similar locations placed monolithic with the pavement are measured as pavement.

Areas constructed other than as pavement are deducted from the pavement area. No deduction is made for any fixture located within the pavement limits that has a surface area in the plane of the pavement surface of 1 square yard (0.80 square meter) or less.

Integral curb is not measured for payment.

501.04.2 Volume Measurement

Portland cement concrete pavement is measured in cubic yards (cubic meters).

The concrete in cubic feet (cubic meters) per batch is calculated by determining the weight per cubic foot (cubic meter) of a batch using Montana Test Method MT-509 and dividing the result into the total accumulated weight of cement, aggregates, and water used in that batch.

The volume of concrete per batch is determined at least twice daily.

The volume per batch for each day's paving run is determined by averaging all volume determinations made that day.

The volume of concrete for payment for each day's run is the total number of batches accepted and placed multiplied by the volume per batch as outlined above.

501.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

Pay Item

Cement Concrete Pavement

Pay Unit

Square Yard (square meter) or
Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for resources necessary to complete the item of work under the contract.

SECTION 551 PORTLAND CEMENT CONCRETE

551.01 DESCRIPTION

These are the general requirements for designing portland cement concrete mixtures, the ingredients, mixing, placing, curing, testing and acceptance for all classes and uses of portland cement concrete.

Additional requirements and exceptions to these specifications may be found in other sections concerning the specific use of the portland cement concrete.

551.02 MATERIALS

551.02.1 Cement

Furnish low-alkali portland cement meeting the requirements of AASHTO M 85 or ASTM C 150, Type I, II, III, IV, or V, as specified.

Furnish Type I, II, or III cement for Class "Pre" concrete.

Do not use Type II-A cement.

Furnish portland cement meeting the following requirements:

1. The total alkali content does not exceed 0.6 percent, calculated as the percentage of sodium oxide (NaO) plus 0.658 times the percentage of potassium oxide (K₂O).
2. Use only one brand of any one type of cement on the contract except by written approval from the Engineer. Different brands or grades, if approved, cannot be used alternately in any one pour.
3. Store all bulk cement in metal silos, bins, or other approved storage. Provide storage facilities that permit convenient sampling and inspection. Store all sack cement in weatherproof buildings or, if approved, in the open on raised platforms with waterproof covering. Partially set, caked or lumpy cement will be rejected.

551.02.2 Air-entraining Agents

Include an air-entraining agent in the mix design. Ensure that the air-entraining agent meets AASHTO M 154 requirements.

551.02.3 Admixtures

Ensure that all chemical admixtures included in the mix design meet AASHTO M 194 requirements. Ensure that the total contribution of chloride ions from all admixtures and air-entraining agents does not exceed 50 parts per million chloride ions (Cl-) by weight of cementitious material.

551.02.4 Epoxy Adhesives

Furnish epoxy adhesives meeting ASTM C 881 or AASHTO M 234 and ASTM C 883 requirements.

Paragraph 1.4.8 of AASHTO M 234 is amended to permit thinning of epoxy for use in sealing ground deck slab areas only.

Furnish coal tar epoxy coating meeting AASHTO M 200 requirements.

551.02.5 Water

Obtain the Engineer's approval of the water to be used in the concrete. Assure the water does not contain oil, acid, alkali, vegative substances, and is not brackish or salty.

Questionable water will be tested by comparing the compressive strength of concrete cubes made with the water in question, against those of concrete cubes made with water of known quality.

The concrete cubes will be cast, cured, and tested for compressive strength under ASTM C 109.

551.02.6 Aggregate

Furnish aggregates meeting Subsection 701.01 requirements.

Store aggregates in compartmented bins, or other methods that separate the different aggregate sizes to prevent contamination. Suspend work for aggregate contamination until corrected.

Build up coarse aggregate stockpiles in successive horizontal layers not exceeding 3 feet (0.9 m) thick. Complete each layer before starting the next one. Re-mix segregated aggregate to the grading requirements at Contractor expense.

When ready-mixed concrete is furnished, the ready-mix company's stockpiled aggregates must meet the aggregate specifications. The Company must establish separate stockpiles for Department work if existing stockpiles do not meet specifications.

Do not use contaminated aggregate removed from stockpiles in the work.

551.02.7 Curing Compounds and Protective Coatings

Furnish concrete curing compounds and protective coatings and combination curing-protective coating compounds meeting Subsection 713.07 requirements.

551.02.8 Preformed Expansion Joint Fillers for Concrete

Furnish preformed expansion joint fillers meeting Subsection 707.01 requirements.

551.02.9 Blended Cements

When specified in the mix design, furnish Type IP, Type I (PM), or Type I (SM) cement meeting AASHTO M-240 requirements.

551.02.10 Fly Ash

When included in the mix design, furnish fly ash meeting AASHTO M-295 Mineral Admixture Class C or Class F, the chemical requirements of Table 1, and the physical requirements of Table 3 in M-295.

551.02.11 Microsilica

When included in the mix design, furnish microsilica meeting AASHTO M-307.

551.02.12 Metakaolin

When included in the mix design, furnish metakaolin meeting AASHTO M-295 Mineral Admixture Class N, the chemical requirements of Table 1 and the physical requirements of Table 3 in M-295.

551.02.13 Ground Granulated Blast Furnace Slag

When included in the mix design, furnish ground granulated blast furnace slag meeting AASHTO M-302.

551.03 CONSTRUCTION REQUIREMENTS

551.03.1 Classification

Concrete mixtures with prefixes "A" contain 1 1/2-inch (37.5 mm) size aggregate.

Concrete mixtures with prefixes "D" contain 3/4-inch (19 mm) size aggregate.

Concrete with prefixes "D" may be substituted for concrete with prefixes "A" when the mix design has been approved by the laboratory.

The following requirements govern:

A. Classes "A" and "D" Concrete. Classes "A" and "D" concrete are used for sidewalks, curbs, and slope protectors.

B. Classes "AD" and "DD" Concrete. Classes "AD" and "DD" concrete are used for all structural concrete.

Class "AD" concrete may be substituted for Class "DD" concrete with the Project Manager's written approval. Bid all structural concrete as Class "DD". If a substitution is made, changing back to Class "DD" must be requested in writing and receive the Project Manager's written approval.

C. Class "SD" (Special Deck) Concrete. Class "SD" (Special Deck) concrete is used for all superstructure concrete including deck slabs and barriers.

D. Classes "AP" and "DP" Concrete. Classes "AP" and "DP" concrete are used for concrete pavement on streets and highways.

E. Classes "AS" and "DS" Concrete. Classes "AS" and "DS" concrete are used for concrete deposited underwater that does not contain an air-entraining agent.

F. Class "Pre" Concrete. Class "Pre" concrete is used in all prestressed items.

G. Class "F" Concrete. Class "F" concrete is used for setting metal fence posts and braces and similar uses where high quality concrete is not necessary.

Obtain the Project Manager's approval for aggregates for Class "F" concrete.

H. Classes "AC" and "DC" Concrete. Classes "AC" and "DC" concrete are used for erosion control devices.

I. Flowable Fill. Use flowable fill for bedding, encasement, and general backfill for trenches. Flowable fill is also known as controlled low-strength material, controlled density fill, flowable mortar, and slurry cement backfill.

J. Air-entrained Concrete. Use air-entrained concrete in all parts of structures, except for Classes "AS", "DS", and "Pre" concrete.

Do not use an air-entrained portland cement.

1. Air-entraining Agents. Add the approved air-entraining agent to produce an entrained air content within the specified limits for the particular class of concrete.

2. Entrained Air. Provide the required air content for each class of concrete shown in Table 551-2.

Testing for the percent entrained air will be by MT-102 using concrete samples taken just before incorporation in the work.

551.03.2 Composition of Concrete

Furnish the names of proposed suppliers and locations of proposed aggregate sources upon receipt of the Notice of Contract Award. This information is not required for Classes "F", "AC", or "DC" concrete.

Coordinate with the Project Manager for submitting samples for testing.

A. Design. Design the concrete mix as follows:

1. Upon written request, the Department will furnish a preliminary laboratory mix design for each class of concrete. Use this mix design as a starting point for designing the final mix.
 2. Design the concrete mix to meet Table 551-2 requirements. State the design proportions in terms of aggregates in a saturated, surface dry condition. Submit the proposed aggregate source and proportion computations. Submit a final mix design for approval.
 3. Do not change the material sources without approval.
 4. The following cementitious materials may be used as partial replacement for portland cement in the mix design.
 - a. Fly ash may be included in the mix design for up to 20 percent by weight of the total cementitious material. Portland cement meeting AASHTO M 85, Table 1, may be used in place of moderate heat of hydration cement where fly ash is substituted.
 - b. Microsilica may be included in the mix design for up to 5 percent by weight of the total cementitious material when a minimum of 15 percent fly ash is also included in the mix design or when the mix design uses Type IP blended cement.
 - c. Metakaolin may be included in the mix design for up to 20 percent by weight of the total cementitious material.
 - d. Ground granulated blast furnace slag may be included in the mix design for up to 20 percent by weight of the total cementitious material.

Calculate the water-cement ratio as the total weight of water divided by the total weight of cementitious material.
 5. Except when Type V cement is specified, blended cements meeting the requirements of Section 551.02 may be used in the mix design.
 6. The mix design may include provisions that address special conditions of the project that would otherwise not be allowed. The following provisions may be included in the mix design:
 - a. **Delayed Initial Set.** The mix may be designed for delayed set time to allow for long haul or other project conditions. When delayed set is included in the mix design, the time requirements for placing the concrete in final position contained in Subsection 551.03.4(A) may be replaced by time to final placement requirements included in the mix design. Include in the mix design information on the delayed set provisions of the design and specific time to final placement requirements.
 - b. **Slow Strength Gain.** The mix design may include cementitious materials or other admixtures that result in slow strength gain. When a slow strength gain is included in the mix, include in the mix design a recommendation for the age in days at which the strength will be obtained. The recommended age must be no less than 28 days and no more than 56 days. Support this recommendation with test results. Upon acceptance, the recommended age will be used in all provisions that refer to 28-day strength.
- B. Class "F" Concrete.** Class "F" concrete is 1 part portland cement, 2 parts of clean, hard, sharp sand passing a #4 mesh (4.75 mm) screen, and 4 parts of clean, broken stone or gravel uniformly graded between the #4 mesh (4.75 mm) and 1 1/2-inch (37.5 mm).
Proportion the materials by weight or volume as approved.
Class "A" or "D" concrete may be substituted for Class "F" concrete.
- C. Classes "AC" and "DC" Concrete.** Classes "AC" and "DC" concrete is low slump concrete meeting Table 551-2 requirements.

Use broken stone or gravel uniformly graded between the #4 mesh (4.75 mm) and the maximum size sieve and clean, hard, sharp sand passing the #4 mesh (4.75 mm) sieve.

Proportion the materials by weight or volume as approved.

Class "A" or "D" concrete may be substituted for Classes "AC" and "DC" concrete.

D. Class "SD" Concrete. Produce Class "SD" concrete meeting Table 551-2 requirements.

Furnish coarse aggregate meeting the gradation requirements for No. 2 coarse aggregate in Table 701-4 in Subsection 701.01.2, with five percent maximum passing the No. 8 (2.36 mm) sieve.

E. Flowable Fill. Flowable fill is a mixture of portland cement, fly ash, fine aggregate, air entraining admixture and water. Flowable fill contains a low cementitious content for reduced strength development. Submit a mix design for approval. No compressive strength testing is required for the mix design.

Table 551-1 has the suggested mix guides for excavatable and non-excavatable flowable fill.

**TABLE 551-1
FLOWABLE FILL MIX DESIGN GUIDE**

MATERIALS	EXCAVATABLE	NON-EXCAVATABLE
Cement, Type I or II	75.6-102.6 lb/yd ³ (45-60 kg/m ³)	75.6-151.2 lb/yd ³ (45-90 kg/m ³)
Fly Ash	None	151.2-596.7 lb/yd ³ (90-355 kg/m ³)
Water	Mix designs must produce a consistency that results in a flowable, self-leveling product at time of placement.	Mix designs must produce a consistency that results in a flowable, self-leveling product at time of placement.
Air	5% to 35%	5% to 15%
Unit Weight (Wet)	2,430-2,970 lb/yd ³ (1,440-1,760 kg/m ³)	2,700-3,375 lb/yd ³ (1,600-2,000 kg/m ³)

Furnish fine aggregate meeting Subsection 701.01.1 requirements. The fine aggregate has no fineness modulus requirement.

High air generators or foaming agents may be used in lieu of conventional air entraining admixtures and may be added at the jobsite and mixed in accordance with the manufacturers recommendation.

The requirements for percent air, compressive strength and unit weight are for laboratory designs only and are not intended for jobsite acceptance requirements. Proportion fine aggregate to yield 1 cubic yard (1 cubic meter).

**TABLE 551-2
CONCRETE PROPORTIONING TABLE**

Class	Size of Coarse Agg, Square Mesh, Inches (mm)	Indicated Compressive Strength, 7-Day, PSI (MPa)	Minimum Required Compressive Strength, 28-Day, PSI (MPa)	Maximum Water / Cement Ratio (W/C)	Target Value for Slump, Inches (mm) ⁴	Tolerance, Inches (mm)	Required Air Content, Percent
A	1 1/2 (37.5)	2,000 (14)	3,000 (21)	0.53	2 1/2 (60)	± 3/4 (20)	4-6
D	3/4 (19)	2,000 (14)	3,000 (21)	0.53	2 1/2 (60)	± 3/4 (20)	5-7
AD	1 1/2 (37.5)	2,000 (14)	3,000 ³ (21)	0.53	2 1/2 (60)	± 3/4 (20)	4-6
DD	3/4 (19)	2,000 (14)	3,000 ³ (21)	0.53	2 1/2 (60)	± 3/4 (20)	5-7
AS	1 1/2 (37.5)	1,600 (11)	2,400 (17)	0.53	6 (150)	± 2 (50)	—
DS	3/4 (19)	1,600 (11)	2,400 (17)	0.53	6 (150)	± 2 (50)	—
AP ¹	1 1/2 (37.5)	2,000 (14)	Note 3	0.53	1 1/2 (40)	± 3/4 (20)	4-6
DP ¹	3/4 (19)	2,000 (14)	Note 3	0.53	1 1/2 (40)	± 3/4 (20)	5-7
Pre ²	3/4 (19)	—	5,000 (34)	—	—	—	—
F	1 1/2 (37.5)	—	—	0.53	—	—	—
AC	1 1/2 (37.5)	—	—	0.53	1 1/2 (40)	± 3/4 (20)	—
DC	3/4 (19)	—	—	0.53	1 1/2 (40)	± 3/4 (20)	—
SD	3/4 (19)	—	Note 3	0.40	2 1/4 (60)	± 3/4 (20)	5-7

Notes:

1. For concrete pavement, the 28-day flexural strength requirement is 500 psi (3.5 MPa) minimum, determined by AASHTO T9 (ASTM C 78).
2. For prestressed beams, the minimum compressive strength at transfer of pre-stress is 4,000 psi (28 MPa). The strength shown at transfer of pre-stress and the 28-day requirement are for standard beams and varies with beam length and design. Check plans and specifications for each project.
3. The minimum required compressive strength at 28 days listed in the table does not apply to Classes "AD" and "DD" concrete used in bridges and structures. The compressive strength for acceptance for Classes "AD" and "DD" concrete used in bridges and for Classes "AP", "DP", and "SD Modified" concrete is that specified in Subsection 551.03.7(C)(1).
4. The target value for slump may be reduced as necessary for concrete placed using slip-form methods. When included in the mix design, mid range or high range water reducers may be used to increase slump to facilitate placement.

551.03.3 Sampling, Handling, Batching, and Mixing

Produce each class of specified concrete from approved material batched in the proportions specified in the approved mix design.

Correct for moisture content variations. The fine and coarse aggregates are sampled using methods described in MT-201 using sample sizes used in MT-202.

The water may be proportioned by weight or volume. Proportion the cement, fine aggregate, and coarse aggregates by weight.

The Contractor may substitute approved volumetric measuring devices for weighing devices when batching aggregates for structures containing less than 10 cubic yards (7.65 cubic meters) of concrete.

Obtain the Engineer's approval of weighing methods before starting batching operations.

A. Water.

- 1. Weigh Measurement.** Assure the weigh equipment measurements are not affected by pressure variations in the water supply lines. The Project Manager may require an auxiliary tank for filling the weighing tank.
- 2. Metering.** Measure water volume by metering through a recording water-meter device, accurate to within plus or minus 1 percent of the required volume or plus or minus 1 gallon (3.8 L), whichever is greater.

Meter water for batching and mixing during warm weather operations.

The Project Manager may permit alternate methods of water measurement for cold weather work.

Completely discharge wash water from the mixer before starting any batching operation.

B. Cement and Aggregate. Proportion cement and aggregate by weight on all projects exceeding 50 cubic yards (38 cubic meters) for all classes of concrete.

Assure equipment for weighing cement and aggregates is accurate to within 0.5 percent of the true weight.

Weigh aggregates to within 1.5 percent of the total aggregate batch weight.

Weigh cement or fly ash to within 1.0 percent of the total cement batch weight. Weigh cement separately.

Equip scales for manual operation with a telltale dial or other device to show at least the last 50 pounds (23 kg) of load.

C. Batching Plant. Equip the batching plant with separate bins, weighing hoppers, and scales for fine aggregate and each size coarse aggregate.

If bulk cement is used, include a bin, hopper, and separate scale for the cement. Seal and vent the cement weighing hoppers to prevent dust escaping to the atmosphere.

Equip the batching plant with a non-resettable batch counter that indicates the number of batches proportioned.

A single weighing hopper with an accumulative scale is permitted if a separate scale is used for weighing the cement.

Batch plants must meet the requirements of having a separate scale for weighing the cement if:

- 1.** The cement is always weighed in a separate inner hopper of standard manufacture design.
- 2.** The cement is always batched and weighed first in the batching sequence.
- 3.** Fly ash is batched separately by weight.

For projects exceeding 20,000 square yards (16,720 square meter) of portland cement concrete pavement, proportion aggregates and cement with equipment that weighs and records batch weights automatically.

Provide the Project Manager a printed record of each batch's weight for aggregate; cement; fly ash; volume of water and admixtures; the time mixing began; time batch discharged; haul unit number; and percent moisture in aggregate. The automatic batching equipment above may be used for smaller concrete volumes.

Provide each scale installation with 10 standard 50 pound (23 kg) test weights.

Locate the aggregate sampling device at the nearest practical point the aggregates enter the batching weigh bins. Obtain the Project Manager's approval of the sampling device before batching operations begin.

D. Mixers. Use mixers that combine cement, aggregates, water, and admixtures within the specified time to form a uniformly mixed mass.

Operate mixers following the manufacturers recommendations.

Assure the manufacturer's plate is prominently displayed on the mixer showing the drum capacity in volume of mixed concrete.

Repair or replace mixer blades worn more than 3/4-inch (19 mm) from the design dimensions.

Clean hardened concrete from the drum. Do not intermingle batches.

Uniformity tests on three consecutive batches will be performed on samples taken after 15 percent and 85 percent of the batch is discharged.

Table 551-3 specifies the maximum permissible variations in test results on samples from the two different portions of the same batch.

TABLE 551-3
ALLOWABLE BATCH VARIATIONS

TEST RESULT	VARIATION
Air Content - Volume, percent of concrete	1.0 percent
Slump	1.0 inch (25 mm)
Coarse Aggregate Content - portion by weight of each sample retained on No 4 sieve (4.75 mm)	6.0 percent
Average Compressive Strength at 7 days for each sample based on average strength of all comparative test specimens, percent (two cylinders will be molded and tested for each sample)	7.5 percent

Concrete is acceptable if test results in two out of three batches meet the limits for three out of the four tests.

Provide the facilities for sampling and arrange schedules for the sampling and testing.

Dump all concrete mixed less than the specified time outside the work or remove if incorporated, at Contractor expense.

Do not mix, transport, or place concrete using equipment with aluminum or aluminum parts that contact the concrete.

Concrete may be mixed in central plant mixers or in truck mixers meeting the following requirements:

- 1. Central Plant Mixers.** Equip central plant mixers with an approved timing device, that automatically locks the discharge device when the drum is charged and releases the lock at the end of the required mixing period. The lock must have an audible warning device, which signals each time the lock is released.

If the locking and timing device fails, the mixer may be used temporarily, provided the mixing time is increased 50 percent by using a clock or watch with a second hand located within full view of the mixer operator. Repair or replace the timing device within three working days.

Equip mixers to have a positive mechanical device to prevent adding aggregate after the drum has been charged and mixing has begun.

Mixing time for central plants is 90 seconds. The required mixing time may be reduced if the plant is capable of producing a homogeneous mix in a shorter time. Reduced mixing time will be approved only if uniformity tests meet Subsection 551.03.3(D) requirements.

- 2. Truck Mixers and Agitators.** Use truck-mounted mixers having a closed, watertight revolving drum fitted with blades that thoroughly mix and completely discharge the concrete without segregation.

Assure the manufacturer's plate showing the rated mixing, agitating capacity and the rated drum speeds for mixing and agitating is attached to the truck mixer and is legible.

Equip truck mixers with an accurate revolution counter that registers the drum revolutions. Mount the counter so it is easily read by both the operator and Inspector.

Equip truck mixers with a water-metering device that is accurate to within plus or minus one percent of the required volume or plus or minus one gallon (3.8 L), whichever is greater.

The truck mixer metering device is not required if all batch water is added at the plant or other location through an approved metering device.

Operate the drum at the manufacturer's recommended speeds.

Introduce water, cement, and aggregates at a central plant and add aggregates into the mixer in any sequence that produces a concrete meeting all contract requirements.

Batch cement and water simultaneously.

Water may be added at the job site provided its introduction is witnessed by an Inspector and the specified water-cement ratio is not exceeded.

If water is added at the job site, provide at least 20 additional mixing revolutions each time water is added before discharge.

Begin mixing immediately after introducing the cement and water and continue for at least 70 revolutions at mixing speed.

Assure at least 100 drum revolutions exceed 6 revolutions per minute. All revolutions exceeding 100 must be at agitating speed.

Keep the drum revolving continuously after the cement and water are introduced until it is discharged.

Do not use mixed concrete that has remained in the truck mixer drum longer than 10 minutes without agitation.

Concrete may be partially mixed by central plant mixing and completed by truck mixing. Central plant mixing must meet the requirements of Subsection 551.03.3(D)(1), except that the central plant mixing time may be reduced to 30 seconds. Continue the additional truck mixing between 50 and 80 drum revolutions at mixing speed.

E. Hand Mixing. Approval may be given to hand mix batches not exceeding 1/2 cubic yard (0.4 cubic meter) provided:

1. The hand mixing is performed on watertight platforms or containers.
2. The sand is spread evenly over the platform.
3. The cement is uniformly distributed over the sand and the two ingredients are thoroughly mixed dry using shovels until the mix is uniform in color.

Form the mix into a "crater", add water, turn and slice the entire mass until a uniform consistency is obtained.

Thoroughly wet the coarse aggregate, add it to the mortar, and turn and re-turn the entire mass at least 6 times until all aggregate is thoroughly covered with mortar and the mix is uniform in color and appearance.

Do not place hand mixed concrete underwater.

551.03.4 Transporting Concrete

Assure that the capacity of the plant and transportation equipment provides a delivery rate to permit handling, placing, and finishing of the work.

Time the delivery of loads to prevent the in-place concrete from taking initial set before succeeding layers or lifts are placed. Do not permit any layer or lift of concrete to remain exposed in excess of 20 minutes before being covered by fresh concrete.

Document the method and time of delivery by plant slips issued to the driver and signed by the Inspector at the plant. Deliver the slip to the Project Inspector upon arriving at the project.

A. Revolving Drum Mixers. Transport concrete in revolving-drum mixers meeting Subsection 551.03.3(D)(2) requirements.

Discharge the concrete at the job and place it in final position within 1 1/2 hours after introducing the mixing water and cement.

When the ambient temperature is 85 °F (29 °C) or above, place the concrete in final position within 1 hour after the water and cement are introduced.

B. Non-agitating Transportation Equipment. Do not use non-agitating transport equipment to transport concrete except when placing concrete pavement under Section 501.

551.03.5 Placing Concrete

Assure all reinforcement and other embedded items are clean and free from dried mortar, rust, scale, oil, or foreign matter before placing concrete.

Keep untreated forms and existing concrete in contact with fresh concrete wet at least 1 hour before placing the concrete.

Wash treated forms with a water spray immediately before placing the concrete.

Place concrete meeting the applicable requirements of Sections 501, 552, and 553.

Compact concrete into final position and consolidate it around fittings and embedded items.

Do not place fly ash or Type IP concrete cement in different parts of the same structure before obtaining the Project Manager's approval. Demonstrate that such use does not result in noticeable color changes or appearance.

Place flowable fill meeting the following requirements:

1. Place by chute or pumping and use a tremie when placing through water;
2. Place to the designated fill line without vibration or other compaction methods;
3. Do not place when the ambient temperature is below 35 °F (1.7 °C). Protect from freezing for a minimum of 36 hours after placement;
4. Use straps, soil anchors or other approved means of restraint when flowable fill is used for pipe backfill and other uses that may result in flotation, uplift or misalignment; and
5. Confine the flowable fill material within the designated placement area. Prevent intrusion damage to adjacent work areas and facilities from lateral hydraulic pressure of the fill during placement and prior to hardening. After placement leave the flowable fill undisturbed until the material has set.

551.03.6 Curing Concrete

Protect exposed concrete surfaces from premature drying by covering it with canvas, plastic sheets with sealed joints, burlap, sand, or other materials. Keep the concrete moist. Continually moisten uncovered surfaces by misting.

The concrete surfaces against forms may be cured by leaving the forms in place for at least seven days.

Protect concrete against freezing or other conditions harmful to strength development under the applicable requirements of Sections 501, 552, and 553.

To aid finishing, side forms on ornamental work, curbs and sidewalks, railings, and parapets may be removed between 12 hours and 48 hours after concrete placement.

Continue moist curing while finishing the concrete.

Keep the concrete surfaces moist after removing forms until surface repair is completed and one of the final cure methods described below is used. Surface repair includes removal of irregularities and repair of all depressions, voids, and air holes.

Cure concrete for at least seven days after the concrete is placed by either of the following methods.

A. Water Curing. Keep all finished top surface concrete moist with a fine water mist until the concrete has set. Keep the moist concrete wet with water or an approved curing cover.

Cure concrete deck slabs and concrete floors by placing burlap, cotton mats, or other absorptive material behind the finishing operation as soon as possible without marring the finished surface. Keep the absorptive material moist while in place.

The absorptive material may be kept in place for the entire curing period, or it may be removed as soon as practical and the entire surface covered with approximately 1 1/2 inches (40 mm) of sand, kept moist for the entire curing period.

B. Impervious Membrane Curing. Use Type 2 white-pigmented membrane curing compound on deck slabs and portland cement concrete pavements.

Use Type 1-D clear membrane curing compound with a translucent fugitive dye for other surfaces.

Deliver membrane-curing compound to the job in the manufacturer's original container, clearly labeled with the manufacturer's name and the contents.

Furnish clear curing compound, transparent and free from permanent color.

The clear compound must contain a fugitive dye that makes the film visible on the concrete for at least four hours after application but does not affect the concrete surfaces natural color after curing.

The compound must be ready to use as shipped by the manufacturer. Do not dilute the compound.

Do not use curing compound without providing the Project Manager a manufacturer's certification.

Pressure apply the curing compound, spraying it over the entire exposed surface in a minimum uniform film of one gallon per 150 square feet (0.27 L per square meter) of concrete surface. Pressurize the curing compound to produce a fine mist on the concrete during application.

Apply the curing compound immediately after the concrete finishing is completed.

If it is necessary that workers or equipment be on the concrete surface before the seven day curing period is complete, cover the sealed surface with a protective cushion. Use a cushion of moist, 1-inch (25 mm) minimum thick layer of fine sand or sufficient layers of moist burlap to prevent damage to the finished concrete. Cover the cushion with 4 feet by 8 feet (1,220 mm by 2,440 mm) sheets of 3/4-inch (20 mm) plywood. Do not place the cushion material until the final application of curing compound has been in place for eight hours.

Alternate cushion material may be approved by the Project Manager in writing. Layers of plastic, visqueen, or canvas are not permitted.

C. Application of Combination Curing and Protective Coating Compounds. When specified, uniformly apply a combination curing and protective coating compound meeting Subsection 713.07 requirements over horizontal surfaces such as pavements, bridge deck slabs, concrete floors, and sidewalks.

Use white-pigmented compound for pavements or deck slabs.

Use a clear compound containing a fugitive dye on curbs, sidewalks, barrier rail, and other superstructure components.

Thoroughly mix and apply the compound following the manufacturer's instructions or apply at a rate exceeding 1 gallon per 150 square feet (0.27 L per square meters).

Apply the curing compound immediately after the finishing operation using a self-powered machine with a mechanical pressure distribution system to provide uniform coverage. Equip the spray nozzles with hoods during windy conditions.

A hand-operated sprayer providing uniform coverage may be used to apply liquid curing compound to areas where a self-powered sprayer is impractical.

If the curing membrane is damaged from any cause during the curing period, re-coat the damaged areas immediately.

551.03.7 Testing and Acceptance of Concrete

A. Compressive Strength Testing.

1. **General.** A compressive strength sample consists of three test cylinders made at the same time from the same batch of concrete.

The Contractor may make additional cylinders to determine strength gain and to maintain job control.

Standard compressive strength tests will be made at seven and 28 days, except as specified below for concrete used in prestressed members and for Class "SD" concrete.

The compressive strength results from one or a combination of the cylinders tested will determine if the concrete meets the required compressive strength in Table 551-2.

Samples for making the cylinder will be taken following MT-105. Test cylinders will be cast and cured following MT-101 and tested meeting AASHTO T 22.

2. **Prestressed Concrete Members.** Standard compressive strength tests for Class "Pre" concrete will be made at 28 days. The average strengths of the three 28-day cylinders will determine acceptance under Subsection 551.03.7(C)(2).

The Contractor may make additional cylinders to determine strength gain and to maintain job control.

3. **Class "SD" Concrete.** Standard compressive tests for Class "SD" concrete will be made at seven and 28 days. The average strengths of two 28-day cylinders will determine acceptance under Subsection 551.03.7(C)(1).

4. **Flowable Fill.** The Project Manager will determine when flowable fill may be covered based on the following:

- a. Supports the weight of a person weighing at least 155 lbs (70 kg) without deforming the surface, when placed beyond the traveled way; or
- b. After 24 hours or obtains 35 psi (240 kPa) penetration resistance as measured by a pocket penetrometer, when placed within the traveled way.

Do not use flowable fill as a driving surface. Grade surface of flowable fill within the traveled way to allow for specified depth and type of surfacing material.

- B. **Flexural Strength Testing.** In addition to the above compressive strength requirements, Classes "AP" and "DP" portland cement concrete pavements require beam tests to determine the concrete's flexural strength.

The number of flexural strength tests required for acceptance is determined by the Department on a random basis. The flexural strength results from one or a combination of the beams tested will be used to determine whether the concrete meets the required flexural strength specified in Table 551-2.

Flexural beams made in the field will be cast and cured using MT-101 and tested under AASHTO T 97 (ASTM C 78).

C. Acceptance of Concrete. The concrete must meet all other specifications and the following:

- Classes "AD", "DD", "SD", "AP", and "DP" Concrete.** These classes of concrete placed in bridges and in concrete pavement are evaluated for acceptance on a lot-by-lot basis.

The concrete quantity placed in a single day for each class of concrete is divided into the number of equal quantity lots shown in Table 551-4.

**TABLE 551-4
CONCRETE LOT QUANTITIES**

CLASSES "AD", "DD", AND "SD" CU. YD. (m³)	CLASSES "AP" AND "DP" CU. YD. (m³)	NO. OF LOTS
Less than 200 (153)	Less than 1,000 (765)	1
200-399 (153-305)	1,000-1,999 (765-1,529)	2
400-599 (306-458)	2,000-2,999 (1,530-2,294)	3
600-799 (459-611)	3,000-3,999 (2,295-3,059)	4
800-999 (612-764)	4,000-4,999 (3,060-3,824)	5

Two sets of standard compressive test cylinders 6-inch x 12-inch (152 mm x 305 mm) or 4-inch x 8-inch (102 mm x 203 mm) will be made for each lot. Each set will be made from a sample taken from a single batch or load selected at random from all loads or batches in the lot. For concrete lots less than 30 cubic yards (23 cubic meters), the Engineer may elect to make only one set of standard compressive test cylinders to represent the lot.

Each set will consist of one cylinder for Classes "AD", "DD", "AP", and "DP" concrete and two cylinders for Class "SD" concrete.

Samples to make the cylinders will be taken following MT-105. Cylinders will be cast and cured using MT-101 and tested under AASHTO T 22.

Each set of cylinders is tested for compressive strength at 28 days. The test results for two cylinder sets will be the average of the strengths of the individual cylinders.

The strengths of other cylinders made from the sample and tested at earlier ages are not used for acceptance.

The lot acceptance strength is the average of the test results for the lot.

Each lot is accepted or rejected based on the lot acceptance test strength. The pay factor for each lot accepted is determined from Table 551-5.

**TABLE 551-5
PAY FACTORS
LOT ACCEPTANCE STRENGTH - PSI (1 psi = 6.9 kPa)**

CLASS	1.0	0.95	0.85	0.70
AP, DP, AD, DD	3,000 or >	2,850-2,999	2,700-2,849	< 2,700
SD	4,500 or >	4,300-4,499	4,100-4,299	< 4,100

The Contractor may request acceptance of a lot at the 0.95 pay factor in lieu of approved corrective work or removal and replacement.

Acceptance at the 0.85 and 0.7 pay factor instead of approved corrective work or removal and replacement will be on the Engineer's determination of the effects the

defective lot will have on structural integrity and durability specified in Subsection 105.03.

The concrete quantity in each accepted lot is paid at the contract unit price multiplied by the appropriate pay factor in Table 551-5.

The lot quantity for pay factors less than 1.0 is computed from:

- a. Plan neat line dimensions of the portions of the bridge or bridges where the lot was placed; or
- b. The plan area in square yards (square meters) of the section of pavement in which the lot was placed.

2. **Class "Pre" Concrete.** Class "Pre" concrete is evaluated for acceptance on a lot-by-lot basis based on the average of the 28-day compressive strength cylinders and variation in test results as measured by the standard deviation.

Each lot will be judged against the formula:

$$X - F'c + 0.35S$$

Where:

X is the average of three 28-day cylinder strengths.

S is the standard deviation of the strengths for the three 28-day cylinders.

F'c is the concrete strength required for final acceptance as specified in the contract.

A lot is defined as all the concrete that is placed in a single pre-cast prestressed member.

Lots with any actual average cylinder strengths less than that calculated from the above formula will be rejected.

Three 28-day compressive test cylinders will be made for each lot, and each 28-day test cylinder sample will be selected on a random basis from all batches or loads.

The strengths of other cylinders made from a sample and tested at an earlier age will not be considered for acceptance purposes.

The cylinders for acceptance will be cast under MT-101, sampled under MT-111 and tested under AASHTO T 22.

The cylinders will be cured within the curing enclosure under the exact conditions and methods used to cure the prestressed member until transfer of pre-stress. After transfer of pre-stress, the cylinders will continue curing under MT-101.

3. **Classes "A", "D", "AS", and "DS" Concrete.**

- a. The average of all the 28-day strength tests representing each class of concrete, as well as the average of any 5 consecutive 28-day strength tests representing each class of concrete, must be equal to or greater than the required compressive strength.
- b. Not more than one test in ten consecutive tests may fall below 90 percent of the required compressive strength.
- c. On projects where less than 10 tests are made, not more than one test may fall below the required compressive strength. The average of all tests must be equal to or greater than the required compressive strength, and paragraph (d) below will not apply.
- d. Not more than ten percent of all compressive strength tests may fall below the required compressive strength for each class of concrete used in each major structure.
- e. Concrete represented by tests that fail to meet the requirements of paragraphs (a), (b), (c), and (d) will be rejected, unless it can be established by other methods

that the concrete is acceptable in place in the completed structure. Procedures to evaluate in-place concrete that has failed one of the above requirements will be approved by the Engineer. Submit these procedures in writing within 7 days after the last compression test representing the specific member. Include in the written procedure details of sampling methods, including sample locations, test methods and conditions, and proposed criteria to evaluate test results. Generally, nondestructive test methods such as the Swiss hammer and the Windsor probe will not be considered. The evaluation procedure must be approved in writing before any sampling or testing of concrete in-place.

- f. Unsatisfactory concrete will be rejected. Remove and replace all rejected concrete at Contractor expense.
4. **Small Concrete Quantities.** The Project Manager may accept 7 cubic yards (5.4 cubic meters) or less of 3,000 psi (20.7 MPa) strength concrete without a formal mix design. Submit a batch proportion sheet to for approval before use. Class "SD" concrete is excluded from this exception. Furnish concrete under this exception meeting the slump requirements in Table 551-2.

551.04 METHOD OF MEASUREMENT

Concrete is measured by the cubic yard (cubic meter) under Subsection 552.04, unless otherwise specified.

Classes "AP" and "DP" concrete is measured for payment under Subsection 501.04.

Concrete used in pre-cast concrete products is measured for payment under Subsection 554.04.

Class "Pre" concrete is measured for payment under Subsection 553.04.

551.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Concrete	Cubic Yard (cubic meter)

Concrete is paid for at the contract unit price per cubic yard (cubic meter) under Subsection 552.05.

Classes "AP" and "DP" concrete is paid for under Subsection 501.05.

Concrete used in pre-cast concrete products is paid for under Subsection 554.05.

Class "Pre" concrete used in prestressed concrete members is paid for under Subsection 553.05.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 552
CONCRETE STRUCTURES

552.01 DESCRIPTION

This work is constructing concrete structures, and portions of prestressed concrete, steel, timber, stone masonry, and composite structures.

552.02 MATERIALS

Furnish materials meeting the following Section and Subsection requirements:

Concrete	551
Reinforcing Steel and Structural Steel	711
Expansion Joint Filler.....	707.01
Water Stops	707.03
Compression Joint Seals	711.15
Fiber-reinforced Pads for Bearing Plates.....	711.16

552.03 CONSTRUCTION REQUIREMENTS

552.03.1 General

The classes of cast-in-place concrete used in bridge substructures, retaining walls, and superstructures are as follows:

- A. Class "AS" or "DS" for foundation seals and other underwater placement;
- B. Class "AD" or "DD" for retaining walls, substructure to the beam seats, backwalls, and diaphragms; and
- C. Class "SD" for decks, curbs, sidewalks, and barriers.

552.03.2 Foundations

Construct foundations meeting Section 209 requirements.

Place concrete only after the foundations are inspected and approved.

552.03.3 Falsework

Construct falsework that supports the concrete work without detrimental deformation or settlement and to the plan lines and grades.

Use piling to support falsework not on solid footings.

Temporary camber all spans allowing for shrinkage and settlement. The contract specifies those bridges that require a permanent camber.

Provide "Tattletales" or other approved devices at locations to indicate form settlement or deflection. Adjust falsework as required to maintain plan line and grade.

Stop the work if detrimental settlement occurs in the falsework that cannot be adjusted. Remove and replace all concrete work affected by detrimental settlement at Contractor expense.

The Contractor is responsible for the adequacy and execution of the falsework plans. Furnish a Contractor approved copy of the falsework plans to the Project Manager upon request. The Contractor approval must be shown on the drawings.

552.03.4 Forms

Construct forms so their removal does not damage the concrete.

Remove all forms and form members not designated to remain in place.

The term "exposed surfaces" means those concrete surfaces that are above the finished ground line.

Use metal or plywood forms for exposed surfaces, and countersink all bolt and rivet holes. Assure the forms are mortar-tight providing a smooth finished concrete surface meeting the specified shape. Rough lumber, tongue-and-groove lumber, and steel-framed wooden panel forms may be used for surfaces not exposed in the finished structure that do not adversely affect the strength or appearance of the finished structure.

Use only one type of material in any form or group of forms for exposed concrete surfaces on similar parts of a structure.

Use filleted forms for re-entrant angles. Chamfer forms 3/4-inch (20 mm) for all exposed corners and edges with an enclosed angle of less than 120 degrees.

Design the forms and falsework assuming the concrete has a liquid weight of 150 pounds per cubic foot (2,432 kg per cubic meter) minimum for vertical loads and 85 pounds per cubic foot (1,378 kg per cubic meter) minimum for horizontal pressure. Include in the design allowances for temporary construction loads.

Do not place concrete exceeding the designed form pressure.

Use forms for completed structures that are removable without disturbing adjacent forms.

Form marks must conform to the general lines of the structure. Column form marks may be horizontal or vertical or both, being as symmetrical as practical.

Provide form openings that permit ready access for form cleanout, inspection, placement, and compaction of the concrete. Provide cleanout ports at the top surface of the concrete where placing is stopped in narrow forms for walls or columns or where the bottom of the form is inaccessible.

Remove all extraneous material within the forms before placing concrete.

Treat the forms interior surfaces to prevent mortar adhesion.

Water soak wooden forms to close shrinkage cracks.

Set and maintain forms to the specified alignment, grade, and section and leave in place after concrete is placed for the specified time in Subsection 552.03.11.

Form defects are cause to stop work until corrected.

Fit metal tie rods or anchorages within the forms with cones or other devices that permit the rod and anchorage to be removed to 1-inch (25 mm) below the surface without damaging the concrete.

Use metal tie fittings that leave the smallest possible size cavities. Dry pack cavities with cement mortar to produce a sound, smooth, even finished surface closely matching that of the adjacent concrete after form removal.

Use deck slab forms that permit vertical adjustment of the bottom of the slab form.

552.03.5 Placing Concrete

A. General. Place concrete within the specified time limits in Subsection 551.03.4

Use an approved set-retarding admixture when ambient temperatures are expected to exceed 60 °F (15 °C) during deck slab concrete placement. Cement content reduction is not allowed.

Maintain the concrete temperature immediately before placement between 40 °F (5 °C) and 90 °F (32 °C).

Prevent concrete segregation and displacement of the reinforcement as the concrete is placed. Thoroughly clean all chutes, troughs, and pipes with water after each run. Discharge flushing water away from the forms and in place concrete.

Use metal or metal-lined troughs and chutes that extend to the point of deposit. Use a hopper or other device to regulate the discharge.

Do not allow concrete to drop from a height exceeding 5 feet (1,500 mm) unless it is within a conduit.

Support bars to maintain their position as shown in the contract.

Deposit concrete in small quantities at many points and then work or run it along the forms. Carefully fill each part of the forms, depositing the concrete as close as possible to its final position, working the coarse aggregates back from the face and forcing the concrete under and around the reinforcing bars. Do not allow concrete to fall through or over reinforcing steel, tie rods, or similar items.

Deposit concrete around steel shapes and closely spaced reinforcing bars, on one side of the steel, uniformly working it until the concrete flushes under the steel to the opposite side before any concrete is placed on the opposite side or over the steel.

Once the concrete has taken initial set, avoid jarring the forms or straining the projecting reinforcement ends.

Thoroughly consolidate all concrete, except seal concrete, during and immediately after depositing using mechanical vibration as follows:

1. Apply the vibration internally unless otherwise approved or as provided herein.
2. Vibrate the concrete at a minimum 4,500 impulses per minute or as recommended by the vibrator manufacturer.
3. The vibration must visibly affect the concrete mass, producing a 1-inch (25 mm) slump over a minimum 18-inch (460 mm) radius.
4. Use enough vibrators to compact each batch immediately after it's placed.
5. Vibrate the concrete around the reinforcement and imbedded fixtures and into the form corners and angles.

Vibrate at the point of deposit in areas of freshly deposited concrete. Slowly insert and remove the vibrators from the concrete. Vibrate to thoroughly consolidate the concrete without causing segregation or forming localized grout areas.

Vibrate at uniformly spaced points and no farther apart than twice the radius over which the vibration is visible.

6. Do not apply vibration directly to or through the reinforcement or to non-plastic sections or layers of concrete. Do not use vibrators to transport concrete in the forms. Use plastic or rubber tipped vibrator heads when placing concrete near epoxy coated reinforcing steel.
7. Supplement vibration by spading and tamping to produce smooth surfaces and dense concrete along form surfaces, in corners and locations impractical to reach with the vibrators.
8. These requirements apply to precast piling, concrete cribbing, and other precast members unless the manufacturer's vibration methods are approved.

Place and secure all reinforcing, dowels, and other embedded items as specified before placing the concrete. Clean rust, scale, oil, dried mortar deposits or foreign material from all embedded materials before embedding in the fresh concrete.

Continuously place concrete in each section of the work in horizontal layers, working continuously if necessary, to prevent stoppage planes.

Place the concrete in layers to thoroughly consolidate them with the concrete beneath. Place the succeeding layer before the previous layer has reached initial set.

Compact each layer to prevent separation planes between the preceding layer and the layer being placed.

The Project Manager may require an emergency bulkhead if concrete placement in a section is delayed longer than 20 minutes.

A construction joint is any place where concrete placement has stopped and the concrete has taken initial set. Make construction joints meeting Subsection 552.03.7 requirements.

Inset construction joints where a "feather edge" might be produced in the succeeding layer. Provide a minimum thickness of 6 inches (155 mm) in all succeeding layers.

Place concrete so all construction joints are across low shear stress regions and out of view to the greatest extent possible.

Place deck slab concrete a minimum of seven calendar days after placing diaphragm concrete or when standard compressive strength test results verify that the diaphragm concrete has attained a compressive strength of 1,360 psi (9.5 Mpa).

- B. Pumping Concrete.** Use pumping equipment having the capacity required for the work and able to produce a continuous stream of concrete free of air pockets. Locate the pump to prevent vibration damage to fresh placed concrete.

Once pumping is completed, remove concrete in the pipeline to be used in the work without causing contamination or separation.

Use concrete pump discharge lines of at least a 4-inch (105 mm) diameter.

Do not permit aluminum pipe or pumping equipment with aluminum parts to contact the concrete.

- C. Concrete Columns.** Place concrete in one continuous operation, unless otherwise specified.

Allow columns to set at least 12 hours before placing the caps.

Place concrete in the superstructure after the column forms have been stripped and the column is inspected by the Project Manager.

The superstructure load may be placed on the columns when the column concrete reaches 80 percent of the required 28-day compressive strength, determined by testing standard 6-inch by 12-inch (152 mm x 305 mm) or 4-inch x 8-inch (102 mm x 203 mm) test cylinders.

- D. Concrete Piling.** Furnish concrete piling meeting Section 559 requirements.

- E. Concrete Slab and Girder Spans.** Place slabs and girders having spans less than 30 feet (9,145 mm) in one continuous operation.

Concrete slabs with girders spanning 30 feet (9,145 mm) or more may be placed in two operations, first placing the girder stems to the bottom of the slab haunches, and then placing the slab.

Use shear keys made of beveled timber blocks inserted at least 1 1/2 inches (40 mm) in the fresh concrete at the top of each girder stem. Place the blocks to uniformly cover about one-half of the girder stem top surface. Remove the blocks when the concrete has set enough to retain its shape.

Do not place the slab until the girders have been in place for at least 24 hours.

Check all falsework for shrinkage, settlement, and tighten all wedges to insure minimum deflection of the stems caused by the slab weight before placing the slab.

Place concrete in girder haunches less than 3 feet (900 mm) high at the same time as the girder stem.

When any haunch or filler has a vertical height of 3 feet (900 mm) or more, place the abutment or columns, the haunch, and the girder in 3 successive stages:

- First, up to the lower side of the haunch.
- Second, to the lower side of the girder.
- Third, to completion.

- F. Concrete Slip-forming.** Concrete barrier rails on bridges may be slip-formed.

Hand-finish the traffic face and top of the barrier to remove air holes and other blemishes, followed by a light broomed finish.

Sections with concrete slumps or bulges causing barrier rail misalignment or inadequate concrete cover for reinforcing steel will be rejected.

552.03.6 Depositing Concrete Underwater

Use Class "AS" or "DS" concrete for seals specified in the contract.

All costs for concrete placed outside of the plan dimensions and any change in the seal mix design for the Contractor's convenience is at Contractor expense.

Do not place concrete underwater without Project Manager approval.

When it is impractical or inadvisable to de-water an excavation before placing concrete, place a seal course underwater to seal the cofferdam. Place the entire seal in one continuous operation, meeting the following requirements:

- Use a tremie system; or
- Pump directly into a tremie hopper; or
- Pump directly to the deposit point.

Use tremie systems made of rigid, watertight steel tube having a minimum diameter of 10 inches (255 mm) with a hopper at the top. Keep the tremies discharge end submerged in the deposited concrete, and the tremie tube full to the hopper bottom at all times during the concrete placement. When a load is dumped into the hopper, raise the tremie to start the flow of concrete until the load discharges to the hopper bottom. Use a tremie support that allows free movement of the discharge end and permits rapid lowering of the tremie to retard or stop the flow.

Pump seal concrete meeting Subsection 552.03.5(B) requirements.

Have a backup concrete pump or tremie available at the site to insure uninterrupted placing of the entire foundation seal.

Pump concrete into a tremie meeting the placing requirements for tremie-placed concrete.

When concrete is pumped directly, the discharge tube must be a rigid pipe extending at least 5 feet (1,520 mm) above the water level during placement. The discharge line from the top of the rigid pipe to the concrete pump may be flexible.

Prevent water from entering the tube while placing concrete. Fill the tubes without washing the concrete.

Place concrete in a compact mass without disturbing it once deposited.

Do not place concrete in running water or expose it to the action of water before it has reached final set. Keep water still at the point of deposit.

Do not pump from the cofferdam while depositing concrete underwater.

Make all formwork retaining concrete underwater practically watertight.

Deposit concrete to produce horizontal surfaces.

After the seal concrete has cured and can withstand the hydrostatic pressure, de-water the cofferdam and place the remaining concrete in the dry.

Prepare the top surface of the foundation seal under Subsection 552.03.7 before joining fresh concrete to the seal concrete. Remove high spots to provide the clearances for reinforcing steel or projection of embedded piling.

552.03.7 Construction Joints

Obtain the Project Managers approval for construction joint locations.

If the concrete develops initial set due to placement delays, the stopping point is considered a construction joint.

Place concrete continuously from joint to joint. Make the joints perpendicular to the principal lines of stress and locate them at points of minimum shear.

Place a gauge strip, at least 2 inches (50 mm) thick, at all horizontal construction joints and at other directed locations inside the forms along all exposed faces to provide a straight line for the joints.

Before placing fresh concrete against set concrete, draw the forms tightly against the set concrete face and remove all gage strips and key forms. Remove all latence, loose and foreign

materials from the surface by sandblasting, high-pressure water cutting, or light bushhammering. Keep the surface moist until resuming concrete placement. Apply a thin coat of neat cement to the surface or coat as specified just before resuming concrete placement.

Bond the successive courses by keying or doweling, as shown in the contract, at the top layer of each day's work and at other points where work is interrupted.

552.03.8 Joints for Bridge Approach Slabs

Construct and seal joints between concrete approach slabs and structures or concrete pavement as specified.

Use forms for joints that are removable without damaging the concrete.

Protect the joint from damage and prevent debris and foreign material from entering the joint before installing the seal.

Limit construction equipment and other vehicles operated directly across the joint to rubber-tired equipment, unless approved joint protection is used.

Repair all spalls, fractures, breaks, or voids in the concrete joint surfaces as approved.

Before placing the seal, clean the joints by abrasive blast or other similar methods, followed with high-pressure air jets to remove all residue and foreign material. Protect expansion joint filler from the blast.

Make joint surfaces surface-dry when placing the seal.

552.03.9 Cold Weather Concreting

A. General. Assume all risk for placing concrete during cold weather. Replace frozen or damaged concrete at Contractor expense.

Cold weather is anytime the ambient temperature is expected to drop below 35 °F (1 °C).

Remove ice, snow, and frost from the forms and reinforcing bars before placing concrete. Do not place concrete on frozen ground.

B. Heating Fresh Concrete. Assure the temperature of fresh concrete is between 60 °F (15 °C) and 90 °F (32 °C) when placed.

Aggregates may be heated by steam or dry heat. Direct flame heating is prohibited. Eliminate frozen lumps, ice, and snow.

Do not add salt or chemical admixtures to the concrete to prevent freezing.

C. Protection of Concrete.

1. General. Maintain the air temperature surrounding fresh concrete at a minimum 60 °F (15 °C) for 7 days after placement or at a minimum 70 °F (20 °C) for 72 hours followed by 40 °F (5 °C) minimum for 96 hours. Place enclosures and heating equipment to maintain these temperatures before placing concrete.

2. Deck Slabs and Barriers. Protect and cure deck slabs and barriers placed after October 15 and before the following May 15 until the standard field-cured cylinders reach 90 percent of the specified minimum required strength.

Maintain air temperatures surrounding the barriers and slabs between 50 °F (10 °C) and 120 °F (50 °C) during the cure period. Fully enclose the slabs and barriers on the tops, bottoms, and sides with space between the enclosures and the slabs and forms. Apply external heat as required to maintain the specified temperature within the enclosure.

Insulated coverings placed directly on surfaces are not an acceptable substitute for the enclosure.

Furnish and place recording thermometers at the locations designated by the Project Manager.

- 3. Concrete Cured Under Water.** Substructure units other than those supported by falsework may be cured by a combination of heating and flooding. Maintain the air surrounding the concrete at between 60 °F (15 °C) and 120 °F (50 °C) for 72 hours after concrete placement. The unit may then be flooded with water for the remainder of the 7 day cure period if the water temperature exceeds 35 °F (2 °C). Maintain the air temperature surrounding any portion of the concrete remaining above water at 40 °F (5 °C) for the remainder of the seven-day period.

Footings may be cured by flooding with at least 12 inches (305 mm) of water over the footing top if the water temperature stays at or above 35 °F (2 °C). Continue curing for 10 days after placement. Cure seals under water for at least 3 days before de-watering.

- D. End of Curing Period.** Lower the temperature within enclosures not to exceed 15 °F (10 °C) per hour until the inside and outside air temperatures are equal.
- E. Heating Equipment.** Block combustion heaters up off the concrete surface and vent them outside the enclosure. Assure heating equipment uniformly distributes heat around the concrete with the air temperature at the concrete surface never exceeding 120 °F (50 °C).
- F. Field-cured Cylinders.** Determine the number of field-cured test cylinders, to include a minimum 6 per each day's placement. Cast field-cured cylinders in single-use 6-inch x 12-inch (152 mm x 305 mm) or 4-inch x 8-inch (102 mm x 203 mm) round molds under MT-101. Protect the cylinders from moisture loss in the same manner used for the slab. Place the cylinders at the locations designated by the Project Manager and expose them to the same conditions as the slab until they are removed for testing.

Test field-cured cylinders within 36 hours after removal and not less than five days after casting under AASHTO T-22, except that the moist cure period is omitted. Perform tests using a certified testing laboratory. Furnish the Project Manager certified copies of the test results.

The Department may witness selected tests and testing procedures.

Two cylinders constitute a test with the test value being the average of the two compressive strengths. Continue curing and protection until the tests indicate the specified compressive strength is reached.

- G. Recording Thermometers.** Use recording thermometers that are automatic, continuous chart recording type. The range must be from 32 °F (0 °C) to at least 150 °F (65 °C) for conventional cure and 212 °F (100 °C) for steam cure. Each chart must cover a minimum of 24 hours and seven days maximum. Record only one cure period on each chart. Give the charts to the Project Manager at the end of each cure period.

Calibrate recording thermometers to the Project Manager's standard thermometer before each use and as directed.

Furnish thermometers, charts, calibration thermometers, and other equipment to maintain the thermometers.

552.03.10 Curing Concrete

Cure concrete under Subsection 551.03.6 and the applicable requirements of Subsection 552.03.9.

552.03.11 Removal of Forms and Falsework

Do not release, loosen, or remove forms or falsework without the Project Manager's approval. This approval does not relieve the Contractor of responsibility for the safety of work.

Approval to remove forms will not be given before the minimum times in Table 552-1.

The times in Table 552-1 are exclusive of days when the ambient temperature falls below 40 °F (5 °C); as the seven day curing period is based on a minimum curing temperature of 60 °F (15 °C).

The exact time lapse before forms may be removed will be determined by the Project Manager based on the site curing conditions of the concrete.

The Contractor may request, in writing, to use high early strength cement or a richer mix to reach concrete compressive strengths earlier and these times may be reduced as directed.

TABLE 552-1
MINIMUM CURE TIMES BEFORE FORM REMOVAL

ITEM	MINIMUM TIME
Walls, piers, and abutments (not yet supporting loads)	24 hours
Sides of columns, beams, and other comparable parts	24 hours
Railings	12 hours
Sidewalks on bridges	7 days
Slabs when supported on steel or wood stringers and precast concrete girders with unsupported span lengths less than 10 feet (3,048 mm)	7 days
Centering under crossbeams, girders, T-beams, caps, struts, box girders, top slabs on concrete box culverts, and slabs	14 days or 80% percent of the specified 28-day strength

Remove all forms, blocks and bracing. Remove mortar lips and all irregularities caused by form joints.

The presence of honeycombed areas may cause rejection of the work, and upon written notice, require removal and rebuilding of the work in whole or part at Contractor expense.

After the forms are removed, cut back and repair all projecting wires, tie bolts, and other metal form ties passing through the concrete meeting Subsection 552.03.4 requirements.

Repair honeycombed concrete in all parts of the work and voids and depressions in exposed portions of the work as follows:

1. Chip back all coarse and broken material to a dense, uniform concrete surface with exposed solid coarse aggregate.
2. Cut back feather edges to form faces perpendicular to the surface being patched.
3. Saturate all cavity surfaces with water, and apply a thin layer of neat cement.
4. Fill the cavity with a thick mortar mixed in the same proportions as the concrete used in the work and at the same temperature as the surface against which the mortar is placed.

Use a blend of portland cement, white portland cement and sand, proportioned to match the color of the concrete being repaired. Tamp the mortar into place, and float the surface using a wooden float before initial set takes place. Cure the patch under Subsection 551.03.6.

For patching large or deep areas, add coarse aggregate to the patching material to provide a dense, well-bonded, and cured patch.

Pull or remove all falsework piling 1 foot (305 mm) below the finished ground line or streambed unless otherwise specified.

552.03.12 Finishing Concrete

Finish all exposed vertical concrete surfaces to meet the ordinary finish requirements in Subsection 552.03.12(A).

Finish concrete bridge deck slabs and concrete curb and sidewalk surfaces to meet the requirements of Subsections 552.03.12(E) and (C) respectively.

- A. Ordinary Finish.** An ordinary finish is the concrete surface left once the forms are removed and all holes caused by form ties, trapped air, and all other defects are repaired. The finished surface must be true and even, free from stone pockets, depressions, or projections beyond the surface.

Ordinary finish is produced as follows:

1. Soak the concrete surface with water, and use the patching mortar specified in Subsection 552.03.11, working it into the small air holes and other voids in the concrete face with a sponge float or wooden float.
2. Rub off excess mortar after the mortar is partially set using burlap or carpet.
3. Remove uneven mortar surfaces that have set too hard by rubbing the entire surface with a carborundum stone and water.
4. Produce a finished surface that is uniform in texture and color.

Rub-finish all surfaces not repairable by the ordinary finish method meeting Subsection 552.03.12(B).

The ordinary finish may not be required for exposed vertical concrete surfaces listed below, if the forming produces a true and uniform surface and minor defects are repaired as specified:

1. Interior surfaces of box type concrete structures such as culverts, stockpasses, and minor grade separations; or
2. Concrete diaphragms for prestress girders; or
3. Pier shafts, abutment walls, columns, struts, crossbeams, or other substructure components located where they are not readily subject to public access or view. In general, substructure elements on bridges in undeveloped rural areas and more than 25 feet (7,620 mm) from the edge of the public road, located in or over streams not used extensively for recreation, or exclusively over railway property are not considered subject to public access and view.

Good forming practice is considered as:

1. Using materials with a smooth surface free from holes, tears, dents, and gouges;
2. Using the largest practical pieces to minimize joints;
3. Arranging joints to be vertically or horizontally symmetrical; and
4. Using bracing to prevent bulges, offsets, and other major defects in the concrete surface.

Repair major surface defects, and finish the substructure unit surface or other structural components to a uniform appearance.

Major surface defects are large rock pockets, offsets at form joints exceeding 1/4-inch (6 mm), bulges, projections and depressions that deviate from the surface plane by more than 1/4-inch (6 mm) in any 4 foot (1,219 mm) length, and all other defects that reduce plan reinforcing bar cover by more than 1/4-inch (6 mm).

Minor surface defects may be corrected without finishing the surrounding surface. Remove mortar fins even with the surrounding surface. Fill air holes exceeding 3/4-inch (20 mm) in the longest dimension with mortar and strike off even with the surrounding surface. Patch minor rock pockets, tie holes, and the like as specified in Subsection 552.03.11.

- B. Rubbed Finish.** After concrete has hardened, saturate the surface with water and rub using a medium-coarse carborundum stone with a small quantity of mortar on its face. Approved bonding agents may be used.

Use mortar consisting of cement and fine sand in the same proportions used in the concrete being rubbed.

When forms are removed while the concrete is "green", wet the surface and rub it with a wooden float. If approved the thin mortar described above may be used for rubbing.

Continue rubbing until all form marks, projections, and irregularities are removed, all voids filled, and a uniform surface is obtained. Keep the paste produced by rubbing moist and allow it to set for at least five days. Smooth the surface by rubbing with a fine carborundum stone and water. Rub to produce a smooth texture and uniform color over the entire surface. After the final rubbing is complete and the surface has dried, rub the entire surface with burlap to remove loose mortar. The finished surface cannot have unsound patches, paste, powder, or objectionable marks.

- C. Broomed Finish for Curbs and Sidewalks.** Finish the surface of concrete curbs and sidewalks to the lines and grades in the contract. Work the concrete until the coarse aggregate is forced into the body of the concrete and no coarse aggregate is exposed. Float the surface with a wooden float producing a smooth and uniform surface.

Apply a broom finish to curbs or sidewalks. Make the strokes square across the curb or sidewalk from edge to edge with adjacent strokes overlapped. Do not tear the concrete surface when applying the finish. Produce regular corrugations a maximum 1/8-inch (3 mm) deep.

- D. Special Tooled Finish.** Produce special tooled finishes using a bushhammer, a pick, a crandall, or other approved tool. Use air tools unless otherwise directed. Do not begin tooling until the concrete has set for at least seven days, or longer if necessary, to prevent "picking" the aggregate out of the surface. Produce a finished surface showing broken aggregate in a matrix of mortar, each aggregate particle being in slight relief.

- E. Concrete Bridge Decks.** Finish deck slabs by the machine method, excluding small or irregularly shaped areas where a machine is impractical.

- 1. Machine Method.** Use a self-propelled transverse finishing machine to strike off and finish the surface of deck-slab concrete. Furnish the Project Manager information on the location and method of rail support, size of rail members, and a description of the machine.

Trial-run the finishing machine over the entire deck area to be finished before placing any concrete. Make the trial run with the machine and rails set to the specified grade and section. Attach a spacer to the bottom of the strike-off 1/8-inch (3 mm) in thickness less than the concrete cover shown in the contract. Adjust the support rails to compensate for dead-load deflections in the bridge girders. Adjust transverse strike-off support rails to match any changes in the deck section. Make transverse rail adjustments to maintain the specified surface tolerances. Record trial run transverse rail adjustments for use during the deck finishing operations. Make all adjustments to maintain proper grade, section, concrete cover over slab reinforcement, and slab thickness before any concrete is placed.

While placing the concrete, make enough strike-off passes to produce the required profile and section.

Maintain the heading of concrete placement nearly parallel to and not more than 10 feet (3 m) ahead of the strike-off. The concrete carried ahead of the strike-off must not cause wheel slippage or other unsatisfactory operation.

Orient the transverse axis of the finishing machine parallel to centerline of bearing on all pre-stress and steel girder spans skewed more than 15 degrees. Make the concrete placement heading parallel to the strike-off heading to produce equal loads on each girder.

2. **Hand Finishing.** Obtain the Project Manager's approval for hand finishing on deck slabs.

Strike off concrete using a template or vibrating screed and finish to a smooth, even surface meeting the required profile and section using longitudinal and transverse floating. Power trowels are not allowed.

3. **Straight-edging.** Test the plastic concrete surface for surface smoothness behind the finishing machine with a 10 foot (3 m) straightedge. Assure the straightedge contacts the surface in successive positions parallel to the centerline of roadway across the entire slab width. Make longitudinal advances in maximum 5-foot (1,524 mm) increments.

Immediately fill depressions with fresh concrete, consolidate, strike off, and finish. Remove high areas with a 10-foot (3 m) cutting straightedge and refinish. Correct all other surface defects using a 10 foot (3 m) float or combination float and cutting straightedge.

Provide footbridge(s) that clear span the fresh concrete for complete finishing, texturing, curing, straightedge testing, and surface correction.

Continue straightedge testing and surface correction until the entire surface meets the specified surface-smoothness requirements.

Limited hand floating may be used to correct defects left by the finishing machine. Hand floating is not required if the machine-finished surface meets surface-smoothness requirements and is free of defects.

4. **Bridge Deck Surface Texture.** Texture the bridge deck surface with transverse grooves while the concrete is plastic. Use a hand or mechanically-operated comb or broom having a single row of steel tines spaced 3/4-inch (20 mm) center-to-center. Use tines of approximately 0.03-inch (1 mm) thick, 0.08-inch (2 mm) wide, and from 4 inches to 6 inches (105 mm to 155 mm) long.

Operate the handheld texturing device from a footbridge. Make the application, the angle of tines with the surface, and the pressure on the concrete to produce a groove depth of between 1/8 inch to 3/16 inch (3 mm to 5 mm) without the grooves flowing together, tearing the surface, or displacing the coarse aggregate.

Do not overlap successive passes of the texturing device.

Terminate grooves 1 foot (305 mm) from the face of any curb or barrier. Skewed bridge decks may be textured parallel to the heading of concrete strike-off and finishing.

The allowable surface smoothness variation is independent of the grooves formed by the transverse texturing.

5. **Broom Texture.** Hand-finish the traffic surface of curbs, sidewalks, and other horizontal surfaces to receive a broom finish under Subsection 552.03.12(E)(2). Manipulate the broom to produce a smooth, sealed surface meeting the specified surface-smoothness requirements.

The texturing broom may be any medium-stiff bristled broom. Broom at right angles to the curb face or sidewalk and produce a uniform close spaced texture not exceeding 1/8 inch (3 mm) deep.

6. **Surface Smoothness.** The finished surface must not vary more than 1/8-inch (3 mm) from a 10-foot (3 m) straightedge placed parallel to the roadway centerline.

High spots are measured as one-half the distance between the end of the straightedge and the pavement surface with the straightedge centered on the apex and the opposite end held in contact with the surface. Low spot variations are measured as the distance from the straightedge to the surface with the straightedge

centered on the low point. Correct unacceptable surface variations by grinding off high spots and patching or filling low areas.

Subsequent surface sealing will not be required where the grooved surface is produced using a diamond-faced saw-type cutter for grinding.

Perform surface sealing as follows for areas ground using conventional star-wheel-type cutters.

Seal all areas where removal exceeds 1/4-inch (6 mm) in depth with an approved, concrete-colored, low-viscosity epoxy-resin adhesive. Produce a non-skid texture using a steel-tine broom or by applying medium-coarse silica sand to the plastic epoxy surface. Meet the surface smoothness requirements.

- 7. Protective, Remedial, and Corrective Work on Deck Slab Concrete.** Do not place concrete for deck slabs and stop work when rain appears imminent. Take immediate action to strike off all concrete in place to promote drainage and prevent ponding.

Placing or finishing work that manipulates the concrete will not be allowed during precipitation.

Deck slabs areas where precipitation has been incorporated into the concrete may be rejected. Make a maximum 3 light passes with a straightedge float to remove excess water after the precipitation stops.

Protective work is that work necessary to protect unhardened concrete from damage by hail and rain. This includes covering the concrete with a protective covering when conditions warrant.

Remedial work is that work to restore a surface profile and texture on unhardened, rain-damaged concrete. Concrete damaged by rain to the extent the texture is obliterated and has a sandy appearance may be repaired by removing excess water and restoring it to the specified surface smoothness and texture.

Hardened concrete is concrete that is non-plastic and does not allow the vibrator to penetrate under its own weight.

Corrective work is work to provide an acceptable profile and texture on hardened, rain-damaged concrete.

Do not place fresh concrete against hardened concrete until a construction joint is placed under Subsection 552.03.7.

Correct areas exceeding the specified surface-smoothness tolerance and areas where the specified texture cannot be produced by grinding and grooving using concrete grinding machines.

Use a diamond saw type grooving machine.

Grooves may be either longitudinal or transverse. Space grooves at 3/4-inch (20 mm) centers and be 1/8-inch (3 mm) wide by 1/8 to 3/16-inch deep (3 to 5 mm).

Grooving is not required on areas that measure 10 feet (3000 mm) or less in length parallel to centerline of roadway.

Do not grind or groove so that concrete cover is reduced over the top reinforcing bars to less than 2 inches (50 mm).

Remove, replace, or overlay areas that cannot be corrected to the required surface smoothness and texture by grinding and grooving. Submit proposed overlay methods in writing to the Project Manager for approval before use.

Remove all laitance and hardened, excess concrete from construction joints before placing curbs, barriers, or other concrete.

Furnish all protective, remedial, and corrective work to provide an approved deck slab at Contractor expense.

- F. Bridge Seats and Tops of Walls.** Bring the concrete at bridge seats and tops of walls up to the required grade elevation, strike off with a straightedge, and float to a smooth, uniform texture.

Slope the concrete surfaces in areas of bridge bearing assemblies to drain water away from the bearing devices as specified.

Bushhammering is permitted only for leveling the concrete surface under the bearing plate and removing lath and loose and foreign material. Bushhammer to produce full, level bearing.

Use steel shims when necessary to bring the masonry plates up to grade. Use shims of the same size as the masonry plate and a minimum 1/4-inch (6 mm) thick. When elastomeric bearing pads are used, perform the beam seat treatment specified in Subsection 556.03.19 using steel shims of the same size as the sole plate except for thickness. Place the shims between the sole plate and the elastomeric pad.

552.03.13 Installation of Expansion and Contraction Joints

Construct expansion and contraction joints meeting the contract requirements.

- A. Open Joints.** Construct open joints by inserting and removing a template made of wood, metal, or other approved material. Remove the template without chipping or breaking the concrete corners.

Do not extend reinforcement across an open joint unless specified.

- B. Filled Joints.** Construct poured expansion joints similar to open joints.

When pre-molded expansion joints are specified, the thickness of installed filler is specified in the contract. Match the joint filler to the shape and size of the surfaces to be joined and fix it firmly against the existing surface. Do not displace the joint filler while placing concrete.

Where more than one piece of filler is used to cover any joint surface, place the abutting pieces in close contact and join them together with a layer of asphalt-saturated roofing felt. Use a minimum 20-pound (1 kg per square meter) grade roofing felt having one side covered with hot asphalt.

The filled joints will be inspected immediately after the forms are removed. Neatly cut and remove all concrete or mortar that has sealed across the joint. Fill openings in deck slab joints during construction with an approved tar or asphalt as directed.

Place the necessary dowels, load-transfer devices, and other devices as specified.

- C. Steel Joints.** Fabricate and paint the joints as specified. Assure that the surface in the finished plane is true and free of warping.

Hold joints in the correct position during concrete placement.

Use the openings at expansion joints shown in the contract, correcting for installation temperature. Maintain the required clearance.

- D. Water Stops.** Place water stops as specified.

552.03.14 Placing Anchor Bolts

Anchor bolt holes may be drilled or formed.

Form bolt holes by inserting treated wood plugs or metal pipe sleeves into the plastic concrete and withdrawing the devices after the concrete has partially set. Form bolt holes at least 3 inches (75 mm) in diameter to allow for horizontal adjustment.

Drill holes at least 1 inch (25 mm) larger than the diameter of the anchor bolts. Verify hole size before setting the beams.

Assure all anchor bolts for shoe assemblies project above the plane of the substructure concrete to assure full anchor bolt and nut engagement after the final placement of the shoe assemblies.

Fill holes two-thirds full with an approved non-shrink or epoxy grout. Force the bolts down using uniform, even pressure or light blows with a hammer until the grout rises to the top of each hole and the anchor bolt nut rests firmly against the metal shoe or pedestal.

Determine the final anchor bolt locations, making allowance for thermal effects on the superstructure at the time of grouting.

Remove all excess grout, and clean the metal surfaces for painting.

Do not grout anchor bolts in freezing weather.

Make a written request to the use non-shrink or epoxy grout products formulated specifically for use at temperatures below freezing.

Protect bolt holes against damage from ice by filling with a non-evaporating antifreeze solution. Before grouting the bolts, remove the antifreeze and thoroughly flush the holes with clean water.

Anchor bolts for simple spans may be set to the exact location in fresh concrete. Correct all inaccuracies in bolt locations using approved methods at Contractor expense.

Install the anchor bolt nuts as shown on the plans. Tighten the upper nut against the lower nut so neither nut can be turned by hand.

552.03.15 Setting Shoes and Bearing Plates

Set shoes and bearing plates under Subsections 556.03.19 and 552.03.12(F).

Place masonry bearing plates on fiber-reinforced pads, sized and positioned to project a minimum of 1/2-inch (15 mm) on all sides of the bearing plates.

552.03.16 Drainage Holes and Weep Holes

Construct drainage holes and weep holes as specified. Place ports and vents for equalizing hydrostatic pressure where required.

Forms for weep holes through concrete may be wood, clay pipe, PVC pipe, concrete drain pipe, wooden boxes, or metal. Remove wooden forms, if used, after the concrete is placed. Paint or galvanize exposed metal drain surfaces as specified.

552.03.17 Pipes, Conduits, and Ducts

Install and rigidly brace pipes, conduits, and ducts encased in concrete before the concrete is placed.

Furnish and install 3-inch (75 mm) length plastic, PVC pipe or approved equal in the bottom slab at the low point of each box girder cell to provide drainage for each cell. Extend the pipe 1/4-inch (6 mm) below the bottom of the slab and flush with the slab's top surface.

552.03.18 Loading of Piers and Abutments

Do not place any superstructure load on finished bents, piers, or abutments until approved. The minimum time before any superstructure load is placed on the substructure is seven days, unless otherwise approved.

552.03.19 Opening to Traffic

Open concrete deck bridges to traffic only with the Project Manager's approval.

Do not open concrete bridge decks to traffic when the air temperature during the cure period is 50 °F (10 °C) or higher, until one of the following is met:

- A. Twenty-one days after placing concrete unless standard strength test results indicate more time is required; or
- B. Test results on field-cured test cylinders indicate that at least 90 percent of the required minimum strength has been attained. Two cylinders constitute a test, with the test strength being the average of the strengths of the two individual cylinders.

The Project Manager will determine the opening date when the ambient temperature during the cure period has been lower than 50 °F (10 °C).

552.03.20 Defective Work

Repair or replace all defective work at Contractor expense. Remove and replace the entire section at Contractor expense when the Project Manager determines the repair is not adequate.

552.04 METHOD OF MEASUREMENT

Concrete is measured in cubic yards (cubic meters) from the plan dimensions. Plan quantities will not be re-measured except as specified in Subsection 552.05.

Filletts, scorings, and chamfers 2 inches (50 mm) or less in the greatest dimension are omitted from the quantity calculations.

No deductions are made for the concrete volume displaced by reinforcing steel, structural steel, prestressed beams, anchor bolts, drains, weep holes, joint fillers, conduits, or junction boxes.

Deductions are made for the concrete volume displaced by timber, steel, and concrete piles. The timber pile volume encased by concrete is assumed as 0.8 cubic foot per foot (0.74 cubic meter per m) of pile.

When ordered in writing by the Project Manager, concrete quantities placed outside neat lines, are calculated and added for payment.

No measurement is made for forms, falsework, cofferdams, bracing, and the like.

552.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

- A. The calculated quantities involved in changes ordered in writing by the Engineer are added or deducted from the contract quantities.
- B. A re-calculation will be made and the corrected quantity included for payment, in lieu of the contract quantity, when the contract quantity of any complete structure element is in error by five percent or more. A complete structure element is the smallest portion of a total structure for which a quantity is included in the contract. The party to the contract requesting an adjustment in quantity must present to the other party three copies of the description and location and recalculated quantities of the structure element that has the quantity error.
- C. Classes "AD", "DD", and "SD" concrete placed in bridges are subject to a payment reduction based on lot payment factors under Subsection 551.03.7(C)(1).

Seal concrete, Class "AS" or "DS" is not under the lot payment factors.

Partial payments for structure elements will be made based on the contract quantities as follows:

1. 40 percent of superstructure concrete when deck forms are complete in place.
2. 80 percent when all types of concrete are placed.
3. 85 percent when curing is complete.

4. 95 percent when all finishing is complete.
5. 100 percent when the structure element area is cleaned up to the Engineer's satisfaction.

Pay Item

Concrete

Pay Unit

Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

SECTION 553
PRESTRESSED CONCRETE
MEMBERS

553.01 DESCRIPTION

This work is the furnishing and placing of precast, prestressed concrete beams, slabs, piling, and other structural members.

553.02 MATERIALS

553.02.1 Concrete

Furnish concrete meeting Section 551 requirements.

553.02.2 Reinforcing Steel

Furnish reinforcing steel meeting Subsection 711.01.1 requirements. Obtain the Engineer's written approval for reinforcing steel substitutions.

State on the fabrication drawings showing reinforcing steel details the following or similar words: "All dimensions are out-to-out".

553.02.3 Steel Rods and Bolts

Furnish rods used as dowels made from ASTM A 307 steel and bolts meeting Subsection 711.07 requirements.

553.02.4 Prestress Steel

Furnish high tensile strength steel wire meeting Subsection 711.11 requirements.

Furnish the typical load-elongation curves for all shipments of prestress steel to the fabrication plant.

Assure all prestress steel used in the work is free of rust, corrosion, dirt, oil, spatter from welding or flame cutting, kinks, bends, nicks, broken wires, or other defects.

Prestress steel is sampled under MT-111.

553.02.5 Enclosures

Use metallic enclosures, excluding aluminum, or forms using removable cores or ducts made of rubber or other approved material. Remove cores and ducts before installing the prestress steel.

Use enclosures that are mortartight and maintain their shape when subjected to loading.

Use enclosures that are 1/4-inch (6 mm) larger in internal diameter than the bar, cable, strand, or group of wires being enclosed.

Equip cores or ducts with pipes or other connections for grout injection when pressure grouting is specified.

553.02.6 Structural Steel

Furnish structural steel meeting Subsection 711.02 requirements.

553.02.7 Elastomeric Bearing Devices

Furnish elastomeric bearing devices meeting Subsection 711.14 requirements.

553.03 CONSTRUCTION REQUIREMENTS

553.03.1 Fabrication

Fabricate all prestress concrete members using a manufacturing plant currently certified by the Prestress Concrete Institute in the category applicable to the member being fabricated.

Furnish a copy of the plant's current certification in the applicable category along with the fabrication drawings for the elements to be fabricated.

The fabricator may prestress by pretension or post-tensioning the member, subject to the contract requirements.

Obtain written approval before changing the prestressing details.

553.03.2 Fabrication Drawings

Before casting members, submit fabrication drawings for approval. Show complete details of the method, materials, and equipment proposed for use in prestressing.

Include in the fabrication drawings the following information:

1. An erection layout of the members placed in the structure or structures with each prestress member assigned a production number. Mark each completed member with an assigned number;
2. A tentative fabrication schedule;
3. The proposed mix design, including admixtures;
4. The prestress steel manufacturer's name and the applicable specifications;
5. Details of the method and sequence of stressing including the numbered or lettered layout to be followed to stress the member. Show complete details of the proposed method for tensioning the draped strands. Include in the details gauge and elongation readings for initial, intermediate, and final tensioning, as well as the deflection sequence, where applicable;
6. Complete details, including anticipated camber, tensioning forces (initial and final), and required concrete strengths (transfer and 28-day);
7. A complete detensioning procedure for the castings;
8. Details of items to be incorporated into the beam, such as chairs, inserts, hold-downs, etc., listed by source, type, size or capacity, and supplier;
9. Show all items incidental to the beams, such as bearing plates, rocker assemblies, anchor bolts, etc., if supplied by the beam fabricator;
10. All information and data required for fabrication;
11. Show the tack welding procedures; and
12. Detail the use of all external weights or hold-downs if used. If weights are not required, note it on the fabrication drawings.

Show all changes from the prestressed details in the contract.

Submit design calculations of the system and method of production prestressing. Submit calculations on standard 8 1/2-inch by 11-inch (A4) paper.

Check and approve the fabrication drawings and design calculations before submitting. Show the Contractor's approval on the drawings.

Furnish all fabrication drawings on 22-inch x 36-inch (A1) paper with a 1 1/2-inch (38 mm) margin on the left side and 1/2-inch (13 mm) margins on the other three sides.

Do not begin fabrication until the drawings are Department approved and available at the plant.

553.03.3 Design of Concrete Mixtures

The prestressed girder concrete must have a minimum ultimate compressive strength of 4,000 psi (27.6 MPa) at transfer of prestress and 5,000 psi (34.5 MPa) at 28 days. The actual required strengths are specified in the contract.

Furnish a concrete mix design that produces concrete meeting the specified compressive strengths before use. Approved changes to the mix design may be permitted during fabrication.

Use a concrete design of between 6.5 to 8.0 sacks of cement per cubic yard (350 kg to 450 kg per cubic meter) of concrete.

Establish the Class "Pre" concrete slump range between 1-inch (25 mm) and 4 1/2-inches (115 mm). The high and low limits of the range may not exceed 1 1/2-inches (38 mm). The range may be changed with the Engineer's approval.

553.03.4 Forms

Use steel side and bottom forms. End bulkhead forms may be steel or plywood.

Form joints and strand exits through bulkhead forms that are mortartight.

Check the grade and alignment of side forms before casting. Check the beam bed alignment for displacement while placing the concrete.

Construct beam bed forms to limit movement to not exceed 1/4-inch (6 mm) from a straight line in any 50-foot (15.25 m) length of the bed.

Use clean forms that are free from warp, bulge, and other defects.

Do not exceed a maximum offset of 1/16-inch (2 mm) where form sections are joined.

Treat the form facing with a bond breaker before each casting. Form treating materials that stain or react with concrete are not permitted. Apply form oil or other bond breaker materials without contaminating the prestress strand and reinforcing steel. Clean soiled strand or reinforcing with a non-contaminating solvent.

Chamfer all exposed concrete edges, excluding the beam top, with an enclosed angle of less than 120 degrees. Use chamfer strips having no irregularities, and maintain smooth joints with the chamfer tightly fitted against abutting forms.

Fit forms with a grade strip or other positive control to establish the nominal depth of the beam.

Use forms that can be removed from the member without damaging the concrete.

Identify production form dimensions that vary from the contract beam dimensions on the fabrication drawings.

553.03.5 Placing Reinforcing Steel

Place and secure all reinforcing steel as shown on the plans before placing concrete.

Fasten all bars at all intersections with adjacent bars.

Do not tack weld reinforcing steel if the reinforcing bar is a stress-carrying member. Welding non-stress reinforcing bars may be permitted with the Engineer's approval. Reinforcing steel welds not shown on the approved tacking detail or fabrication drawings are prohibited.

For convenience, additional reinforcing steel may be tied in for securing inserts, void ducts, etc., or may be secured by tack welding.

Protect the tensioning strand from weld spatter using wet burlap or other protective covering. Replace all strands with weld spatter at Contractor expense.

Provide the distance between the reinforcing and side forms using approved stays, ties, or chairs. Do not use precast mortar blocks, pebbles, pieces of broken stone or brick, metal pipe, or wooden blocks.

Provide clearance between the beam stirrups and the beam bed using metal chair supports with stainless steel or other approved, corrosion-resistant legs.

Use reinforcing steel in the ends of prestressed beams to provide clearance for the paving notch blockout, void ducts, embed plates and anchorages, and inserts without interfering with the reinforcement spacing.

Reinforcement in the prestressed member will be inspected in place and approved by the Inspector before the concrete is placed. Concrete placed before inspection may be rejected.

553.03.6 Prestressing Equipment

Use approved jacking equipment for prestressing.

Equip hydraulic jacks with pressure gauges. Have a certified testing laboratory calibrate each jack and gauge combination as a unit with the cylinder extension in the approximate position that it will be in at the final jacking force. Have a certified calibration chart for each jack.

Other types of jacks may be used with proving rings or other approved devices calibrated by a qualified testing laboratory.

Calibrate jacking equipment once each year and after each repair. Re-calibration may be required if any jack or gauge gives erratic results or if the difference between the gauge reading and elongations exceed allowable limits.

Equip tensioning systems with hydraulic gauges that prevent the gauge pointer from fluctuating until the jacking load is released from the tendon. The gauge must read loads directly in pounds (Newtons) or have a chart to convert the dial reading into pounds (Newtons). Assure the gauge readings are accurate to within plus or minus two percent.

Locate the gauges to provide the operator and Inspector a clear view of elongation measurements and gauge readings. Use gauge dials graduated in increments not exceeding 100 pounds (700 kPa) pressure. The gauge range or load cells must not use the lower 10 percent of the manufacturer's rated capacity in determining the jacking stress, unless calibration data establishes accuracy within the two percent requirement at the lower range.

Assure the end anchorages and prestressed member stressing blocks can maintain the required tension in all prestressed tendons until the concrete has been placed and reached transfer strength. Equip the end anchorages and stressing blocks to detect deflection while prestressing. The Inspector will check for deflection.

Provide the equipment to determine concrete compressive strengths at the location the prestressed members are manufactured. The test equipment may be mechanical or hydraulic, capable of applying and measuring the required load. Error for loads within the loading range of the test equipment may not exceed an error of plus or minus 1.5 percent. Have a certified calibration diagram covering the entire use range with the equipment at all times. The indicated load of the testing equipment does not have to be corrected by calculation or by the calibration diagram to obtain values when the values are within the required variation of +1.5 percent.

Certify the concrete strength testing equipment every two years; after each repair or adjustment of the equipment; when a non-portable machine has been moved; and whenever accuracy is in question.

553.03.7 Pretensioning

Hold the prestressing elements in position using jacks when stressing. Keep a record of the jacking force and the elongations.

Multiple units may be cast in a continuous line and stressed at one time. Leave a space between the ends of the units to permit cutting of the strands.

Furnish strand in coils, reel-less packs, or on reels. Stringing may be performed by pulling single or multiple strands. Pull to gradually relieve strand rotation on coil or reel-less packs.

Strand with gripped points are not permitted within the lengths to be stressed.

Bring all prestress tendons to the uniform initial tension on the approved fabrication drawings. Initial tension is the minimum force required to equalize stresses and eliminate slack in the strand. Submit alternate initial loading proposals for approval.

The initial load may be applied by the jack used for single strand tensioning or by any other approved method that provides a definite, uniform load. Regardless of the method used, measure the initial load within plus or minus 100 pounds (450 N). Compute elongation measurements for initial tensioning but do not use as a measurement of the initial force.

Once initial tensioning is complete, reference mark the strand as directed. The mark must provide an accurate measurement of elongation by final tensioning.

Measure the induced stress by gauge and check it by elongation, load cell, or both. The results must agree within five percent. Do not permit jacking stress to exceed 75 percent of the specified minimum ultimate tensile strength of the prestressing steel. Measure the strand elongation to within 1 percent of the theoretical elongation or 1/8-inch (3 mm), whichever is smaller. If a discrepancy between measured elongations and gauge readings exceeds 5 percent, check and correct the entire operation before proceeding with the work.

All uplift devices, hold-down devices, and strand openings in end bulkheads must have rounded, smooth surfaces at all contact points with the strand.

Take gauge readings, elongation measurements, and make calculations for elongation and include allowances for operational losses for the tensioning system used. These allowances must include losses for strand slippage, anchor movement, friction, strand rotation, and other forces acting on the strand.

If the temperature difference between the strand at the time of tensioning and the concrete at the time of pouring exceeds 30 °F (16 °C), correct the computed elongation measurements for the temperature differences.

Provide copies of the elongation calculations to fabrication and inspection personnel at the beginning of production to insure all allowances for the method of tensioning have been considered.

553.03.8 Final Tensioning

A. Single Strand Tensioning. After the initial load is applied and the reference marks are established, individually pull the strands to the final load. Tension each strand to the load required by the gauge reading.

The elongation measurement must be within plus or minus five percent of the load indicated by the gauge reading. If the load indicated by gauge reading doesn't agree with the measured elongation within the required tolerance, discontinue tensioning and inspect the bed for restrictions that could affect the accuracy of the applied load.

If the measurements agree, three more strands may be tensioned. If elongation measurement and gauge readings are within the required tolerance, the remaining strands may be tensioned.

As some variation in the modulus of elasticity and the cross-sectional area of a strand does exist, the strand tensioning may be accepted, if the difference between the load determined by elongation and that indicated by the gauge does not exceed five percent. A maximum 10 percent of the total number of straight strands for any one line of casting will be accepted on this basis.

If the difference between the elongation load and gauge readings exceed the limits, discontinue tensioning and correct the problem.

B. Multiple Strand Tensioning. Mark each strand, once pre-loaded and seated in the anchorage, at both end anchorages to determine elongation and slippage. The Inspector will establish references to verify parallel movement.

Measure the stressing force by the gauge system and check it by the elongation measurement.

Use two load cells to verify the applied design load and check the uniformity of pull. Place one load cell on each side of the line of pull, preferably on the outermost strands of an upper row of straight strands.

If the hydraulic gauge and the load cells agree with the elongation measurements within plus or minus five percent, the strands are acceptably tensioned. If the gauge

reading is within five percent but either or both of the load cells exceed that limit, re-tension the strands including pre-loading. Locate and place the load cells on the strands nearest to those previously gauged.

If, upon re-tensioning, the load cells are within the five percent tolerance, no excess strand slippage has occurred, and the movable anchorage has traveled the required distance, the tensioning may be accepted.

If the difference between the gauge readings, load cell readings, and elongation measurements exceed the tolerance limit, stop tensioning and correct the problem.

Lubricate the jacking ram or rams, guide rods, and movable anchorage rails to minimize friction and run the ram through its length of travel at least four times before tensioning the strand.

- C. Tensioning Draped Strands.** Draped, pre-tensioned strands may be tensioned by partial jacking at the stressing block and subsequent depressing or uplifting to the deflected position or by tensioning to the initial and final loads with the tendons held in the final design position using pins, rollers, or other devices. Use low-friction devices at all points of slope change of the draped strand.

When draped strands are partially tensioned in the straight condition and then depressed to the final design position, determination of the final load is made as follows:

1. Before starting the tensioning operation, place a load cell at the dead end anchorage on one of the strands to be deflected in each line of beams.
2. The Inspector will select the strand to which the load cell will be placed.
3. Once tensioning is complete, the load cell reading must be within plus or minus six percent of the final design load.

Should the load cell reading exceed the allowable tolerance, use additional deflecting jacks to distribute friction and restraint at the deflection points or, if necessary, revise the entire method for applying the final design load within tolerances.

If the tensioning of draped strands indicates readings within the tolerances, the Inspector may require load cells for occasional checks.

If tensioning of the draped strands is performed by partial tensioning and uplift or, by tensioning in the draped position, submit the method for approval before use.

Strand splicing using approved devices is permitted. One splice is allowed on any one strand between anchorages. Splices must not fall within a beam. For single strand tensioning, the number of strands spliced is not restricted. When multiple strand tensioning is used, the number of strands spliced may not exceed ten percent of the total number of strands in the casting line, or all the strands must be spliced.

Use only one manufacturer's strand in any one tensioning operation.

Use the same direction of twist of strand wires in all spliced strands.

One wire failure in seven wire strands may remain in the casting, subject to the following:

1. For beams with:
 - a. Less than 20 strands.....No wire breaks permitted
 - b. 20 to 39 strands 1 wire break permitted
 - c. 40 to 59 strands2 wire breaks permitted
 - d. 60 or more strands.....3 wire breaks permitted

Should wire breaks exceed these limits, or more than one wire break in any individual strand, remove and replace that strand or strands.

Locate all wire breaks allowed to remain in the casting, and securely wrap the broken ends with tie wire to prevent unraveling.

The Fabricator may be ordered to check the prestressing steel in a tensioned member for loss of prestress before placing concrete. The Engineer will approve the checking method for loss of prestress. Re-tension all strands showing a loss of prestress exceeding three percent of the original computed jacking stress.

Except as permitted in Subsection 553.03.5, do not weld, flame-cut, or ground welding equipment to the bed or forms after the prestress strand has been tensioned.

553.03.9 Placing Concrete

A. General. Batch and mix concrete under Subsection 551.03.3, except as provided below:

1. Provide master batch sheets to the Project Manager for review before production.
2. A timing device that locks the discharge gates of a stationary mixer is not required, however, the mixer must not be emptied until the materials have been mixed the specified time.
3. Ready-mix delivery slips are not required unless specifically requested.

The batching operation and equipment may be inspected at any time. The work will be stopped for failure to use approved procedures or equipment.

B. Method and Manner. Place concrete meeting Subsection 552.03.5 requirements and the following.

Obtain the Project Manager's approval before placing concrete in large members. Concrete may be placed in the member in a single lift if satisfactory results are obtained, or in multiple horizontal lifts provided cold joints are not formed. Remove and replace concrete containing cold joints. When concrete is placed in layers, place the first lift to fill the form slightly above the juncture of the bottom flange and the beam web.

Compact the concrete immediately after pouring with high-frequency mechanical vibrators operating at a minimum 4,500 impulses per minute. Apply vibration internally, externally, or a combination of both methods to flush the mortar to the surface of the forms. Vibrate succeeding concrete layers to extend into the previously placed layer. Use vibrators to thoroughly consolidate the concrete to a plastic mass without causing segregation. Do not permit vibrator heads to contact reinforcing steel, prestressing steel, or other embedded items to aid consolidation. Slowly insert and remove internal vibrators from the concrete.

Have one additional vibrator available at the site at all times during concrete pours.

C. Concreting in Adverse Weather Conditions. Perform concrete work meeting Subsections 552.03.9(A) and (B) when the ambient air temperature falls below 40 °F (4 °C), except that the placement temperature for steam-cured Class "Pre" concrete must be between 50 °F (10 °C) and 90 °F (32 °C) at placement.

When the ambient temperature before concrete is placed is 35 °F (2 °C) or less, pre-heat forms to a minimum 50 °F (10 °C) removing all frost, snow, and ice from the forms and components to be embedded in the concrete.

Do not permit the concrete temperature to exceed 90 °F (32°C).

Cover open buckets of concrete with wet burlap mats or other approved coverings, when necessary, to prevent slump loss or premature drying.

553.03.10 Curing

Water-cure prestressed concrete members meeting Subsection 551.03.6(A) or steam-cure as specified below.

Protect water-cured concrete meeting Subsection 552.03.9(C) requirements.

Perform elevated-temperature steam process cure meeting the following requirements.

Completely enclose or cover the casting beds for steam-cured members using curing blankets or other approved flexible coverings. Provide a minimum 6 inches (155 mm) of free air space between the enclosure or coverings and all concrete surfaces.

Secure flexible coverings to prevent moisture loss. Provide moisture before the cure cycle to aid hydration and prevent surface cracks caused by rapid water loss from the concrete.

Steam may be introduced before starting the cure cycle if the enclosure temperatures are maintained between 50 °F (10 °C) and 70 °F (21 °C). Fog-spray or cover the top surfaces of the members with wet blankets within 15 minutes after placing concrete to prevent moisture loss for a three hour period before the cure cycle.

Begin the steam-cure cycle after the concrete has been in place at least three hours. Maintain steam at 100 percent relative humidity, applied so it does not damage the surface of the concrete, forms, or tendons.

Raise the ambient temperature within the enclosures no faster than 40 °F (22 °C) per hour to a maximum temperature between 140 °F (60 °C) and 160 °F (71 °C). Maintain the temperature until the concrete has reached strength for transfer of prestress.

Once the cure cycle is complete, cool the beams by decreasing the temperature within the enclosures no faster than 40 °F (22 °C) per hour until the temperature difference between the inside and outside air is within 25 °F (14 °C), unless otherwise approved.

Keep a curing time-temperature record for each concrete pour in the casting bed. Provide one automatic temperature-recording thermometer for each 200 feet (61 m), or fraction thereof, of continuous bed length used. Record curing temperatures continuously for the full curing cycle. Place the temperature sensors at approved locations. Supplement automatic recording thermometers with standard bulb-type thermometers placed at approved locations. Certify the accuracy of automatic recorders once each year or when the recorder accuracy is in question. Steam curing is not permitted without automatic recorders.

The sideforms may be removed at the Contractor's discretion. Assume all responsibility removing forms before breaking the release cylinders. Concrete members damaged from early form removal will be rejected.

The cure cycle may be interrupted a maximum 20 minutes for form removal.

Do not expose the members to below-freezing temperatures within six days of casting. In place of the six-day requirement, the cure time may be based on the concrete strength. The concrete strength is determined by the average strengths of three standard 6-inch x 12-inch (152 mm x 305 mm) or 4-inch x 8-inch (102 mm x 203 mm) cylinders cast from different batches of concrete used in each round of beam castings. Expose these cylinders to the same cure and temperature conditions as the prestressed members. Immediately test the cylinders according to AASHTO T22 without further curing, once they are removed from the cure area.

Curing may be discontinued if the average strengths of the three cylinders equals or exceeds the strengths specified in Subsection 551.03.7(C)(2). Should all cylinders fail, protect the member from freezing temperatures for the 6-day period. Cool all members as specified in this Subsection.

Cast compression cylinders for field tests of the 28-day strengths following MT-101. Cast the number of test cylinders as required in Subsection 551.03.7(A)(2) and MT-111.

The Contractor may submit in writing, alternate curing methods, for approval.

553.03.11 Transfer of Prestress

Prestressed strands may be released when the concrete has:

1. Reached the minimum compressive strength for transfer of prestress;
2. The cure cycle is complete; and
3. Restrictive forms are removed.

If delays are anticipated, maintain the temperature in the curing enclosure at a minimum 50 °F (10 °C) until transfer of prestress.

Use positive, external hold-downs or weights to offset the uplifting forces in the member when the hold-down strands are released, when required.

Use a method of harped and straight strands release to hold the lateral eccentricity of prestress to a minimum. Detail the bed release and the strand-cutting pattern on the fabrication drawings. Changes to the release procedures shown on the approved drawings are not permitted except by written request and the Engineer's written approval.

Cast cylinders to determine prestressed transfer strengths using MT-101 and MT-111 as modified below:

- Cast and cure the release cylinders under the exact conditions the prestressed members were cured.
- The concrete sample for each cylinder will be selected at random from different batches.

Once the cure cycle is complete, test the release cylinders under AASHTO T 22. Test three cylinders to determine the prestressed transfer strengths for each round of beam castings. The average strengths of the three cylinders must equal or exceed:

$$F'r + 0.35S$$

Where:

S = the standard deviation of the strengths for the three cylinders

F'r = the required concrete transfer strength as specified in the contract

Test all three cylinders within 30 minutes.

Furnish the number of release cylinders required to perform these tests.

The Contractor may cast additional back-up test cylinders.

Should the release strengths not be reached and all back-up cylinders are broken, put the casting through at least one additional complete cure cycle. The Engineer may direct other tests to determine release strengths.

Test compression specimens using AASHTO T 22. While testing, apply the last one-half of the load at a rate between 1,200 to 3,000 psi (8.28 to 20.7 MPa) per minute.

The Inspector will witness the Fabricator's casting and testing of release cylinders.

553.03.12 Post-tensioning

Begin tensioning of the prestress reinforcing steel when the concrete cylinders representing the member to be prestressed reach the compressive strength shown on the approved fabrication drawings.

Stress the prestress reinforcing steel, using jacks, to the specified tension with the stress transferred to the end anchorage.

Measure the tension and elongation at all times.

Make a record of gauge pressures and elongation while post tensioning and submit it for review.

553.03.13 Bonding Steel

Bond post-tensioned steel to the concrete unless otherwise specified.

Clean all dirt, loose rust, grease, or other deleterious material from all pre-stress reinforcing steel.

Flush all conduits with water and blow them out with compressed air after post-tensioning.

Remove rubber sheaths used as enclosures, then flush and blow out the voids as described above.

Once cleaned, pressure-grout the conduit or void using a pressure not exceeding 100 psi (690 kPa). Continue grouting until a steady flow of grout exits from the pipe outlet. Close the outlet, then the inlet with the grout under pressure. Maintain the final grout pressure at between 50 psi to 100 psi (345 kPa to 690 kPa).

553.03.14 Concrete Surface Finish

Perform the concrete finish work immediately after de-tensioning. Give the exterior surfaces of exterior members and the entire bottom flange of all girders to the juncture with the beam web an ordinary finish as specified in Subsection 552.03.12(A).

All other beam surfaces may be left with the surface created by the forms, if the surfaces are true, even, and free of stone pockets, depressions, or surface projections. Point with mortar and strike off even with the surrounding surface, all air holes in the concrete measuring 1/2 inch (13 mm) or more in any direction. Repair rough, uneven, and non-uniform concrete surfaces using power grinders, carborundum stones, brushhammers, or other approved equipment and then apply an ordinary finish.

Match the appearance of the surface adjacent to the repair. Apply an ordinary finish to the entire adjoining surface of the member if a match is not possible.

Repair rock pockets identified for repair. Chip rock pockets back to sound concrete, clean, and permit inspection before patching. Rock pockets affecting the member's strength will be further evaluated before repair.

Notify the Inspector of all members having the prestress strand exposed for 8 inches (205 mm) or more on any one strand or any exposure of multiple strands before repair.

Provide an ordinary finish on beam ends not embedded in concrete. The Contractor may use approved epoxy or quick-setting grout products, provided the colors blend with the surrounding surface. Before finishing the beam ends, cut the strands back a minimum of 1/2 inch (13 mm) and fill the depressions with an approved epoxy.

When beam ends are to be embedded in concrete, the ends may be left rough and strands cut back to extend a maximum 1-inch (25 mm) beyond the surface of the concrete. Cut the strands in the area of the paving notch flush with the concrete surface.

Screed and rough-float the top surface of prestressed girders to the required depth of the member, bringing grout to the surface, and covering all aggregate.

Clean all projecting reinforcing stirrups of mortar and other foreign materials before starting the cure cycle.

553.03.15 Workmanship and Tolerances

All tolerances are applied to the theoretical positions and dimensions shown on the plans and approved fabrication drawings.

The tolerances from the plan and theoretical dimensions listed in Table 553-1 are the maximum acceptable cumulative deviations. The Engineer will verify that the girders are within the allowable tolerances when the girders alignment is not influenced by temporary temperature differences between the girders surfaces. Tolerances in other manufacturing sequences cannot accumulate to supersede any individual tolerance. Members having dimensions outside the tolerance limits may be rejected.

**TABLE 553-1
TOLERANCES FOR PRESTRESSED CONCRETE MEMBERS**

ELEMENT	TOLERANCE
Length of beam, end-to-end, measured at centerline of beam, top or bottom flange	± 3/4 inch (20 mm)
Centerline-to-centerline of end bearing plates	1/8 inch per 10 feet (3 mm per 3 m), but no greater than 1/2 inch (13 mm)
Depth of flanges, fillets, and web	± 1/4 inch (5 mm)
Depth overall	+ 1/2 inch (13 mm) to 1/4 inch (5 mm)
Width of flanges, fillets, and web	+ 3/8 inch (10 mm) to 1/4 inch (5 mm)
Beam ends - deviation from square or specified skew	Horizontal ± 1/4 inch (5 mm), Vertical 1/8 inch per foot (3 mm per 300 mm) of beam height or 1/2 inch (13 mm), whichever is less
Side insert, center-to-center and center to beam end	± 1/2 inch (13 mm)
Horizontal alignment (deviation from a straight line parallel to centerline of the member)	1/8 inch per 10 feet (3 mm per 3 m) of beam length but not greater than 1 inch (25 mm)
Camber differential between adjacent beams measured at release of prestress (to be applied only to identical members cast in same line)	1/8 inch per 10 feet (3 mm per 3 m) of span to a maximum of 1 inch (25 mm)
Stirrup bars (specified projection above beam top)	± 1/2 inch (13 mm)
Tendon position	± 1/4 inch (5 mm) in center of gravity of strand group and individual tendons
Position of deflection points for deflected strands	± 6 inch (150 mm)
Position of handling devices along centerline of beam	± 6 inch (150 mm)
Centerline of bearing plates to end of beam	± 1/4 inch (5 mm)
Bearing plates (deviation from a plane perpendicular to the vertical axis of the beam)	± 1/16 inch (2 mm)
Stirrup bars (longitudinal spacing)	± 1 inch (25 mm)
Position of post-tensioning ducts	± 1/4 inch (5 mm)

553.03.16 Storage and Transportation

Exercise care during transporting, storing, hoisting, and handling of the precast units to prevent cracking or damage.

Transport precast girders and slabs in an upright position, with the points of support and directions of the reactions with respect to the members being approximately the same during transport and storage as when the members are in the final planned position.

Lift the beams using the lifting eyes. During lifts, use spreaders between slings to eliminate the horizontal component of the lifting force from being applied to the beam. A spreader is not required when the angle between the sling and the top of the beam exceeds 45 degrees.

Do not move prestressed members from the casting yard until the concrete has reached the 28 day strength and the Project Manager has been notified of the intent to transport the beams.

Replace units damaged by improper storing, handling, or transporting at Contractor expense.

553.03.17 Placing

Place precast, prestressed structural members as specified. Place piling under in Section 559.

553.04 METHOD OF MEASUREMENT

Precast, prestressed concrete members, excluding piling, are measured by the foot (meter) to the nearest 0.1 foot (0.1 m) for each specified type and/or size, installed and accepted.

Prestress beams are measured by the foot (meter) from centerline bearing to centerline bearing to the nearest 0.1 foot (0.1 m).

553.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

Pay Item

Precast Member
Prestress Member
Concrete Piling

Pay Unit

Foot (meter)
Foot (meter)
See Subsection 559.05

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

**SECTION 554
PRECAST CONCRETE
PRODUCTS**

554.01 DESCRIPTION

This work is the furnishing and installing of reinforced precast concrete bridge members, precast curbs, barrier rails, cattle guard bases, guardrail posts, and other precast concrete products.

554.02 MATERIALS

554.02.1 Concrete

Furnish portland cement concrete meeting Section 551 requirements.

554.02.2 Reinforcing Steel

Furnish reinforcing steel meeting Section 555 and Subsection 711.01 requirements.

554.02.3 Structural Steel

Furnish Structural steel meeting Subsection 711.02 requirements.

554.03 CONSTRUCTION REQUIREMENTS

554.03.1 Fabrication Drawings

Submit fabrication drawings and design calculations for review. Do not begin fabrication until the drawings are returned. The drawings must include the following information:

1. An erection layout with each individual piece identified;
2. The concrete mix design proposed for use in production including proposed admixtures;
3. The size, type, capacity, and location of items incorporated in the member such as chairs, inserts, and other hardware; and
4. All other information necessary to fabricate and install the product.

Submit prints of the drawings and calculations initially. After review furnish additional prints of drawings. Furnish prints on 22-inch x 36-inch (A1) paper with a 1 1/2-inch (46 mm) margin on the left side and 1/2-inch (43 mm) margins on the other three sides.

554.03.2 Design of Concrete Mixtures

Upon request, the Engineer will furnish a concrete mix design when a specific concrete class is specified. The Contractor may submit a proposed mix design for approval, in lieu of using the Department-furnished mix design, when concrete is designated by class.

Submit a proposed mix design with the shop drawings for approval.

The Contractor may request to change aggregate size and gradation to use aggregates in an established plant. Submit the request in writing and include sizes and gradation limits for each size aggregate. Furnish evidence of satisfactory performance of concrete produced from the aggregates. Do not make changes in the aggregates without approval.

554.03.3 Sampling, Handling, Batching, and Mixing

Sample, handle, batch, and mix materials for concrete under Subsection 551.03.3.

554.03.4 Forms and Forming

Meet the form requirements in Subsection 552.03.4.

554.03.5 Placing Concrete

Place concrete under Subsection 552.03.5.

554.03.6 Curing and Testing Concrete

Cure precast concrete products by water curing, impervious membrane curing, elevated temperature curing, or a combination of these methods.

Perform water curing and impervious membrane curing meeting Subsection 551.03.6 requirements.

Perform elevated-temperature steam process curing meeting Subsection 553.03.10 requirements.

Submit procedures for curing by the elevated-temperature electric coil process or a combination of methods in writing for approval before use.

Perform at least one test per 50 cubic yards (35 cubic meters) or per each day's production if less than 50 cubic yards (35 cubic meters) to verify reaching the compressive strength required to discontinue curing.

A test is the average strengths of three cylinders, each cast from different batches of concrete used in the day's production. Take the three samples from as many different batches as possible if more than two batches are used.

Sample and cast cylinders using MT-101.

Cure until the compressive strength of the standard 6-inch x 12-inch (152 mm x 305 mm) or 4-inch x 8-inch (102 mm x 203 mm) cylinders, cured under the same conditions as the concrete represented, reaches the required strength for the class of concrete or the specified strength.

Field-cure cylinders a maximum 28 days and test for compressive strength within 24 hours after removal from the field curing conditions. Perform strength testing under AASHTO T 22. Furnish the certified laboratory test results or arrange for the tests to be witnessed the Department.

Test results are acceptable if the average of the three cylinder strengths exceed the strength for the concrete class or the specified strength and no individual cylinder tested has a strength less than 90 percent of the specified strength.

Continue un-interrupted curing until test results are obtained. Should all cylinders be tested without reaching the specified strength, the concrete represented by the cylinders may be rejected.

554.03.7 Cold-weather Concreting

Furnish concrete at between 60 °F to 90 °F (15 °C to 32 °C) for placing when the air temperature is less than 40 °F (4 °C). Heat the concrete under Subsection 552.03.9(B).

Clear form work of snow, ice, and frost before placing concrete.

Protect the concrete from freezing for at least 48 hours after its placed or until it reaches the strength required to discontinue curing.

After 48 hours, provide freeze protection to develop the required strength.

Construct and protect bridge components meeting Subsection 552.03.9(C) requirements.

Assume all risk of concrete work during cold weather.

554.03.8 Form Removal

Remove lateral support forms only when it does not damage the concrete. Do not interrupt curing and protection in excess of 30 minutes for form removal.

554.03.9 Finish on Exposed Surfaces

Produce concrete surfaces free from rock pockets, depressions, or projections.

Scattered holes from surface trapped air are not considered defects. Point holes larger than 1/2 inch (13 mm) in any direction with mortar and strike off even with the surface. Apply an ordinary finish to surfaces not smooth and uniform in texture and appearance under Subsection 552.03.12.

554.03.10 Handling, Transporting, and Storage

Do not remove, handle, or transport items designed to carry loads from the casting bed before they reach the required strength.

Other items may be moved from the casting bed to other curing locations when they have reached the strength to prevent damage.

Replace all cracked or broken items at Contractor expense.

Handle, transport, and store precast concrete items without damage. Replace or repair all damaged items at Contractor expense.

554.03.11 Placement

Place precast concrete members as specified.

554.04 METHOD OF MEASUREMENT**554.04.1 Precast Concrete Curb**

Precast concrete curb is measured under Subsection 609.04.

554.04.2 Precast Concrete Barrier Rail

Precast concrete barrier rail is measured under Subsection 606.04.

554.04.3 Plain Reinforced Precast Concrete Bridge Members

Plain reinforced precast concrete bridge members are measured under Subsection 553.04.

554.04.4 Precast Concrete Cattle Guard Bases

Precast concrete cattle guard bases are not measured or paid for separately but are included in the payment for cattle guards under Subsection 611.05.

554.04.5 Precast Concrete Guardrail Posts

Precast concrete guardrail posts are not measured or paid for separately but are included in the payment for metal guardrail under Subsection 606.05.

554.04.6 Other Precast Concrete Products

Other specified precast concrete products are measured and paid for as specified in the contract.

554.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Precast Concrete Curb	See Subsection 609.05
Precast Concrete Median Barrier Rail	See Subsection 606.05
Precast Concrete Bridge Members	See Subsection 553.05

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

**SECTION 555
REINFORCING STEEL**

555.01 DESCRIPTION

This work is furnishing and placing reinforcing steel and wire fabric.

555.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Reinforcing Steel	711.01.1
Epoxy-coated Reinforcing Bars	711.01.2
Wire and Wire mesh	711.01.3

555.03 CONSTRUCTION REQUIREMENTS

555.03.1 Protection of Material

Protect reinforcing steel from damage. Store reinforcing and supports on blocks.

Handle epoxy-coated steel reinforcing with padded or nonmetallic slings and padded straps to prevent damage to the epoxy coating. Store the bars on wooden cribs. Damaged material will be rejected, or repaired meeting AASHTO M 284 at Contractor expense.

Cover all reinforcing steel from weather exposure using an opaque moisture resistant covering that permits air circulation. Do not permit epoxy coated reinforcing steel to be exposed to sunlight in excess of 60 days.

555.03.2 Fabrication

Bend reinforcing bar as specified in the contract.

Bend all bars cold. Do not field bend bars partially imbedded in concrete unless otherwise specified.

Meet Table 555-1 bend radii for standard hooks and all other bars other than stirrups and ties. Provide a minimum inside radii of two bar diameters for stirrups and ties.

**TABLE 555-1
MINIMUM BENDING RADII**

BAR SIZE	MINIMUM INSIDE RADII
3 thru 8 (#10 thru #25)	3 bar diameters
9 thru 11 (#30 thru #35)	4 bar diameters
14 or 18 (#45 or #55)	5 bar diameters

Obtain approval for special fabrication or bends exceeding 90 degrees for No's. 14S and 18S reinforcing steel.

Ship reinforcing bar in bundles tagged and marked meeting the Concrete Reinforcement Steel Institute Code of Standard Practice.

Submit fabrication drawings when specified or requested.

555.03.3 Placing and Fastening

Place the reinforcing steel as shown in the contract and hold in place during concrete work. Submit a written request for approval to weld reinforcing steel to hold in place or fasten. Include in the request ANSI/AWS procedures to be used.

Assure steel reinforcing is free of loose rust and scale, dirt, paint, oil, or other foreign material.

Verify the anchor bolt clearances before placing reinforcing steel.

Tie bars at all intersections unless bar spacing is less than 1 foot (305 mm) in each direction, which requires alternate intersections be tied.

Provide the minimum cover for reinforcing bars shown in Table 555-2.

**TABLE 555-2
MINIMUM BAR EMBEDMENT**

BAR LOCATION	EMBEDMENT
Top of Slab	2 3/8 inches (60 mm)
Bottom of Slab	1 inch (25 mm)
Stirrups and Ties	1 1/2 inches (38 mm)
Footing and Pier Shafts	3 inches (75 mm)

Separate forms using stays, ties, hangers, metal chairs, blocks, or other approved supports.

Precast mortar blocks may be used at locations approved by the Project Manager, excluding supports for bridge deck slab reinforcing steel. Use blocks precast from concrete used on the project and water cured for seven days before use. Use blocks of the size specified having an embedded wire for fastening to the reinforcing bar. Separate bar layers using precast mortar blocks, upper continuous metal chairs, or other approved devices.

Separate the upper and lower mats of reinforcing steel for deck slabs, depending upon the vertical distance between the mats, using "Upper Continuous High Chair (U.C.H.C.)" or "Slab Bolsters with Runners (S.B.R.)". Place Continuous bar supports at right angles to structure centerline for "Flat Slab" structures and parallel to structure centerline for all other deck slabs. Do not use pebbles, pieces of broken stone, concrete rubble, broken brick or building blocks, metal pipe, or wooden blocks.

Use metal chairs and supports contacting epoxy-coated bars that are epoxy coated or coated with another inert approved coating.

Use plastic-coated tie wires to tie the coated bars in place.

Space deck slab reinforcing supports a maximum 4 feet (1,200 mm). Space supports closer if necessary to prevent deflection during placement of concrete.

Obtain approval of reinforcing placement before placing concrete. Remove concrete placed before inspection.

Flatten rolled reinforcing fabric into sheets before placing.

555.03.4 Splicing

Furnish all reinforcing steel in the specified lengths. Splice as shown in the contract or as directed.

555.03.5 Reinforcing Steel - Material Guaranty and Random Sampling

Furnish for each shipment of reinforcing steel delivered to the project, duplicate copies of the following:

1. Shipping invoice showing the weight and price per pound (kilogram) of all of the steel in the shipment;
2. Certified mill test reports showing physical and chemical analysis on each heat of reinforcing steel;
3. A statement from the fabricator certifying that the mill tests furnished are representative of the reinforcing steel furnished and that it meets Subsection 106.09 requirements; and
4. For epoxy-coated reinforcing bars, the coating applicator must furnish with each shipment a certificate of compliance confirming that the coated reinforcing bars were cleaned,

coated, and tested meeting the requirements of AASHTO M 284 and Subsection 106.09. Additionally, the certification must include for each bar size the preheat temperatures, cure times, thickness checks, holidays detected, and bend test results.

A shipment is the quantity of reinforcing steel in each truckload delivered to the project. When delivery is by railroad car, each 20 tons (18.1 mt), or fraction thereof, is a shipment.

Furnish the samples as requested for testing.

Do not place concrete until the steel test results are known. If a reinforcing steel sample fails, two additional samples representing the failed sample will be tested. If either of the check samples fail, the steel in the shipment represented by the failing sample may be rejected; or if the Project Manager determines that the steel is usable, a price reduction will be assessed as follows:

$$P = A \times B$$

Where:

A = Total invoice price of reinforcing steel in the lot¹

B = 10 percent, 20 percent, or 30 percent, dependent upon departure from specifications; the value to be used will be determined by the Engineer

P = Price reduction for the lot

Notes:

1. A lot is defined as all the bars of one bar number and pattern of deformation contained in an individual shipment.

The amount of reduction calculated above will be deducted from monies due the Contractor on the final estimate.

Remove and replace all rejected steel at Contractor expense. Furnish invoice statements, mill reports, and fabrication certificates for replacement steel. Replacement steel is subject to the tests specified above.

No reinforcing steel in a shipment will be final accepted until the test results are known. The Contractor may proceed with the work at its own risk before testing.

555.04 METHOD OF MEASUREMENT

The reinforcing steel quantity in the contract is the calculated theoretical weight of the steel in pounds (kilograms), measured as shown in the contract or ordered in writing, complete in place and accepted.

Plan quantities will not be re-measured except as provided for in Subsection 555.05.

The weights of standard sizes of reinforcing bars meeting the requirements of AASHTO M 31 are computed using Table 555-3.

**TABLE 555-3
WEIGHTS OF STANDARD SIZES OF REINFORCING BARS**

Bar Size English (metric)	Bar Diameter inch (mm)	Weight lb/ft (kg/m)
No. 3 (#10)	0.375 (9.5)	0.376 (0.560)
No. 4 (#13)	0.500 (12.7)	0.668 (0.994)
No. 5 (#16)	0.625 (15.9)	1.043 (1.552)
No. 6 (#19)	0.750 (19.1)	1.502 (2.235)
No. 7 (#22)	0.875 (22.2)	2.044 (3.042)
No. 8 (#25)	1.000 (25.4)	2.670 (3.973)
No. 9 (#29)	1.128 (28.7)	3.400 (5.060)
No. 10 (#32)	1.270 (32.3)	4.303 (6.404)
No. 11 (#36)	1.410 (35.8)	5.313 (7.907)
No. 14 (#43)	1.693 (43.0)	7.650 (11.38)
No. 18 (#57)	2.257 (57.3)	13.600 (20.24)

Non-standard reinforcing bars or wire fabric, when required, have the unit weight specified in the contract.

No allowance is made for clips, wires, separators, or other material used for fastening or supporting the reinforcing steel.

555.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Reinforcing Steel	Pound (kilogram)

Reinforcing steel is paid in place for the quantities shown in the contract, except as follows:

1. The calculated quantities involved in changes ordered in writing by the Engineer are added or deducted from the plan quantities.
2. A recalculation will be made and the corrected quantity will be included for payment, in lieu of the plan quantity, when the plan quantity of reinforcing steel in any complete structure is in error by five percent or more. A complete structure is the smallest portion of a total structure for which a quantity is included in the contract. The party to the contract requesting an adjustment must present to the other party three copies of the description, location and recalculated quantities of the structure having the quantity error.

Partial payments for reinforcing steel will be made based on the contract quantity as follows:

1. 85 percent when the material is accepted and placed and tied.
2. 100 percent when covered with concrete.

**SECTION 556
STEEL STRUCTURES**

556.01 DESCRIPTION

This work is the furnishing, fabricating, painting, and erecting of steel structures and the steel structure portions of composite structures.

The Department has calculated the contract quantities using the following:

<u>Material</u>	<u>Weight Per Cubic Foot (cubic meter)</u>
Malleable Iron	470 lbs (7,530 kg)
Wrought Iron	487 lbs (7,800 kg)
Rolled, Cast Copper Bearing, Silicon, Nickel, and Stainless Steel	490 lbs (7,850 kg)

The weights of rolled shapes and plates up to and including 36 inches (915 mm) in width are computed based on their nominal weights and dimensions as shown on the shop drawings. One-half of the allowed percentage of overrun in weight as tabulated in ASTM A 6 will be added to the nominal weights of plates exceeding 36 inches (915 mm) in width. The weight is computed on the basis of rectangular dimensions for all plates and overall lengths for all structural shapes with no deductions for copes, slips, sheared edges, punching, borings, milling, or planing. When parts can be economically cut in multiples from materials of larger dimension, the calculated weight is that of the material from which the parts are cut.

Bolts, nuts, and washer weights are the calculated weight in the AISC Manual of Steel Construction.

A 0.4 percent multiplier may be specified in the contract and added to the computed weight of metals for shop paint.

Weld metal weight is not computed.

556.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Structural Steel	711.02
Structural Steel Tubing	711.03
Pins and Rollers.....	711.04
Welding Electrodes.....	711.05
High Tensile Strength Bolts	711.06
Bolts and Nuts	711.07
Galvanized Metal	711.08
Welded Stud Shear Connectors	711.09
Castings.....	711.12
Fiber-reinforced Pads for Bearing Plates.....	711.16
Bearing Assembly Anchor Bolts for Bridges	711.13
Elastomeric Bearing Devices	711.14
Compression Joint Seals	711.15

556.03 CONSTRUCTION REQUIREMENTS

556.03.1 Pre-qualification

Use metal fabricators that are pre-qualified under the AISC Quality Certification Program. Registration and certification of the plant or shop under the AISC Quality Certification Program (categories seen below) and submission of a valid certificate to the Bridge Engineer, MDT, PO

Box 201001, Helena, MT 59620-1001 is required. Furnish an annual endorsed copy for continued qualification.

AISC has quality certification in the following categories:

- A. Conventional Steel Building Structures (SBD).** The certification is typically specified for small public service and institutional buildings (schools, etc.), shopping centers, light manufacturing plants, miscellaneous and ornamental iron work, warehouses, low rise beam/column/light truss structures.
- B. Simple Steel Bridge Structures (SBR).** The certification is typically specified for unspliced rolled beam bridges.
- C. Complex Steel Building Structures (CBD).** The certification is typically specified for high-rise buildings, large public service and institutional buildings, heavy manufacturing plants, powerhouses, and petro/chemical processing facilities.
- D. Major Steel Bridges (CBR).** The certification is typically specified for large span bridges. Main members are typically fabricated girders that must be spliced with a welded or bolted connection.
- E. Metal Building Systems (MB).** Pre-engineered metal building systems including cold formed members and panels.

Fabricators certified for Complex Steel Building Structures are automatically certified for Conventional Steel Building structures and those certified for Major Steel Bridges are automatically certified for Simple Steel Bridge Structures.

- A. Sophisticated Paint System Endorsements (P1, P2, P3).** There are three Paint Endorsements available:
 1. **P1.** Sophisticated Paint Endorsement - Enclosed;
 2. **P2.** Sophisticated Paint Endorsement - Covered; and
 3. **P3.** Sophisticated Paint Endorsement - Exposed
- B. Fracture Critical Members Endorsement (F).** Familiarity with procedures required to produce fracture critical members in accordance with a fracture control plan as defined by AASHTO or AREA.

Use only fabricators having a Category CBR certification to fabricate the following:

- A.** Fracture critical members and attachments. Fabricators must have the Fracture Critical Endorsement (F);
- B.** Main members, except for rolled beams;
- C.** Welded floor beams; and
- D.** Cross frames and diaphragms for curved bridges.

Use fabricators having a Category SBR, SBD, CBD, or CBR certification to fabricate the following:

- A.** Modular expansion joints;
- B.** Welded bearings;
- C.** Steel grid flooring;
- D.** Overhead, truss, and cantilever sign structures; and
- E.** Lighting poles and anchor bases.

556.03.2 Fabrication Drawings

Submit the fabrication drawings for review. Include on the drawings complete details, dimensions, size of material, welding procedures, and other information necessary for the complete fabrication and erection of the work.

Check and approve fabrication drawings before submitting. The Contractor's approval stamp and signature must be on each drawing.

The Project Manager must review the Drawings before fabrication begins. The Department has 20 working days to review and return the fabrication drawings. The contract time will be extended day for day for any delay beyond the 20-day review period if the Department's delay affects the Contractor's operation as shown on the current work schedule.

Furnish all fabrication drawings on 22-inch x 36-inch (A1 paper) with a 1 1/2-inch (46 mm) margin on the left side and a 1/2-inch (43 mm) margin on the other three sides. Once the work is completed, provide the original tracings, if required, to the Project Manager.

Changes to the plans or substitutions of sections requested by the Contractor regarding plate size, splice location, details of appurtenances, or details of welds cannot decrease the dimensions or section properties of the member or increase the weight of the member.

Submit all requests for changes for review and approval. All approved changes are at the Contractor's expense, including any additional freight and handling charges. The approved changes will be by change order, and include any cost savings.

556.03.3 Mill and Shop Inspection

- A. Inspection of Work.** Do not begin manufacturing or shop fabrication until the Department's Inspector has inspected the shop.
- B. Facilities for Inspection.** Furnish facilities for inspecting the material and workmanship in the mill and shop. Allow the Inspector free access to the work at all times.
- C. Inspector's Authority.** The Inspector may reject material or work not meeting the specifications. In case of dispute, the Contractor may appeal the Inspector's decision to the Project Manager.
- D. Mill Test Reports.** Furnish the Project Manager a complete certified mill test report showing chemical analysis and physical tests for each heat of steel for all members. Identify each piece of steel with a mark number on the mill test report.
- E. Facilities for Testing.** Furnish, at Contractor expense, test specimens, labor, testing machines, and tools to make the specimens and tests.
- F. Rejections.** Material or finished members accepted by the Inspector may be rejected if the material is subsequently found defective. Replace or repair rejected material at Contractor expense.

556.03.4 Storage and Identification of Materials

Store structural steel meeting Subsection 556.03.17 requirements.

Mark alloy and high-strength steels as required by Article 11.4.1 of the AASHTO Standard Specifications for Highway Bridges. Mark material required to meet a Charpy requirement for identification.

556.03.5 Workmanship and Finish

Round all edges of primary members corners to a 1/16-inch (2 mm) radius.

Make all surfaces and edges smooth, uniform, and free from fins, tears, and cracks.

Shear, flame cut, and chip neatly and accurately. Neatly finish all exposed portions of the work.

Straighten rolled material before lay out or working. Do not injure the metal when straightening. The maximum temperature of the steel cannot exceed 1000 °F (537 °C) unless approved. Perform heat straightening of AASHTO M 270 Gr. 100/100w (ASTM A 709 Gr 100/100w) or ASTM A 517 steel only under controlled procedures with the heat application approved by the Project Manager. Material with sharp kinks and bends will be rejected.

Lay out and cut plates and splice plates for flanges and webs with the direction of rolling parallel to the longitudinal axis of the girder. Show on the shop drawings the direction of rolling for these plates.

Curve rolled beams and welded girders meeting Articles 11.4.12.2 and 11.4.7 of the AASHTO Standard Specifications for Highway Bridges.

556.03.6 Finishing and Shaping

Finish members true to line, free from twists, bends, and open joints. Camber girders as shown on the plans.

- A. Edge Planing.** Plane sheared plate edges exceeding 5/8-inch (16 mm) in thickness and carrying stress to 1/4-inch (5 mm). Fillet re-entrant cuts before cutting.
- B. Facing of Bearing Surfaces.** For bearing, base plates and other bearing surfaces in contact with other members or with concrete, meet the surface-roughness requirements of Table 556-1.

TABLE 556-1
SURFACE ROUGHNESS REQUIREMENTS¹

ITEM	REQUIREMENT
Steel slabs	ANSI 2,000 (50 μ m)
Heavy plates in contact in shoes to be welded	ANSI 1,000 (25 μ m)
Milled ends of compression members, stiffeners, & fillers	AMS 500 (12.5 μ m)
Bridge rollers and rockers	ANSI 250 (6.3 μ m)
Pins and pin holes	ANSI 125 (3.2 μ m)
Sliding bearings	ANSI 125 (3.2 μ m)

Notes:

1. As defined in ANSI B Y 14.36 - 1978 Surface Roughness, Waviness, and Lay, Part I

Stress relieve shoes meeting AWS specifications after all welding and before pin holes are drilled or curved bearing surfaces are finished.

- C. Abutting Joints.** Face and bring to an even bearing, abutting joints in compression members, girder flanges, and tension members, if specified. Joints not faced must have an opening not exceeding 1/4-inch (5 mm).
- D. End Connection Angles.** Build floor beams, stringers, and girders with end connection angles to exact length back-to-back of connection angles. Assure the finished thickness of the angles is at least that shown on the plans if end connections are faced.
- E. Web Plates.** Do not exceed a 3/8-inch (10 mm) clearance at web splices between the ends of the web plates. Do not exceed 1/4-inch (5 mm) clearance at the top and bottom ends of the web splice plates.
- F. Bent Plates.** Furnish cold-bent, load-carrying, rolled-steel plates meeting the following requirements:
 1. Use stock plates that place the bend lines at right angles to the direction of rolling; and
 2. Bending must not crack the plate. Meet minimum bending radii, measured to the concave face of the metal, as specified in Table 556-2.

TABLE 556-2
MINIMUM BENDING RADII - ROLLED STEEL PLATES

THICKNESS OF PLATE IN INCHES (mm)					
	Up to 1/2 (12)	Over 1/2 to 1 (12 to 25)	Over 1 to 1 1/2 (25 to 38)	Over 1 1/2 to 2 1/2 (38 to 63.5)	Over 2 1/2 to 4 (66 to100)
Bending Radii²	$2t^1$	$2\ 1/2\ t^1$	$3t^1$	$3\ 1/2\ t^1$	$4t^1$

Notes:

1. t = plate thickness
2. For all grades of structural steel in this specification.

Hot bend low alloy steel over 1/2-inch (12 mm) thick for small radii if required.

Springback allowance for AASHTO M 270 Gr. 100/100w (ASTM A 709 Grade 100/100w) and ASTM A 517 steels is about 3 times that for structural carbon steel. When break press forming, use a lower die span at least 16 times the plate thickness.

Hot bend the plates at a temperature not exceeding 1,200 °F (649 °C), excluding AASHTO M 270 Grade 100/100w (ASTM A 709 Grade 100/100w) and ASTM A 517 steels if a shorter radius is required. Re-quench the plates and temper following the mill's common practice if AASHTO M 270 Grade 100/100w (ASTM A 709 Grade 100/100w) or ASTM A 517 steel plates to be bent are heated to a temperature exceeding 1,125 °F (607 °C). Hot bent plates must meet requirement (1) above.

3. Round the corners of the plate to a radius of 1/16-inch (2 mm) throughout the area to be bent.

G. Fit of Stiffeners. Mill or grind end stiffener plates or girder and stiffener angles for use as supports for concentrated loads to provide an even bearing against the flange. Make fillers under stiffeners to fit within 1/4-inch (5 mm) at each end. Welding is permitted in lieu of milling or grinding if noted in the contract. Welding transversely across the tension flanges of beams or girders is permitted only with the Project Manager's approval. Horizontal stiffeners must not leave a gap exceeding 2 inches (50 mm) between the vertical stiffeners and the end of the horizontal stiffeners.

H. Flame Cutting. Steel or wrought iron may be flame cut, if a smooth surface is produced using a mechanical guide. Perform hand flame cutting only where approved, smoothing the surface by planing, chipping, or grinding. Adjust the cutting flame to prevent cutting beyond the specified lines. Make fillet re-entrant cuts having a minimum radius of 1/2 inch (10 mm).

Remove flame-cut edges back at least 1/4-inch (5 mm) by milling, chipping, or grinding for silicon steel. Machine flame-cut edges may be used as cut if the edges are softened after cutting by either of the following methods:

1. Heat the cut edge uniformly and progressively to a red heat (1,150 °F to 1,250 °F) (621 °C to 676 °C) to at least 1/16-inch (2 mm) deep; or
2. Using a post-heating torch attached to and following the cutting torch; regulate the tips, gas pressure, speed of travel, and the distance of post-heating torch from kerf to the thickness of the steel.

556.03.7 Pins and Rollers

- A. General.** Furnish straight, smooth pins and rollers meeting the specified dimensions, free from flaws. Forge and anneal pins and rollers more than 9 inches (225 mm) in diameter. Pins and rollers 9 inches (225 mm) in diameter or less may be forged and annealed or cold-finished carbon-steel shaft.

Gradually cool pins 9 inches (225 mm) in diameter or larger to prevent damage before annealing. Bore a hole 2 inches (50 mm) or larger in diameter the full length along the axis.

- B. Boring Pin Holes.** Bore pin holes to the specified diameter at right angles with the axis of the member, and parallel with each other unless otherwise specified. Finish cut the final surface.

Maintain a tolerance of $\pm 1/32$ -inch (1 mm) for outside-to-outside of end holes in tension members and inside-to-inside of end holes in compression members.

Bore holes in built-up members after the welding is completed.

- C. Pin Clearances.** Meet the following pin hole diameter maximum tolerances:

1. The pin diameter plus 0.02-inch (0.5 mm) for pins 5 inches (125 mm) or less in diameter.
2. $1/32$ -inch (1 mm) for larger pins.

- D. Surface Finish.** Finish surfaces of bridge rollers, rockers, pins and pin holes meeting Subsection 556.03.6(B) requirements.

- E. Pilot and Driving Nuts.** Furnish two pilot nuts and two driving nuts for each size of pin unless otherwise specified. Pilot and driving nuts are not required when shoes are assembled at the fabrication plant.

- F. Threads.** Use Unified Standard Series UNC - ANSI B1.1, Class 2A threads for external threads, and Class 2B for internal threads, for all imperial dimension bolts and pins for structural steel construction, except for pin end diameters of 1 3/8 inches (35 mm) or more which must be 6 threads per inch (25 mm).

Furnish American Standard Metric Screw Treads - M Profile, ANSI B1.13M-1983 for all metric dimension bolts and pins for structural steel construction. Tolerance is Class 6H/6g. Use a 4 mm pitch for pin end diameters of 1 3/8 inches (35 mm) or more.

556.03.8 Bolt Holes

- A. General.** Punch or drill all bolts holes.

Members built up with five thicknesses or less of metal may be punched $1/16$ -inch (2 mm) larger than the nominal diameter of the bolt, if the metal thickness does not exceed $3/4$ -inch (19 mm) for carbon steel or $5/8$ -inch (16 mm) for alloy steel.

Sub-punch or sub-drill all holes $3/16$ -inch (5 mm) or smaller for members exceeding 5 thicknesses, where the material is $3/4$ -inch (19 mm) carbon steel or thicker, or $5/8$ -inch (16 mm) in alloy steel. Ream the holes $1/16$ -inch (2 mm) larger. The holes may be drilled from the solid to $1/16$ -inch (2 mm) larger than the nominal diameter of the bolts.

- B. Punched Holes.** Make holes, punched full size, $1/16$ -inch (2 mm) larger than the nominal diameter of the bolt. The die diameter cannot exceed the diameter of the punch by more than $1/16$ -inch (2 mm).

Ream undersized holes. Clean-cut holes without torn or ragged edges. Poorly matched holes will be rejected.

- C. Accuracy of Punched and Sub-drilled Holes.** Punch all holes, punched full size, sub-punched, or sub-drilled so that after assembling (before any reaming is done) a cylindrical pin $1/8$ -inch (3 mm) smaller in diameter than the nominal size of the punched hole will enter without drifting, in at least 75 percent of the contiguous holes in the same

plane. Any hole that will not pass a pin 3/16-inch (5 mm) smaller in diameter than the nominal size of the punched hole will be rejected.

- D. Reamed or Drilled Holes.** Ream or drill all holes, perpendicular to the member, and not to exceed 1/16-inch (2 mm) larger than the nominal diameter of the bolts. Where practical, use mechanically directed reamers.

Drill holes 1/16-inch (2 mm) larger than the nominal diameter of the bolts.

Remove all outside surface burrs. Poorly matched holes will be rejected. Use twist drills for reaming and drilling. Disassemble assembled parts to remove burrs caused by drilling. Assemble connecting parts to be reamed or drilled and held during the work, then match-mark before disassembling.

- E. Accuracy of Reamed or Drilled Holes.** Eighty-five percent of reamed or drilled holes in any contiguous group must not exceed a 1/32 inch (0.8 mm) offset between adjacent thicknesses of metal.

556.03.9 Bolts and Bolted Connections

- A. General.** Make bolted connections meeting the contract requirements. Use unfinished bolts (ordinary rough or machine bolts). Provide turned bolts when specified. Special ribbed drive-fit bolts may be substituted for turned bolts with the Project Manager's written approval.

Provide bolted connections, using high-tensile-strength bolts, meeting Subsection 556.03.9(E) requirements.

Furnish bolts that are free of rust. Lubricate bolts before use.

Drive the bolts into the holes without damaging the thread. Use snaps to prevent damaging the heads.

Draw the heads and nuts tightly against the work with wrenches. Tap bolt heads with a hammer as the nuts are being tightened.

Use beveled washers to provide full bearing to the head or nut where bolts are used on beveled surfaces.

All bolts threads must be cut and finished.

Fully draw up the nuts of unfinished turned bolts and ribbed bolts after tightening.

Fully erect continuously supported girder sections between expansion joints before production bolt tightening. Tighten field splices to the proof loads in Table 556-5 after field splices have been set to grade.

- B. Unfinished Bolts.** Furnish standard unfinished bolts having hexagonal heads; with nuts having a bolt hole diameter 1/16-inch (2 mm) larger than the bolt diameter. Use threaded bolts, for transferring shear, to prevent no more than one thread within the grip of the metal. Furnish bolts that extend through the nuts a maximum 1/4-inch (6 mm).
- C. Turned Bolts.** Ream turned bolt holes, and turn the bolts to a driving fit with the threads entirely outside of the holes. Use hexagonal headed bolts and nuts and provide washers. Turned bolts must be finished cut.
- D. Spacing and Edge Distance of Bolts.** Follow the spacing and edge distance of bolts specified in Table 556-3.

**TABLE 556-3
SPACING AND EDGE DISTANCE OF BOLTS**

BOLT LOCATION	BOLT SIZE			
	1 inch (M24)	7/8 inch (M22)	3/4 inch (M20)	5/8 inch (M16)
	Spacing or Distance, inches (mm)			
Minimum spacing of bolts, center-to-center	3 1/2 (90)	3 (75)	2 1/2 (65)	2 1/4 (55)
Minimum distance from center of bolt to nearest sheared edge and to edges of beams and channels	1 3/4 (42)	1 1/2 (38)	1 1/4 (34)	1 1/8 (28)
Minimum distance from center of bolt to nearest rolled, planed edge, or gas cut	1 1/2 (30)	1 1/4 (28)	1 1/8 (26)	1 (22)
Maximum distance from center of bolt to nearest edge	Eight times the thickness of the thinnest outside plate but not greater than 5 (125) for all bolt sizes			

E. Bolted Connections - High-Tensile-Strength Bolts.

- Bolt Lengths.** Use bolt lengths having the grip-length values in Table 556-4 plus the total thickness of connected material. The values in Table 556-4 consider nut, one flat washer, and bolt point.

Adjust the length to the next 1/4-inch (10 mm) increment up to a 5-inch (120 mm) bolt and to the next 1/2-inch (10 mm) increment for bolts over 5 inches (120 mm).

Increase the bolt length 1/8 inch (3.2 mm) if direct tension indicator washers are used.

**TABLE 556-4
BOLT LENGTH DETERMINATION**

BOLT DIAMETER Inches (mm)	ADDED GRIP LENGTH ¹ inches (mm)
1/2 (13)	7/8 (22)
5/8 (16)	1 (25)
3/4 (19)	1 1/8 (29)
7/8 (22)	1 3/8 (35)
1 (25)	1 1/2 (38)
1 1/8 (29)	1 5/8 (41)
1 1/4 (32)	1 3/4 (44)
METRIC	
M16	25 mm
M20	30 mm
M22	35 mm
M24	40 mm

Notes:

- Add to total thickness of connected material.

Where beveled washers are used, adjust bolt lengths to account for the use of nonstandard or beveled washers.

- 2. Bolted Parts.** Assure bolted surfaces in contact with the bolt head and nut do not have a slope of more than 1:20 to a plane normal to the bolt axis.

Assure bolted parts fit solidly when assembled without gaskets or other compressible material.

Remove all mill scale, dirt, burrs, and other defects that prevent solid seating of the parts.

Clean contact surfaces of oil, paint, lacquer, or galvanizing.

- 3. Installation.** Install bolts with a hardened washer under the nut or bolt head, whichever element is turned in tightening. Use a hardened washer under the head of regular, semi-finished hexagon bolts and under finished hexagon nuts, even when these are not the elements turned in tightening. Washers may be omitted under the head of heavy hexagon bolts and interference-body bolts and under heavy, semifinished hexagon nuts, when these are not turned. A flat washer may be used when the surface adjacent to the bolt head or nut does not have a slope greater than 1:20 to a plane normal to the bolt axis. Use a smooth beveled washer where the outer face of the bolted parts has a slope greater than 1:20 to a plane normal to the bolt axis.

Tighten each fastener to provide the minimum tension in Table 556-5 when all fasteners in the joint are tight.

Tighten threaded bolts as specified in Subsections 556.03.9(E)(3)(a) or (b). Turn the bolt if the nut is prevented from rotating because of clearance problems.

**TABLE 556-5
FASTENER TENSION**

BOLT SIZE inch (mm)	MINIMUM FASTENER TENSION¹ pounds (A 325 BOLTS) (kN)
1/2 (13)	12,050 (53.5)
5/8 (16)	19,200 (85.3)
3/4 (19)	28,400 (126.2)
7/8 (22)	39,250 (174.4)
1 (25)	51,500 (228.9)
1 1/8 (29)	56,450 (250.9)
1 1/4 (32)	71,700 (318.7)
1 3/8 (35)	85,450 (379.8)
1 1/2 (38)	104,000 (462.2)
METRIC	
M16	94.2 kN
M20	147 kN
M22	182 kN
M24	212 kN

Notes:

1. Equal to 70 percent of specified minimum tensile strengths of bolts.

Impact wrenches perform the required tightening of each bolt in approximately ten seconds.

- a. **Turn-of-Nut Tightening.** Bring a minimum 50 percent of the bolts up snug tight. Then bring the remaining bolts up snug tight. Then tighten all bolts starting with the inside bolts working towards the free edge under Table 556-6. Permit only the element being tightened to turn. Obtain the Project Manager's approval of the tightening method.

TABLE 556-6
NUT ROTATION FROM SNUG TIGHT CONDITION

Bolt Length, Measured From Underside of Head to Extreme End of Point	DISPOSITION OF OUTER FACES OF BOLTED PARTS		
	Both Faces Normal to Bolt Axis	One Face Normal to Bolt Axis and Other Face Sloped Not More Than 1:20 (Bevel Washers Not Used)	Both Faces Sloped Not More Than 1:20 From Normal to Bolt Axis (Bevel Washers Not Used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12	2/3 turn	5/6 turn	1 turn

Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. For bolts tightened by one-half turn and less, the tolerance is plus or minus 30 degrees (1/12 turn); for bolts tightened by two-thirds turn or more, the tolerance is plus or minus 45 degrees (1/8 turn).

The rotation for bolts exceeding twelve diameters is by testing representative bolts in a tension device.

- b. **Calibrated Wrench Tightening.** Provide bolt tension at least five percent more than the tension specified using calibrated wrenches. Calibrate wrenches at least once each working day for each bolt diameter installed. Re-calibrate wrenches when equipment changes or when differences in the surface condition of the bolts, nuts, or washers are observed. Calibrate by tightening three bolts of each diameter, in a Skidmore-Wilhelm calibrator or approved equal.

Adjust the wrenches to prevent nut or bolt rotation from exceeding that specified in Table 556-6. Tighten the nuts to the specified torque when using manual torque wrenches.

When using calibrated torque wrenches to install bolts in one joint, check the bolts with the wrench after initial tightening of all bolts.

Adjust power wrenches to stall or cut out at the required tension.

4. **Inspection.** The bolt installation will be inspected to verify procedures and results.

Bolt tension is checked in each connection by applying the job inspection torque to at least 10 percent of the bolts, but not less than two. If any element is below the job inspection torque, re-torque all bolts in the connection. Tighten and re-inspect any element turned by the job inspecting torque. As an alternate, the Contractor may re-tighten all bolts in the connection and request a re-inspection of the connection.

Assist the Inspector with bolt tension checks. Provide an approved torque wrench as the inspection wrench. The Inspector will observe the wrench readout as the bolt is being checked.

The job inspection torque is established from three bolts of the same grade, size, and condition as those in the work. The bolt length may be any length representing

bolt lengths used in the structure. A new inspecting torque is established when the bolt grade, size, or condition changes. Place the bolts in an approved calibration device that will indicate bolt tension. Use the same surface under the nut and bolt for testing as that used in the structure when establishing the inspection torque.

Bring the three bolts to an initial tension of approximately 15 percent of the fastener tension in Table 556-5, then tighten to the minimum tension in Table 556-5. Tightening above the initial tension must not cause nut rotation beyond that permitted in Table 556-6. Turn the turned element 5 degrees (approximately 1 inch (25 mm) at a 12-inch (300 mm) radius and read the applied torque. The average of the torque readings in the three tests is the job inspection torque.

556.03.10 Welding Requirements

Meet the current requirements of the American National Standard Bridge Welding Code, ANSI, AASHTO, the AWS Structural Welding Code, and the contract. Use AWS certified welders for the type of weld required.

556.03.11 Welded Stud Shear Connectors

The type, size or diameter, and length of stud shear connectors are specified in the contract.

Furnish fabrication material and perform welding meeting Subsection 556.03.10 requirements.

556.03.12 Field Welding

Do not weld temporary construction supports to beams, girders, or other main members. Unauthorized field welds, tack welds, or arc strikes to any member will be rejected.

556.03.13 Assembling Steel

Field or shop assemble steel parts as follows:

- A. Shop Work.** Clean all contacting metal surfaces of deleterious materials before assembling, bolting, or welding. Paint may be applied to contact surfaces after bolting or welding.

Shop assemble and adjust to line and camber all bolted trusses, continuous plate girders, curved steel elements, box girders, I-beam spans, skew portals, skew connections, rigid frames, bents, and towers.

Drill and ream the field splice holes during assembly. Holes for other field connections may be shop drilled or reamed with the connecting parts assembled or drilled or reamed to metal templates with hardened bushings, without assembling.

Use an approved alternate procedure where shop space prevents complete shop assembly of continuous span girders or trusses. The procedure may require adjusting the line and camber of at least two abutting sections of girder for drilling or reaming of field splices if all girder lines for the complete structure are assembled consecutively.

Field butt joints for welded girders may be assembled with abutting members adjusted for line and camber and prepared to fit for welding, subject to Project Manager approval.

Bridge expansion devices must be initially shop assembled to establish the proper fit between the joint parts.

- B. Field Work.** Assemble the parts as specified in the contract, following the match-marks. Prevent damaging the material while handling. Clean bearing surfaces and all member surfaces in permanent contact before assembly.

Splices and field connections must have a minimum of 1/2 of the holes filled with bolts or erection pins before removing temporary supports or releasing the load from

erecting equipment. Splices and connections carrying traffic during erection must have 3/4 of the holes pinned or bolted.

Do not begin production bolt tightening of the field splice bolts until the complete girder line is aligned and erected matching the full camber line.

Use erection pins 1/32-inch (1 mm) larger than the nominal diameter of the permanent bolts.

Erect truss spans on blocking, unless they are erected using the cantilever method, to provide truss camber. Leave the blocking in place until the tension cord splices are fully bolted and all other truss connections pinned and bolted. Do not tension bolts in butt joint splices of compression members and in railings until the span is swung.

- C. Drifting of Holes.** Only use drift pins during assembly to the extent necessary to bring the parts into position without enlarging or distorting the holes or metal. Enlarge holes by reaming to fit the bolts.
- D. Match-marking.** Match-mark parts assembled in the shop for reaming field connection holes and furnish the Project Manager a diagram showing the marks.

556.03.14 Marking and Shipping

Paint or mark each member with an erection mark, and furnish the Project Manager an erection diagram detailing the erection marks.

Furnish copies of material orders, shipping statements, and erection diagrams. Show the individual member weights on the statements.

A shipping statement must accompany the material and be marked to clearly identify it with the delivered material and mill test reports.

Mark the weight on members weighing 3 tons (2.7 t) or more. Load and unload structural members on trucks or cars without stressing or causing damage.

Pack bolts, loose nuts or washers of each size separately. Ship pins, small parts, bolts, washers, and nuts in boxes, crates, kegs, or barrels, with the gross weight of each package not exceeding 300 pounds (136 kg). Plainly mark each shipping container, listing and describing the contents on the outside of each shipping container.

Keep structural material clean and free from damage.

556.03.15 Painting

Clean and paint all iron and steel surfaces meeting Section 612 requirements.

556.03.16 Erection

Erect the members using the camber diagrams on the drawings and complete the structure or structures as specified.

When requested, furnish the Project Manager erection details before starting the work.

Support girders and beams at intervals that maintain camber, elevation, and horizontal alignment during final grading, bolt-up, and field splice tightening.

556.03.17 Handling and Storing Materials

Store materials off the ground and keep them clean and dry. Place and shore girders and beams upright. Support long members, including but not limited to columns, chords, and girders, on blocks spaced to prevent deflection. For erection contracts, check the material received against the shipping lists and report in writing all shortages and damaged materials. Be responsible for lost or damaged material while in Contractor possession.

556.03.18 Falsework

Design, construct, and maintain falsework to support the maximum construction loadings. Check and approve falsework drawings before submitting. The Department has 20 working days

to review and return the falsework drawings. The contract time will be extended day for day for any delay beyond the 20-day review period if the Department's delay affects the Contractor's operation as shown on the current work schedule.

556.03.19 Bearing and Anchorage

Place masonry bearing plates on bearing areas that meet specifications. Install bearing plates level to provide an even bearing on the masonry.

Place masonry bearing plates on fiber-reinforced pads meeting Subsection 711.16, that project at least 1/2 inch (13mm) on all sides of the bearing plate.

Make allowances for bottom chord elongation due to dead load when setting shoes or bearing plates for steel truss spans.

Install bridge rocker shoes to be vertical under full dead load at 60 °F (15 °C). Raise spans and make adjustments if the rockers are not correctly positioned with the final dead load on spans.

Construct concrete surfaces receiving elastomeric pads to compensate for bearing pad compression. Finish the bearing area with a wood float to a level plane. The surface must not vary by more than 1/16 inch (2 mm) from a straightedge placed in any direction across the area. Extend the bearing area at least 1 inch (25 mm) beyond the elastomeric bearing pad dimensions. The finished elevation of the bearing surface must not vary by more than 1/8 inch (3 mm) from the specified beam-seat elevation unless otherwise approved.

556.03.20 Placing Anchor Bolts

Place anchor bolts meeting Subsection 552.03.14 requirements.

556.03.21 Straightening Bent Material

Straighten bent plates, angles or other shapes without damaging the material. The metal may be heated if approved. Do not exceed 1,000 °F (537 °C). Once heated, cool the metal slowly.

All straightened metal will be inspected for defects.

556.03.22 Pin Connections

Furnish the Project Manager the pilot and driving nuts provided with the steelwork once the work is complete. The members must take full bearing on the pins. Bring pin nuts up tight, and burr the threads at the nut face.

556.03.23 Misfits

Correct all misfits, errors, and injuries as a part of the assembly and erection work. Report to the Project Manager all shop work errors that prevent the assembly and fitting of parts with a minimum use of drift pins, reaming, slight chipping or cutting. Obtain Department approval for the correction method. Corrections must be inspected and approved.

556.03.24 Cleanup

Remove all falsework, excavated or unused materials, rubbish, and temporary buildings. Restore all public and private property damaged during construction to its original condition.

Pull, cut off or otherwise remove all falsework piling 1 foot (305 mm) below finished the ground line or streambed, unless otherwise directed. Perform all work affecting the stream channel meeting the applicable requirements of Subsection 208.03.4 before final acceptance.

556.03.25 Rejections

An Inspector's acceptance of material or finished members does not prevent later rejection if defects are found. Replace or repair rejected material and work at Contractor expense.

556.04 METHOD OF MEASUREMENT

Structural steel is measured by the lump sum.

556.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Structural Steel	Lump Sum

The weight of structural steel in the contract is an estimate only. No guarantee is made that the estimated weight is the correct weight to be furnished. No adjustment in the contract unit price is made if the weight furnished is more or less than the estimated weight.

If changes in the work ordered by the Project Manager vary the weight of steel to be furnished, the lump sum payment is adjusted as follows:

The value per pound (kilogram) of a decrease or increase in the weight of structural steel involved is determined by the following:

$$\text{Value Per Pound (kilogram)} = \frac{\text{Contract Lump Sum Bid}}{\text{Estimated Contract Weight}}$$

The adjusted contract lump sum amount paid is the contract lump sum bid plus or minus the value of steel involved in the change.

Should the ordered change materially alter the character of the work and the unit cost, compensation for that work is made at an agreed price established before the work is performed. Detail, in writing, the changes in procedures and the resulting costs for labor, equipment, and materials to support the agreed price.

Partial payments for structural steel will be made based on the lump sum contract unit price as follows:

1. 90 percent when erected.
2. 97 percent when bolted and spot painted.
3. 100 percent when painted in compliance with the plans and specifications.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 557
STEEL BRIDGE RAILING

557.01 DESCRIPTION

This work is the furnishing and installing of steel bridge railing.

557.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Structural Steel Tubing	711.03
High Tensile Strength Anchor Bolts	711.06
Galvanized Metal	711.08
Structural Steel	711.02
Steel Beam Guardrail and Wood Blocks.....	705.01
Fiber-reinforced Pads for Rail Post Base Plates.....	711.16

557.03 CONSTRUCTION REQUIREMENTS

557.03.1 Fabrication Drawings

Furnish fabrication drawings for steel bridge railing meeting Subsection 556.03.2 requirements.

557.03.2 Fabrication

Fabricate steel bridge railing meeting the applicable requirements of Section 556.

557.03.3 Erection

Construct steel bridge railing as shown on the plans. Adjust the completed railing to compensate for any unevenness in the structure. Assure all rail posts are vertical. Do not place railing on a span until centering or falsework is removed. Place rail post base plates on fiber-reinforced pads, sized and positioned to project a minimum 1/2 inch (13 mm) on all sides of the base plates.

557.03.4 Painting

Clean and paint steel bridge railing specified to be painted meeting Section 612 requirements.

557.04 METHOD OF MEASUREMENT

Steel bridge railing of the type or types specified is measured by the foot (meter). Measurement is based on the computed horizontal distance between the centerlines of end base plates.

557.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Bridge Railing	Foot (meter)

Partial payments of steel bridge railing will be made based on the total quantity as follows:

1. 90 percent when erected.
2. 95 percent when bolted and spot painted.
3. 100 percent when painted in compliance with the contract.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 558
TIMBER STRUCTURES

558.01 DESCRIPTION

This work is furnishing materials for, and constructing timber structures and the timber portions of composite structures.

558.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Treated and Untreated Timber Piles.....	706.05
Structural Timber and Lumber	706.01
Treated Timber	706.04
Bolts and Nuts	711.07
Galvanized Metal	711.08
Structural Steel	711.02
Crushed Top Surfacing.....	701.02

Drift-pins and dowels may be wrought iron or medium steel.

Furnish washers made of iron castings or malleable castings, unless otherwise specified.

Furnish galvanized or cadmium plated hardware, except cast iron washers, meeting ASTM A 165, Type OS.

558.03 CONSTRUCTION REQUIREMENTS

558.03.1 Construction Drawings

Furnish shop drawings that detail the material grade, cutting, framing, boring details, dimensions, size of material, and all other information necessary for fabrication and erection of the timber.

Furnish all shop drawings on 22-inch x 36-inch paper (A1 paper) with a 1 1/2-inch (46 mm) margin on the left side and a 1/2-inch (43 mm) margin on the other three sides.

Check and approve fabrication drawings before submitting. The Contractor approval must be shown on the drawings. Do not begin cutting and framing until the drawings are returned by the Project Manager.

558.03.2 Handling of Materials

Handle timber without dropping, breaking outer fibers, bruising, or penetrating the timber surface. Use rope slings to handle treated timber.

558.03.3 Storage of Materials

Store timber in neat stacks on ground free of weeds and rubbish.

Open-stack untreated timber at least 12 inches (300 mm) above the ground. Cover timbers as required to protect them from weather. Close-stack treated timbers to prevent warping.

558.03.4 Treatment of Breaks and New Cuts

Trim and treat all cuts and abrasions in treated timbers with three applications of a solution of copper naphthenate containing a minimum of two percent copper metal or with chromated copper arsenate (CCA) meeting AWPA M4. Follow treatment with one coat of hot tar.

558.03.5 Temporary Attachment

Attach forms or temporary braces to treated timber with nails or spikes. Once the nails or spikes are removed, fill the holes by driving galvanized nails or spikes flush with the surface or plugging with creosote plugs after treating the holes with creosote oil.

558.03.6 Bearing

Level post and pile caps to provide full, even bearing on all posts or piles in the bent. Secure caps to each pile or post using a 3/4-inch (19 mm) diameter drift-pin extending at least 9 inches (230 mm) into the pile or post center.

558.03.7 Sills and Mud Sills

Evenly bed mud sills to solid bearing and tamp in place. Assure sills have true and even bearing on concrete sills, piles, or pedestals. Drift-bolt sills to mud sills or piles with 3/4-inch (19 mm) diameter bolts or larger extending into the concrete sills or piles at least 6 inches (155 mm). Remove all soil in contact with sills to provide free air circulation.

558.03.8 Framing

Cut timber for framing before treating with preservatives.

Cut and frame truss and bent timbers to a close fit providing even bearing over the entire joint contact surface. Blocking, shimming or open joints are not allowed.

Construct mortises true to size for the full depth. Fit tenons snugly in mortises.

Accurately frame cross bridging between stringers at the center of span and securely toe-nail with at least 2 nails in each end. Assure all cross-bridging members have full bearing at each end against the sides of stringers.

558.03.9 Bolt Holes

Size holes for drift-pins, dowels, and bolts the same diameter of the pin or dowel to be used. Do not make holes for lag screws larger than the body of the screw at the base of the thread. Make holes for rods 1/16 inch (2 mm) larger in diameter than the rod.

Treat all bore holes in treated timber, made after treatment, with an approved pressure bolt hole treater. Seal holes for rods with hot tar or other approved waterproofing once the rods are inserted.

Countersink where smooth faces are specified. Treat horizontal recesses formed for countersinking with 3 applications of copper naphthenate containing a minimum of two percent copper metal or with chromated copper arsenate (CCA) meeting AWPA M4. Fill the countersink with hot tar once the bolt or screw is in place.

558.03.10 Stringer Sizing

Size stringers between bearing points only. Make butt joints for outside stringers. Frame interior stringers to bear over the full width of floor beam or cap at each end. Securely anchor the stringer ends to the cap. Separate untreated timbers at least 1/2 inch (13 mm) for air circulation.

558.03.11 Roadway Floors

Make roadway floors strip or laminated as specified, surfaced S1S1E or S4S.

A. Laminated Floors. Place the strips on edge and draw down tightly against the stringer or nailing strip and the adjacent strip and spike them. Extend each strip the full deck width unless otherwise specified.

Spike each strip to the adjacent strip at intervals not exceeding 2 feet (610 mm), staggering the spikes 8 inches (205 mm) in adjacent strips. Use spikes long enough to pass through 2 1/2 strips. Toe-nail each strip to alternate stringers with 40d (125 mm x 5.7 mm) common nails with adjacent strips nailed to every alternate stringer unless

bolting is specified. Toe-nail the ends of all strips to the outside stringer. Cut off the strip ends on a true line parallel to the centerline of the roadway. When bolts are used to fasten laminated floors to stringers, space the bolts as specified and draw them down tightly on the bolting strips. Draw the bolt heads down flush with the deck surface. Use double nuts or single nuts with lock washers on all bolts. Spike the strips as specified above.

- B. Plank Floors.** Make plank floors out of a single thickness of plank on stringers or joists. Unless otherwise specified, lay the planks heart side down. Spike planks to each joist or nailing strip with at least two spikes that are 4 inches (100 mm) longer than the plank thickness. Spike the planks at least 2 1/2 inches (64 mm) from the edges with the edges cut off on a straight line parallel to the roadway centerline. Adjacent planks must not vary in thickness by more than 1/16-inch (2 mm). Planks are S1S1E unless otherwise specified.

558.03.12 Deck Surface Treatment

Treat the entire top surface of the deck and the inside surfaces of curbs with hot tar meeting ASTM D 490, Grade RT-7 or RT-8 (RT-7 is adapted to cold-weather application, RT-8 to warm-weather application).

Heat the tar in an open tank or kettle to between 200 °F to 225 °F (93 °C to 107 °C). Apply three even coats to the surfaces to be treated, each at 1/4 gallon per square yard (1.1 L per square meter). Allow each coat sufficient time to cool and set up before applying the next coat.

After the final coat of tar has cooled and set up, cover the entire deck surface with aggregate surfacing at 1 cubic yard per 24 square yards (1 cubic meter per 25 square meters) of surface area before opening to traffic. Furnish aggregate surfacing meeting the requirements of crushed top surfacing Type A Grade 2 or 3, or Type B Grade 3, except that the material passing the 200-mesh (0.075 mm) sieve may not exceed 10 percent.

558.03.13 Wheel Guards

Bolt wheel guards to the outside stringers using 3/4-inch (19 mm) machine or hook bolts spaced a maximum 5 feet (1525 mm) center-to-center. Lap all joints. A bolts must pass through each lapped joint.

Provide drain holes as specified. Line the drain holes with galvanized iron lining, positioned to discharge free of the structure.

558.03.14 Reserved

558.03.15 Nailing

Drill holes for nails that are driven near timber ends. Drill the hole only in the piece to be attached. Drill the hole smaller than the nail to provide a tight fit.

558.03.16 Washers

Use washers behind all bolt heads and nuts. Place washers for carriage bolts and large-head timber bolts under the nuts only.

Use cast-washers of the thickness equal to the bolt diameter and a diameter four times the thickness. Use malleable and plate washers with a thickness equal to one-half the diameter of the bolt, and the length of each side equal to four times the bolt diameter.

Use cast iron washers when timber is in contact with earth.

558.03.17 Treating and Painting Untreated Timbers

Treat the following surfaces with three applications of copper naphthenate containing a minimum of two percent copper metal or with Chromated Copper Arsenate (CCA) meeting AWPA M4 requirements:

1. Ends, tops, and all post contact surfaces, sills, caps, floor beams, and stringers;
2. Ends, joints, and contact surfaces of bracing and truss members;
3. Timber bumper surfaces;
4. The back face of bulkheads; and
5. All other untreated timber that is in contact with earth.

558.04 METHOD OF MEASUREMENT

Treated and untreated timber and lumber is measured by the thousand feet board measure (cubic meter) based on nominal actual thicknesses and widths. Measurements are computed using the plan dimensions unless changes in plan dimensions are approved by the Engineer. The actual lengths (volume) of the individual pieces in the finished structure will be measured, without deductions for daps, cuts, or splices.

The measurement of laminated timber decking is based on the number of pieces of the size or sizes specified, after dressing, and the actual lengths used in the structure.

Measurements consist of only timber that is a part of the completed and accepted work and does not include timber used for erection, such as falsework, forms, bracing, and sheeting.

558.05 BASIS OF PAYMENT

Payment for the completed and accepted work is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Treated and Un-treated Timber	Thousand Board Foot (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 559 PILING

559.01 DESCRIPTION

This work consists of furnishing and placing piling.

559.02 MATERIALS

Furnish materials meeting the following Section and Subsection requirements:

Portland Cement Concrete	501
Structural Steel Piles	711.10.1
Steel Pipe Piles.....	711.10.2

559.02.1 Inspection of Steel Pile

Steel pile may be inspected at the rolling mill and will be inspected at the project.

Furnish copies of the mill test reports showing the chemical and physical test results for each steel pile heat number included in the shipment.

Provide steel pile with a maximum camber or sweep of 0.013 inches per foot (1 mm per meter) of pile length.

Store and handle steel piles to prevent damage. Bent, deformed, or kinked piles will be rejected.

559.02.2 Furnish Pile

Furnish pile quantities shown in the contract.

The specified lengths are those required below cutoff. Adjust lengths for the difference between the cut off length and the pile position in the driving equipment. Increase pile lengths 1 foot (300 mm) for steel pile. Remove and dispose of excess pile length after the pile is driven.

559.02.3 Metal Pile End Protection

Furnish prefabricated cast steel driving point or cutting shoe conforming to ASTM A27 requirements. Furnish cast steel driving point for H-pile. Furnish cast steel inside-flanged, open-end cutting shoe or 60-degree, inside-flanged conical driving point for pipe pile as specified. Weld driving point or cutting shoe to steel pile in accordance with ANSI/AASHTO/AWS D1.1 or D1.5, as applicable. Use welders certified by the Department or a Certified Welding Inspector.

559.02.04 Splicing Piles

Splice piles driven to plan grade that do not obtain the required driving resistance and continue driving until the required capacity is obtained. Weld steel pile in accordance with AWS D1.5 requirements. Use 10-foot (3-meter) minimum spacing for steel pile splice welds. When steel piles are driven less than 10 feet (3 meters) below the cutoff elevation specified, use one splice to obtain the required cutoff elevation.

559.03 CONSTRUCTION REQUIREMENTS

559.03.1 Equipment for Driving Pile

A. Pile Hammers. Drive piles with impact hammers that include air, steam, diesel or hydraulic hammers.

For air or steam hammers, provide equipment that maintains the volume as specified by the manufacturer of the hammer as the pile is driven. Provide equipment with accurate pressure gauges that are easily read from ground level. Ensure that the striking parts of

the hammer are at least 1/3 the weight of the helmet and the pile being driven or 2,750 lbs. (1,250 kg), whichever is greater.

Provide open-end (single-acting) diesel hammers with rings or other indicators on the ram that permit visual determination of the hammer stroke as the pile is driven. Submit a copy of the hammer manufacturer's chart that equates the stroke and blows per minute for the hammer being used.

Provide closed-end (double-acting) hammers with an accurate bounce chamber pressure gauge that is easily read from ground level. Submit a copy of a chart, calibrated to the actual hammer performance that equates the bounce chamber pressure to the equivalent energy or stroke of the hammer.

Provide equipment for hydraulic hammers that are sized to maintain the manufacturer's specified volume and pressure during driving. Provide equipment with accurate pressure gauges that are easily read from ground level.

Delays and additional costs resulting from load tests or other extra work required to verify approval of the vibratory hammer or driving aids is at Contractor's expense. If a vibratory hammer is used, re-drive each pile with an impact hammer having the energy to verify the ultimate pile capacity, as required in Subsection 559.03.3.

B. Pile Driving Aides and Accessories.

1. **Followers.** Do not use followers.
2. **Helmet.** Provide metal helmets for pile to be driven by impact drivers. Helmets must fit around the pile top, align axially with the hammer and pile, distribute the hammer energy to the total pile head cross section and have leads to guide them.
3. **Hammer Cushion.** When driving pile with an impact hammer, use a cushion to prevent damage to the pile and hammer. Use a cushion recommended and approved by the hammer manufacturer. Use a striker plate recommended by the hammer manufacturer on the hammer cushion to provide uniform compression of the cushion material.
4. **Leads.** Support the piles in line and position during driving. Use pile hammer leads that permit free movement of the hammer, maintain hammer and pile alignment and provide concentric impact for each blow.
5. **Jets.** Do not use water jets.
6. **Caps.** Follow the pile manufacturer's recommendations regarding caps, driving heads, mandrels or other required devices.

C. Pile Pre-drilling. When specified in the plans, use the prescribed drilling methods discussed in this specification. Do not impair the capacity of previously installed pile or the safety of adjacent structures. If drilling reduces the capacity of previously placed pile, restore the disturbed pile to conditions meeting this specification by re-driving after drilling operations in the area have been completed.

1. **Pile Pre-bore.** When pile pre-bore is specified, use an auger, wet-rotary drill or other approved method. Drill pre-bore holes to the specified diameter and depth. Drive the pile in the pre-bore hole, starting from the bottom of the hole, with an impact hammer evaluated in accordance with Subsection 559.03.2. Continue driving the pile to the ultimate pile capacity and the depth specified. After driving, fill the annular void around the pile with dry, fine concrete aggregate meeting the requirements of Subsection 701.01.1 and Table 701-2.
2. **Pile Drill and Socket.** At each pile location, drill pilot holes a maximum of one inch (25 mm) in diameter less than the outside diameter of the round pile and a maximum of 4 inches (100 mm) less than the outside diagonal cross sectional measurement of square or H-pile, to the elevation specified. Drive the pile into the pre-drilled pilot hole

to the bottom of the hole with an impact hammer evaluated in accordance with Subsection 559.03.2. Continue driving the pile below the bottom of the drilled hole to the design tip elevation specified in the plans, or deeper if directed by the Project Manager.

559.03.2 Evaluation of Pile Driving Equipment

The Department will evaluate pile-driving equipment provided by the Contractor. The equipment must have the capability to drive the project pile to the design pile tip elevation and required ultimate pile capacity without damage to the pile. When dynamic load tests are required by the contract, submit a wave equation analysis performed by a pile specialty consultant meeting the requirements of Subsection 559.03.3(B)(2). The Department will base hammer evaluations on wave equation analysis. Submit the pile driving equipment information on Form CSB559_03_2. Provide pile-driving equipment that produces the following results from the wave equation analysis:

- 35 to 120 blows per one foot (0.3 meter) at ultimate capacity; and
- Maximum compressive driving stress less than 90 percent of the minimum pile material yield strength.

The Project Manager will notify the Contractor of results of the pile driving equipment evaluation within 14 calendar days after receipt of the Pile and Driving Equipment Data form. If the wave equation analysis indicates that pile damage may occur or that the proposed pile driving equipment cannot drive the pile to the specified ultimate capacity, re-submit a plan that modifies the equipment or the method to ensure the ability to drive pile to the specified ultimate capacity without pile damage. The Project Manager will notify the Contractor of results of the revised pile driving submission within seven calendar days after receipt of the re-submittal.

Do not vary from the evaluated driving system without prior written approval. The Department will consider proposed changes to the pile driving equipment or method only after submittal of revised information for a new wave equation analysis. The Project Manager will notify the Contractor of evaluation results of the pile driving system changes within seven calendar days after receipt of the submittal. Delays and additional costs associated with developing, submitting and obtaining evaluation results for pile driving proposals and resulting changes in the pile driving equipment and work methods are at Contractor's expense.

559.03.3 Pile Capacity

A. Driven Pile Capacity. Drive the pile to the design tip elevation shown on the plans or deeper, if necessary, to reach ultimate pile capacity. The Project Manager will use one of the following methods specified to determine ultimate driven pile capacity.

- 1. Wave Equation.** The Department will determine ultimate pile capacity based on a wave equation analysis. Drive piles with the pile driving equipment evaluated in accordance with Subsection 559.03.2 to the depths necessary to obtain ultimate pile capacity. Do not use other methods to aid pile penetration, unless specified or approved after a revised driving resistance is established from the wave equation analysis. Unless otherwise specified, adequate pile penetration consists of reaching the specified wave equation resistance criteria within 1 foot (0.3 meter) of the pile tip elevation. Drive pile not achieving the specified resistance within these limits to penetrations established by the Project Manager.
- 2. Dynamic Formula.** The Department will determine ultimate pile capacity based on a dynamic formula. Drive pile to obtain the ultimate pile capacity determined by the following formula:

$$R_u = 1.75 \sqrt{E} \log_{10} (10N_b) - 100 \quad (\text{English})$$

Where:

- R_u = Ultimate pile capacity in kips
 E = Manufacturer's rated hammer energy in foot-pounds at the field observed ram stroke
 $\log_{10} (10N_b)$ = Logarithm, to the base 10, of the quantity, 10 multiplied by N_b , the number of hammer blows per inch at final penetration

$$R_u = [7 (E_r)^{1/2} \log_{10} (10N_b)] - 550 \quad (\text{metric})$$

Where:

- R_u = Ultimate pile capacity in kN
 E_r = Manufacturer's rated hammer energy in Joules at the field observed ram stroke
 $\log_{10} (10N_b)$ = Logarithm, to the base 10, of the quantity, 10 multiplied by N_b , the number of hammer blows per 25 mm at final penetration

B. Compression Load Tests.

1. **Static Load Tests.** If specified, perform compression load tests to meet the requirements of ASTM D-1143 using the Quick Load test method. Load the test pile to the required ultimate capacity shown on the plans. Provide testing equipment and measuring systems meeting ASTM D-1143, except the loading system must be capable of applying 150 percent (150 percent) of the ultimate pile capacity. Provide a load cell and spherical bearing plate. Submit detailed plans for the proposed loading system prepared by a professional engineer licensed in the State of Montana for approval. The load system must gradually and incrementally place the load on the test pile without vibration. If the static load test method includes tension (reaction) anchor pile, provide anchor pile of the same type and size as the service pile. Drive the anchor pile in a permanent pile location, unless the Project Manager approves another location.

Determine top elevation of the test and anchor pile immediately after driving and again just before load testing to check for heave. Re-drive all pile that heaved in excess of 1/4 inch (6 mm) or jack the pile to the original elevation before testing. Wait 72 hours between driving the anchor pile or the load test pile and performing the load test.

Define the failure load for a tested pile as the axial compressive load that produces a settlement of the pile head equal to:

- a. For piles 2 feet (610 mm) or less in diameter or width:

$$s_f = \Delta + (0.15 + 0.008b) \quad (\text{English})$$

$$s_f = \Delta + (4.0 + 0.008b) \quad (\text{metric})$$

- b. For piles greater than 2 feet (610 mm) in diameter or width:

$$s_f = \Delta + b / 30 \quad (\text{English and metric})$$

Where:

- s_f = Settlement at failure in inches (millimeters)
 b = Pile diameter or diagonal width in inches (millimeters)
 Δ = Elastic deformation of total pile length in inches (millimeters)

If the Project Manager determines that the pile has failed before achieving the ultimate capacity, perform additional load tests. The Department will measure and pay for each additional load test.

When load testing is complete, remove all test or anchor pile not part of the finished structure or cut them off at least 1 foot (300 mm) below the bottom of the footing or below the finished ground elevation, if the pile fall outside the footing area.

- 2. Dynamic Load Tests.** Use a pile specialty consultant with at least three years experience in dynamic load testing and analysis to perform the dynamic load test, Case Pile Wave Analysis Program (CAPWAP) and the wave equation analysis, including the initial wave equation analysis specified in Subsection 559.03.2. Use a Geotechnical Engineer licensed as a Professional Engineer in Montana who has achieved at least Advanced Level on the Foundation QA Examination for Providers of PDA Testing Services to perform the CAPWAP analysis. Use a technician with a Basic Level classification on the Foundation QA Examination for Providers of PDA Testing Services Operation to operate the Pile Driving Analyzer. Provide the specialty consultant on site during the dynamic load tests. Submit the specialty consultant's resume for approval.

Furnish digital data acquisition system equipment with a display screen and printer. Perform dynamic load tests in accordance with ASTM D 4945 on the pile designated for dynamic load tests.

With dynamic testing equipment attached, drive the pile to the design tip elevation, or deeper if directed by the Project Manager. The Project Manager will use the ultimate pile capacity measurements at the time of driving or re-driving to determine the required pile tip elevation. Reduce the driving energy to the pile to maintain pile stresses below the values specified in Subsection 559.03.3(A)(2), using additional cushions or reduction of the hammer's output energy. If eccentric driving is indicated, immediately re-align the driving system. Provide a printed summary of the dynamic load test results and recommendations for production pile driving criteria (blow count and stroke) and pile tip elevation. The Project Manager will determine the production pile driving criteria and minimum pile tip elevations based on the dynamic load test results and specialty consultant's recommendations.

If the Project Manager requires a re-drive, each re-drive will be measured and paid for as an additional dynamic load test by the Department. After initial driving, wait the minimum time specified, then re-drive each dynamic load test pile with the instruments attached. Apply at least 20 resistance blows to warm the hammer before re-driving. Do not warm the hammer using the dynamic load test pile. Re-drive the dynamic load test pile for a maximum penetration of 6 inches (150 mm), a maximum of 50 blows or to practical refusal, whichever occurs first. Practical refusal is considered as 15 blows per inch (25 mm) for steel piles.

Verify the assumption used in the initial wave equation analysis submitted in Subsection 559.03.3(A)(1) using CAPWAP. Analyze one blow from the original driving and one blow from the re-driving for each pile tested.

Perform additional wave equation analysis with adjustments based on the CAPWAP results. Provide a graph showing blow count versus ultimate capacity. For open-ended diesel hammers, provide a blow count versus stroke graph for the ultimate capacity. Provide the driving stresses, transferred energy and pile capacity as a function of depth for each dynamic load test. Submit a written report with numerical and graphical results of the dynamic load testing, CAPWAP analysis and wave equation analysis.

- C. Vibratory Hammer.** Base the ultimate pile capacity of pile driven with vibratory hammers on the driving resistance recorded during impact driving after the vibratory equipment has been removed. Splice vibrated pile not reaching the ultimate pile capacity at the design tip elevation at the Contractor's expense, then drive with an impact hammer until the ultimate pile capacity is achieved as indicated by the requirements of Subsection 559.03.3.

559.03.4 Pile Driving Location and Alignment

Drive piles so the pile head at cutoff elevation is horizontally within 2 inches (50 mm) of the plan location for bent caps supported by piles and within 6 inches (150 mm) of plan location for piles capped below final grade. Ensure no pile is within 4 inches (100 mm) of a cap edge.

The allowable alignment tolerance from a plumb line is 3/4 inch per yard (20 mm per 1,000 mm) of pile length.

The Project Manager may suspend driving if the either the pile location or alignment is not maintained as the pile is driven.

Submit a written plan for correcting piles that do not meet the alignment or location tolerances.

Laterally pulling on mis-aligned pile or splicing a properly aligned section on mis-aligned piles is not allowed.

559.03.5 Service Pile

Drive service pile to the specified pile tip elevation and ultimate pile capacity. If specified, establish pile tip elevation and ultimate pile capacity by compression load testing or dynamic load testing.

Furnish the service pile lengths specified in the contract. Adjust pile lengths for the difference between cutoff length and the pile position in the driving equipment.

Drive each service pile in one continuous operation unless the Department requires a re-drive.

The Project Manager will observe the pile driving and calculate the predicted pile capacity as it is being driven.

Stop pile driving if the pile top is within 2 feet (610 mm) of cutoff elevation and the predicted capacity has exceeded the required capacity.

Re-drive the pile not less than 24 hours or more than 72 hours after initial driving and do not drive the pile below cut off elevation. If the Project Manager determines pile stresses during driving are damaging the pile, the Department may require other installation methods or equipment to obtain pile penetration.

Correct or replace improperly driven, damaged or defective pile at Contractor's expense.

559.03.6 Cutting Off Steel Pile or Steel Pipe Pile

Cut steel pile heads square and furnish a driving cap before driving the pile. After driving piles to the required capacity, cut piles off at the specified elevation.

559.03.7 Steel Pipe Pile

Remove water in steel pipe piles before placing concrete or place the concrete using a tremie when water is present in the pile.

Provide lighting to illuminate the full pile length when requested to aid inspection of the pile before placing concrete. Fill steel pipe piles to the cut off elevation with Class "DD" portland cement concrete.

Do not place concrete in pipe piles until all piles for the bent have been driven.

559.03.8 Painting Steel Pile or Steel Pipe Pile

Paint steel pile having a portion of the pile exposed to the atmosphere meeting the following requirements.

- A. Paint.** Furnish paint meeting the requirements of Subsection 710.02(B)(4).
- B. Surface Preparation.** Prepare the pile surface to the paint manufacturer's recommendations.
- C. Painting.** Before driving, apply two coats of paint to the pile starting a minimum of 2 feet (610 mm) below finish ground surface or finish channel bottom to the top of exposed steel.

Apply the first two paint coats to produce a minimum 12 mils (300 μm) dry film thickness. Field repair paint damage caused by transport, splicing and handling following the paint manufacturer's recommendations before applying the finish coat.

When piles are in the final location in the structure, apply the finish coat paint. Provide a finish coat with a minimum 3 mils (75 μm) dry film thickness on all surfaces exposed to the air at time of paint application. The Project Manager will select the finish coat paint color from one of the following:

**TABLE 559-1
FINISH COAT PAINT COLOR**

COLOR	FEDERAL SPECIFICATION 595B PIGMENT CODE
Montana Brown	33578
Montana Blue	35450
Montana Green	34138
Concrete Gray	36440

559.04 METHOD OF MEASUREMENT**559.04.1 Load Tests**

Static and dynamic load tests completed and accepted are measured by the unit. Include all materials, tools and equipment required to perform each test. Furnishing, driving, splices, and pile end protection are measured for payment as outlined in other Subsections. Do not include these costs in the static and dynamic load tests.

559.04.2 Furnish Pile

Furnish pile is measured by the foot (meter) based on the plan quantity or the length between the pile tip and the cutoff elevation. Pile furnished in addition to the plan quantity is measured for payment.

559.04.3 Drive Pile

Drive pile is measured by the foot (meter) of pile driven into the ground. Drive pile is measured by the foot (meter) of pile driven through pile drill and socket pilot holes. Pile driven through pre-bore holes is not measured for payment.

559.04.4 Pile Pre-drilling

Pile pre-bore and pile drill and socket pilot holes are measured by the foot (meter) drilled below the existing or finished ground elevation to the bottom of the hole.

559.04.5 Pile Splice

When the pile tip extends more than 1 foot (300 mm) below the plan estimated pile tip elevation, splices required to obtain specified cutoff elevation are measured for payment. Pile splices are measured by the number of pile splices performed in the field and approved by the Project Manager.

Splices made for Contractor convenience, to facilitate driving operations, or to produce pile sections meeting specified design lengths are not measured for payment.

559.04.6 Pile Driving Point and Cutting Shoe

Pile driving point and cutting shoe are measured by the unit for the quantity specified in the contract.

559.04.7 Filler Concrete

Filler concrete is not measured for payment.

559.04.8 Painting Steel Pile and Steel Pipe Pile

Painting steel pile and steel pipe pile is not measured for payment.

559.05 BASIS OF PAYMENT

The Department will not pay for furnishing or driving falsework pile, pile driven out of place, defective pile, or pile damaged in handling or driving.

Include payment for the costs associated with painting steel pile and steel pipe piles and filler concrete in the contract unit price per foot (meter) of drive pile.

Pile furnished, based on the plan quantities, but not incorporated in the finished structure, is paid for at the contract unit price per foot (meter) of furnish pile and becomes the property of the Contractor. Pile furnished in addition to plan quantity that is incorporated in the finished structure, is paid for at invoice price.

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Static Load Test	Each
Dynamic Load Test	Each
Furnish Pile	Foot (meter)
Drive Pile	Foot (meter)
Pile Pre-bore	Foot (meter)
Pile Drill and Socket	Foot (meter)
Pile Splice	Force Account
Pile Driving Point	Each
Pile Conical Driving Point	Each
Pile Cutting Shoe	Each

Partial payments for drive pile will be made based on the total quantity as follows:

1. 95 percent when the piles are driven to final penetration.
2. 100 percent when the piles are cut off and painted as specified.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 601
METAL WATER SERVICE LINES**

601.01 DESCRIPTION

This work is constructing steel and copper water service lines, 1/2-inch through 2-inch (13 mm through 50 mm) nominal diameter.

601.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Seamless Steel Pipe.....	709.09
Copper Pipe	709.10

601.03 CONSTRUCTION REQUIREMENTS

Install water service lines, make all connections, and pressure test the system meeting the requirements of the Montana Public Works Standard Specifications, and the contract.

Meet the requirements of Section 207 for trench excavation, foundation preparation, and backfilling.

601.04 METHOD OF MEASUREMENT

Water service lines are measured by the foot (meter).

Excavation is measured by the cubic yard (cubic meter) under Subsection 207.04.

601.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Water Service Line	Foot (meter)
Excavation	Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 602
REMOVE AND RELAY PIPE
CULVERT**

602.01 DESCRIPTION

This work is removing pipe culverts from the specified locations, salvaging and storing, disposing of, or cleaning and re-laying the removed pipe.

602.02 MATERIALS

Replacement pipe for existing pipe not re-usable is specified in the contract.

602.03 CONSTRUCTION REQUIREMENTS

602.03.1 Culvert Removal

Remove pipe culverts without damaging the pipe. Replace pipe that is damaged by removal with equal lengths of pipe, at Contractor expense. The replacement pipe must be the same type and diameter and in equal or better condition than the removed pipe before it was damaged.

Store removed pipe at the specified locations.

Backfill pipe removal locations within the new roadway template section meeting Subsections 203.03.2 and 203.03.3 applicable requirements.

602.03.2 Relaying Culverts

Clean out pipe to be re-laid of dirt, rubbish, and other materials and relay meeting Section 603 requirements.

602.03.3 Restoration and Maintenance of Existing Pavement

Restore and maintain existing pavement structures disturbed during the removal or relaying of pipe culverts meeting Subsection 603.03.5 requirements.

602.04 METHOD OF MEASUREMENT

602.04.1 Remove Pipe Culverts

Pipe culvert removal is measured by the foot (meter) of pipe removed to the nearest 0.3 foot (0.1 meter).

Excavation required to remove pipe culverts is not measured for payment.

602.04.2 Relay Pipe Culverts

Relay pipe culvert is measured by the foot (meter) along the flowline of the re-laid lengths.

Excavation required to relay pipe culverts is not measured for payment.

602.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Remove Pipe Culvert	Foot (meter)
Relay Pipe Culvert	Foot (meter)

Payment for all costs associated with excavation required for removing or relaying pipe culverts is included in the contract unit price per foot (meter) of remove or relay pipe culvert.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 603
CULVERTS, STORM DRAINS,
SANITARY SEWERS,
STOCKPASSES, AND UNDERPASSES

603.01 DESCRIPTION

This work is furnishing and installing culverts, storm drains, sanitary sewers, stockpasses, underpasses, further referred to as pipe.

603.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Culvert Sealers	707.02
Reinforced Concrete Pipe.....	708.01
Concrete Pressure Pipe.....	708.02
PVC Sewer and Drain Pipe.....	708.05
PVC Water Pipe.....	708.06
Polyethylene Corrugated Drainage Pipe or Tubing	708.07
Ductile Iron and Steel Water Pipe.....	709.01
Corrugated Steel Pipe and Pipe Arches	709.02
Steel Structural Plate Pipe and Pipe Arches.....	709.03
Bituminous Coated Corrugated Steel Pipe, Pipe Arches, Steel Structural Plate Pipe and Pipe Arches.....	709.04
Pre-coated, Galvanized Steel Culverts and Underdrains	709.05
Corrugated Steel Pipe for Underdrains.....	709.06
Corrugated Aluminum Pipe and Pipe Arch Culverts	709.07
Corrugated Aluminum Pipe for Underdrains	709.08
Seamless Steel Pipe.....	709.09
Slotted Corrugated Steel Pipe	709.11

Materials will be acceptance inspected at the manufacturing source.

603.03 CONSTRUCTION REQUIREMENTS

603.03.1 General

The locations and pipe lengths shown in the contract are an estimate only and may be revised. Order pipe using only the Project Manager furnished list of sizes and lengths.

Repair or replace pipe damaged during delivery, storage, or placing at Contractor expense.

When the contract allows optional types of pipe material for culverts at specific locations, any of the material types shown in the contract may be used for that installation.

Provide the Project Manager in writing, at the pre-construction conference, a list of proposed materials for use at each location optional material is allowed.

The type and quantity of material for bidding is listed in the contract in columns under the heading "Basic Bid Items". The information in these columns is what would be required to complete the planned installation using the "Basic Bid Pipe," which is concrete, when it is an option. If concrete is not an option, steel pipe is the basic bid pipe. Include terminal sections, where required.

Each pipe size is paid for at the contract unit price and is full compensation for the pipe regardless of the pipe optioned by the Contractor. Only work shown in the "Basic Bid Items" columns on the plans is paid for at a given installation, and the quantities are based on

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measurements for the basic pipe. Additional work that is required due to field conditions and not associated with the selected pipe is measured and paid for on quantity changes that would result if the basic bid pipe had been installed. All pay items are measured and paid for based on the basic bid pipe in the contract.

Strut pipe arches if specified in the contract.

603.03.2 Excavation and Foundation Preparation

Excavate and prepare the pipe foundation as specified in Section 207.

Place bedding material meeting Section 207 requirements and the Detailed Drawings.

603.03.3 Installation

A. Prefabricated Non-metal Pipe. Lay non-metal pipe on the foundation in standard lengths starting at the outlet end, with the groove or bell ends up grade. Recess the bell ends into the foundation.

Join the pipe ends to form a positive, tight-fitting joint by applying uniform pressure along the entire circumferential ends of the sections. Place pipe, using methods that prevent pipe damage. Replace pipe damaged during placing at Contractor expense.

Make the joints watertight for round concrete pipe, used for irrigation, storm drainage, or sanitary sewage, or other purposes subject to continuous flow, sealing them with rubber gaskets meeting Subsection 707.02.1. Use flexible plastic joint seal compound for concrete arch pipe joints that meet Subsection 707.02.2 requirements.

The culvert joints for normally dry installations may be sealed with rubber-type gaskets or an approved joint-sealing compound, except where open joints are specified.

Construct angles, turns, and branch connections using pre-fabricated sections or construct as shown in the Detailed Drawings.

Construct pipe dead ends and branches using closed ends or stoppers of equal strength to the pipe wall, cemented to the pipe.

Flared end terminal sections used with concrete pipe may be precast standard sections or cast in place as shown in the Detailed Drawings.

Cap one end of concrete pipe tee sections that connect to median inlets when specified. Use a pre-fabricated cap or construct a cap of reinforced concrete and connect to the tee section forming a watertight joint with a strength equal to the pipe wall strength.

Keep all trenches dry when placing pipe and until the joint filler has cured.

B. Prefabricated Corrugated Metal Pipe. Place the pipe on the foundation with each section approximately 1-inch (25 mm) apart. Follow the pipe manufacturer's instructions for connecting joints. Connect the sections with bolted coupling bands shaped to fit the formed pipe. Tap the coupling bands with mallets as the bolts are tightened.

The difference in diameter of abutting pipe ends to be coupled must not exceed 1/2-inch (13 mm).

Do not damage the pipe coating.

Culverts for siphons are designated as "CSP Siphon" or "CSP irrigation".

Construct field joints following the manufacturer's instructions for the type of pipe and coupling bands or devices used.

Construct the field joints for corrugated metal pipe to maintain the pipe alignment and prevent the fill material from infiltrating the joints. Provide circumferential and longitudinal strength using the structural joint performance criteria of Division 2, Section 23 of the AASHTO Standard Specifications for Highway Bridges. Assure the field joints for siphon

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and irrigation pipe installations are watertight and meet Subsection 709.02 requirements. Correct all installations not meeting any of these requirements at Contractor expense.

Conduct all required water-tightness tests on siphon and irrigation pipe installations using MT-420 or an approved procedure.

Cap one end of steel and aluminum pipe tee sections that connect to median inlets. Use a metal cap of equal thickness to the pipe wall and attach it to the tee section forming a watertight joint of equal strength to the pipe wall strength.

Field coat aluminum or Type II aluminized pipe to be in contact with fresh concrete with an asphalt mastic meeting AASHTO M 243 requirements over the full surface to be in contact. The asphalt container's label must provide the following information:

1. Name of Product;
2. Specification;
3. Lot Number;
4. Date of Manufacture;
5. Quantity of Mastic in Container; and
6. Manufacturer's Name and Address.

Separate aluminum pipe coupled to dissimilar metals by either a bituminous-coated coupling, polyvinyl sheeting, painted with rubber-base paints, or use aluminized steel.

- C. Structural Plate Types.** Follow the manufacturer's field erection recommendations and the contract requirements. Do not start work until the Project Manager and Contractor have the manufacturer's specifications and instructions at the work site.

Do not place backfill until all plates in a ring are complete and all bolts in the structure are tightened to the manufacturer's specifications.

Compact backfill using hand-operated compaction equipment within 6 feet (1.8 m) of the pipe neat lines.

Tighten all bolts in the assembly to the pipe manufacturer's torque specifications.

Long-span structure requirements are specified in the contract.

Match the existing pipe section extensions for existing steel structural plate pipe and pipe arch culverts and stockpasses. Remove beveled ends on existing pipe, install the new pipe sections, and re-install or replace the beveled ends as specified.

Pipe end treatment and slopes are detailed in the contract.

Replace damaged structural plates at Contractor expense.

- D. Ductile Iron Pipe.** Lay pipe to the specified line and grade, installing all appurtenances as specified. Uniformly support the pipe throughout its length, except at joints. Make depressions in the foundation for bells, couplings or other connectors at joints.

Bring the pipe to grade by working the material along the barrel of the pipe, leaving the joints un-supported. Flare, grind, file, or machine the pipe cut ends to make the connections. Prevent foreign material from entering the pipe during the work.

Do not deflect pipe beyond the manufacturer's allowable tolerances.

Inspect fittings for cracks, blowholes, chips, and coating damage before installation. Replace defective fittings.

Lower fittings into the trenches without damaging the inside lining or outside coating.

Install concrete thrust blocks against undisturbed soil.

Make pipe joint connections following the manufacturer's recommendations.

- E. Storm Drain Manhole and Trunkline Connections.**

1. **Concrete Pipe to Manhole and Trunkline Connections.** Install the pipe entering the manhole wall so the pipe end is flush with the inside wall of the manhole as

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shown in the Detailed Drawings. Grout the connection using a commercial non-shrink grout.

2. **Stub Connections to Trunklines.** Place the stub pipe with the pipe end projecting a maximum 2 inches (50 mm) into the trunkline. Contour the projecting end to match the trunklines inside wall. Grout the connection using a commercial non-shrink grout.

- F. Embankment Protectors.** Construct embankment protectors as shown in the Detailed Drawings. Include the flared end section, the 18-inch (450 mm) CMP, the reducer and the bends in the total length of embankment protector.

603.03.4 Backfilling

- A. General.** Use backfill material free of sticks, sod, frozen soil, or other deleterious matter. Do not permit stones, rocks, chunks of broken concrete, or other material larger than 3 inches (75 mm) within the top 2 feet (610 mm) of the top of water and sanitary sewer lines and within 1 foot (305 mm) of the pipe top for all other installations.

Replace the top 2 feet (610 mm) of backfill for excavations in existing roadway sections "in-kind".

Place backfill material in maximum 6-inch (155 mm) layers loose thickness and compact. Firmly tamp the backfill under the pipe haunches. Extend the backfill material placed above the excavation limits or the ground line beyond each side of the pipe equal to twice the pipe diameter or 12 feet (3.7 m), whichever is less.

Compact backfill equally on each side of the pipe to at least 1 foot (305 mm) above the pipe top.

Use equipment and methods for backfilling and compacting that do not distort, misalign, or damage the pipe. Replace pipe that is distorted, misaligned, or damaged at Contractor expense.

Do not allow heavy equipment to pass over any pipe until at least 4 feet (1.2 m) or one-half pipe diameter of backfill, whichever is greater, is placed and compacted over the pipe.

- B. Imperfect Trench Method.** Culvert installation using the imperfect trench method is shown in the Detailed Drawings.
- C. Rock Embankment.** Install pipes placed in blasted or fractured rock embankments as follows:

- Envelope the exposed pipe surface above the level of the bedding trench with graded bedding material.
- Extend the envelope to 1/2 the nominal pipe diameter or 3 feet (915 mm), whichever is greater. Completely surround the pipe with graded bedding material when a bedded trench is not specified.
- Use graded bedding material meeting Subsection 701.04.1 requirements; placed and compacted meeting Subsection 603.03.4(A).

603.03.5 Restoration and Maintenance of Existing Pavement

Restore the existing pavement excavated for pipe installation using material equal to or better than the in place pavement. Restoration includes replacing and compacting excavated aggregate base with materials equal to those in the existing roadway and placing new bituminous surfacing equal to the existing, but not less than 0.25 feet (76 mm) in thickness. Place and compact the replacement bituminous surfacing to match the adjacent pavement providing a smooth riding surface, including the joints.

Maintain the restored pavement areas in good condition until the new pavement is placed.

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603.04 METHOD OF MEASUREMENT**603.04.1 Pipe**

Pipe is measured by the foot (meter) in place from end-to-end of the installed structure along the bottom or pipe invert. Gasket material, specified coatings, coupling bands, bolts, bands, fittings, tees, risers, end sections, joint testing, restoring disturbed pavement, flared ends, beveled, skewed, and similar shapes or special designs, riser pipe lengths, riser tee sections and field cast concrete bends and connections are not measured separately but are included in the pipe lengths measured.

Storm drain and sanitary sewer are measured by the foot (meter) from manhole center to manhole center.

Excess pipe installed and not ordered by the Project Manager is not measured for payment.

603.04.2 Excavation

Excavation is not measured for payment.

603.04.3 Bedding and Foundation Material

Bedding and foundation material is measured by the cubic yard (cubic meter) in place.

603.04.4 Embankment Protectors

Embankment protectors are measured by the foot (meter) of installed pipe and include all necessary hardware.

603.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Pipe (Type and Size)	Foot (meter)
Bedding and Foundation	Cubic Yard (cubic meter)
Embankment Protector	Foot (meter)

Payment at the contract unit price is full compensation for all resources necessary to complete those items of work under the contract.

Payment for all costs associated with excavation, foundation preparation and backfilling is included in the unit price bid per foot (meter) of pipe.

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**SECTION 604
MANHOLES,
COMBINATION MANHOLES
AND INLETS, AND INLETS**

604.01 DESCRIPTION

This work is constructing manholes, combination manholes and inlets, and inlets.

604.02 MATERIALS

604.02.1 General

Furnish materials and precast structures meeting the contract requirements.

604.02.2 Concrete

Furnish Class "DD" concrete or equivalent meeting Section 551 requirements, except that precast concrete manhole riser sections must have a minimum 4,000-psi (27.6 MPa) 28-day compressive strength.

604.02.3 Reinforcing Steel

Furnish reinforcing steel meeting Subsection 711.01 requirements.

604.03 CONSTRUCTION REQUIREMENTS

604.03.1 General

Construct and install the structures as specified in the contract.

604.03.2 Excavation

The Project Manager will establish the lines and grades for structure excavation.
Compact foundations meeting Subsection 203.03.3 to provide full bearing for the structures.

604.03.3 Backfill

Uniformly place backfill around structures in maximum 6-inch (155 mm) deep loose layers, and compact meeting Subsection 203.03.3.
Maintain the established structure lines and grades while backfilling.

604.04 METHOD OF MEASUREMENT

Manholes, combination manholes and inlets, and inlets are measured by the unit for each specified type, complete in place. Slotted drain, as shown in the Detailed Drawings, is measured by the foot (meter) and includes the end cap and the elbow connection to the inlet.
Excavation and backfill are not measured for payment.

604.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Manhole, Manhole and Inlet, and Inlet	Each
Slotted Drain	Foot (meter)

Payment for all costs associated with excavation and backfill required for manholes, manhole and inlets, inlets, and slotted drains is included in the contract unit price of each respective drainage item.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 606
GUARDRAIL AND CONCRETE BARRIER RAIL

606.01 DESCRIPTION

This work is the furnishing, installing, removing, replacing and revising metal beam guardrail, cable guardrail, box beam guardrail and concrete barrier rail.

606.02 MATERIALS

Furnish metal beam guardrail, cable guardrail, box beam guardrail and concrete barrier rail materials meeting the following Section and Subsection requirements:

Steel Beam Guardrail and Fittings	705.01.1
Wood Guardrail Posts and Blocks	705.01.2
Wire Rope and Connecting Hardware	705.02
Concrete Barrier Rail	554
Box Beam Guardrail	Detailed Drawings
Guardrail Reflectors	704 and Detailed Drawings

Furnish all new materials unless otherwise specified.

606.03 CONSTRUCTION REQUIREMENTS

606.03.1 General

Install guardrail and concrete barrier rail meeting the Detailed Drawings and contract requirements.

Submit two copies of the manufacturers installation instructions for all guardrail terminal sections and impact attenuators installed on the project, to the Project Manager at least 15 days prior to the installation.

The Project Manager will establish the line and grade for the terminal sections. Establish the line and grade between the terminal sections.

Correct all vertical and horizontal mis-alignment to the specified line and grade at Contractor expense.

Complete the guardrail installation(s) within 48 hours of starting work at all locations exposed to traffic. Where difficult post placement conditions prevent completion in one working day without additional resources, place, at Contractor expense, hazard panels at maximum 50-foot (15.2 m) spacing to delineate partial installation areas when work on those installations is not active.

Excavate the postholes and drive the posts using methods and equipment that do not damage the adjacent pavement.

Stop post driving that heaves the adjacent pavement more than 1/2 inch (13 mm) in 10 feet (3 m), measured using a 10-foot (3 m) straightedge parallel to the pavement.

Level and repair all damaged surfaces around the installed posts.

Use only steel or wood guardrail posts for new metal beam guardrail runs unless wood posts are specified.

Where the contract specifies extending an existing guardrail run, the Contractor may use either the existing post type or other approved post types in the extension. Use the post type specified for terminal sections.

When wood posts and blocks are damaged, cut or bored after treatment, treat the injuries, cuts and holes with three applications of a copper naphthenate solution containing at least two

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percent copper metal or with chromated copper arsenate (CCA) meeting AWPA M4 requirements.

606.03.2 Installing Posts

If the posthole is excavated, compact the posthole bottom, insert the post, and backfill and compact around the post in 6-inch (155 mm) loose layers ensuring the material is at optimum moisture before placing and compacting the next layer. Maintain the post line and grade.

Always drive steel posts. Wood and concrete posts may be placed by excavating and backfilling or by driving.

Replace all posts damaged by post driving.

Maintain the post alignment as the posts are driven.

Fill the area between the surrounding ground and the post by backfilling and tamping. Re-compact the loose material around the post and level the area as directed.

Remove, replace or re-install mis-aligned, loose or damaged posts at Contractor expense.

Pilot holes approximately 6 inches (155 mm) in diameter may be used when necessary.

If furnishing steel guardrail posts, meet Subsection 705.01.6. Submit to the Project Manager at least 15 calendar days before installation, two copies of the following:

1. Manufacturer's information detailing dimensions, steel grade, and other pertinent information for the guardrail posts, blockouts, bolts, and all other hardware for the installation;
2. Installation instructions; and
3. Manufacturer's certification that the guardrail system meets NCHRP 350 requirements.

606.03.3 Metal Beam Guardrail Erection

Install metal beam guardrail, including the terminal sections and bridge approach sections as shown in the Detailed Drawings and meeting the contract requirements.

Splice the metal rail sections with the lap in the direction of traffic. Locate all rail splices at the posts. Construct splices, laps, and terminal connectors as shown in the Detailed Drawings and meeting the contract requirements. Splice the terminal connectors for attaching the rail sections to the bridge ends by lapping as shown in the Detailed Drawings.

Tighten the bolts through the splices and mounting bolts "snug tight".

Ensure the bolts project at least 1/4 inch (6 mm) beyond the nut. Place the bolt heads on the traffic side of the guardrail.

Paint holes, slots, or cut ends in metal guardrail caused during installation with an approved galvanizing paint. Spot paint all bruised, broken, scaled, or damaged spelter coating on metal parts following the paint manufacturer's recommendations after the guardrail is installed.

606.03.4 Stiffened Guardrail Sections

Construct stiffened guardrail sections as shown in the Detailed Drawings.

606.03.5 Box Beam Guardrail

Construct box beam guardrail and bridge approach sections as shown in the Detailed Drawings.

606.03.6 Cable Guardrail

Furnish and install cable guardrail and terminal sections meeting the Detailed Drawings and the contract requirements. Install the posts plumb without damaging the post and its protective coating. For terminal sections, set the end posts, backfill and machine compact the backfill material in 4-inch (100 mm) lifts.

Install reflectors meeting Section 704 requirements on every other post in the guardrail run excluding posts in the terminal sections that curve away from the driving lanes.

606.03.7 Concrete Barrier Rail

Install concrete barrier rail meeting the contract requirements and the Detailed Drawings.

606.03.8 Reset Concrete Barrier Rail

Reset concrete barrier rail as specified in the contract.

606.03.9 Raise Guardrail

Raise the existing guardrail to the specified height.

Remove the rail elements or cable, and completely remove the post. Backfill and compact the posthole bottom, re-install the posts and compact the backfill around the post meeting 606.03.2, and replace the rail elements or cable to the specified height.

Replace all guardrail materials damaged during the work at Contractor expense.

Correct all horizontal and vertical alignment in the guardrail to the specified line and grade.

606.03.10 Remove Guardrail

Remove and salvage the existing guardrail from the specified locations meeting the applicable requirements of Section 202. Replace all guardrail damaged during removal at Contractor expense. Dispose of removed materials not designated to be salvaged.

Load all salvaged guardrail materials from the project, transport and unload it at the specified location or as directed.

Backfill and compact the postholes left from post removal using clean material or crushed base or top surfacing, to the base of the adjacent bituminous surfacing. Apply a light asphalt spray to the hole sides and bottom and backfill with asphalt surfacing. Compact the plant mix surfacing as specified.

Do not cut off and leave existing posts in place.

606.03.11 Revise Guardrail Elements

Revise the guardrail elements as specified. The items include but are not limited to bridge approach sections and terminal sections.

606.03.12 Nested W-Beam Guardrail Sections

Construct nested guardrail as shown in the Detailed Drawings.

606.04 METHOD OF MEASUREMENT**606.04.1 Metal Guardrail**

Metal guardrail, excluding terminal sections, is measured by the foot (meter) from center-to-center of the end posts of each section.

606.04.2 Metal Guardrail Terminal Sections

Metal guardrail terminal sections are measured by the unit or the foot (meter) as shown in the Detailed Drawings, unless otherwise specified, for each type specified.

606.04.3 Bridge Approach Sections

Bridge approach sections, including tapered curbs, are measured by the unit for each type specified.

606.04.4 Stiffened Guardrail Sections

Stiffened guardrail sections are measured by the foot (meter) from center-to-center of the end posts of each stiffened section as shown in the Detailed Drawings.

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Box beam guardrail is measured by the foot (meter), excluding the terminal sections, as shown on the Detailed Drawings.

606.04.6 Box Beam Guardrail Terminal Sections

Box beam guardrail terminal sections are measured by the unit as shown in the Detailed Drawings for each type specified.

606.04.7 Cable Guardrail

Cable guardrail is measured by the foot (meter), excluding the terminal sections as shown on the Detailed Drawings.

606.04.8 Cable Guardrail Terminal Sections

Cable guardrail terminal sections are measured by the unit as shown on the Detailed Drawings.

606.04.9 Concrete Barrier Rail

Concrete barrier rail is measured by each 10-foot (3.05 m) section. Connections to the existing barriers are included in the cost of the rail.

Measurement does not include those portions of barrier constructed as an integral part of sign foundations.

606.04.10 Impact Attenuators

Impact attenuators are measured by the unit as specified in the contract.

606.04.11 Reset Concrete Barrier Rail

Reset concrete barrier rail is measured by each 10-foot (3.05 m) section.

606.04.12 Concrete Barrier Rail Transition

Concrete barrier rail transitions are measured by each 10-foot (3.05 m) section.

606.04.13 Concrete Barrier Rail Terminal Section

Concrete barrier rail terminal sections are measured by each 10-foot (3.05 m) section.

606.04.14 Raise Guardrail

Raise guardrail, including terminal sections, is measured by the foot (meter) from center-to-center of the end posts of each section.

606.04.15 Remove Guardrail

Remove guardrail is measured by the foot (meter) from center-to-center of end posts of each section removed.

606.04.16 Remove Concrete Barrier Rail

Remove concrete barrier rail is measured by each 10-foot (3.05 m) section.

606.04.17 Revise Guardrail Elements

Revise guardrail elements is measured by each element revised, as specified in the contract.

606.04.18 Nested W-Beam Guardrail Sections

Nested guardrail is measured by the foot (meter), as shown in the Detailed Drawings.

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606.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following.

<u>Pay Item</u>	<u>Pay Unit</u>
Metal Guardrail	Foot (meter)
Metal Guardrail Terminal Section	Each or Foot (meter)
Bridge Approach Section	Each
Stiffened Guardrail Sections	Foot (meter)
Box Beam Guardrail	Foot (meter)
Box Beam Guardrail Terminal Section	Each
Cable Guardrail	Foot (meter)
Cable Guardrail Terminal Section	Each
Concrete Barrier Rail	Each
Impact Attenuators	Each
Reset Concrete Barrier Rail	Each
Concrete Barrier Rail Transition	Each
Concrete Barrier Rail Terminal Section	Each
Raise Guardrail	Foot (meter)
Remove Guardrail	Foot (meter)
Remove Concrete Barrier Rail	Each
Nested Guardrail Sections	Foot (meter)

Revise guardrail elements is paid for under the appropriate bridge approach section or guardrail terminal section.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 607
FENCES

607.01 DESCRIPTION

This work is constructing, removing and resetting barbed wire, combination barbed and woven wire, chain link fences and gates.

607.02 MATERIALS

Furnish materials meeting the following Section and Subsection requirements:

Chain Link Fence	712.01
Interstate and Farm Fence	712.02
Class "F" Portland Cement Concrete	551

Fence material acceptance test samples will be taken from the materials delivered to the project.

607.03 CONSTRUCTION REQUIREMENTS

607.03.1 General Requirements

Construct fencing before any other work is performed on all parcels of land. This requirement may be waived where the Contractor has obtained a landowner written waiver. The waiver must state a completion date agreed to by the landowner and the Contractor for completing the fence work.

Maintain all existing fence enclosures. Close Contractor fence openings using new permanent fence, or use temporary fence, cattle guards, or watchman where new permanent fence cannot be constructed the same day.

Temporary fence may be used in place of new permanent fence if approved.

607.03.2 Fence Preparation

Fence preparation consists of removal of vegetative and ground surface obstacles prior to actual fence installation. For fence preparation, clear only those portions of brush, shrubs and vegetation interfering with the fence installation. Cut off, trim or mow interfering vegetation without exposing bare soil in, or adjacent to, streams, stream banks, natural drainages or wetlands. Dispose of the resulting debris, slash, branches, etc. in accordance with subsection 201.03.5. Avoid or minimize injury or damage to remaining vegetation. Do not grub, excavate, grade, or disturb the soil surface, unless in direct conflict with fence wire.

Soil disturbance associated with fence preparation, both inside and outside the construction limits, may not be included in the Storm Water Pollution Protection Plan (SWPPP) permit. If disturbance of soil is unavoidable, revise and update the SWPPP, and install appropriate erosion and sediment control features (BMP's) as required. Prior to fence installation, seed all exposed soil in accordance with the contract requirements. The seeding dates specified in the contract do not apply to this seeding.

Prior to commencing work that alters or disturbs the bed or banks of any stream or its tributaries, obtain authorization from the Montana Department of Fish, Wildlife, & Parks; commonly referred to as the Montana Stream Protection Act authorization (SPA 124).

Prior to conducting any work that results in the placement, or discharge of soils into waters of the United States, including wetlands, obtain a US Army Corps of Engineers Section 404 authorization.

Prior to conducting any work in State waters, including wetlands, that causes an increase in turbidity; obtain a 318 authorization from the Montana Department of Environmental Quality.

Use equipment that minimizes disturbance to soil and vegetation (i.e. low pressure rubber tired equipment, wide tracked low-weight tractors, etc.) in fence preparation areas, for setting fence posts and installing fencing material. If it is necessary to operate equipment in wetlands, place and operate the equipment on mats, or utilize other measures as necessary to avoid or minimize soil and vegetation disturbance. When installing fence posts and fencing, utilize measures, including hand work, to avoid or minimize soil and vegetation disturbance in streams and natural drainages and on, or adjacent to, stream banks.

607.03.3 Constructing Chain Link Fence

Construct chain link fence as specified in the contract and meeting the following requirements:

- A. Posts.** Set posts vertically, spaced at maximum 10-foot (3 m) centers, measured parallel to the ground surface.

Set posts for 5 foot, 6 foot and 8 foot (1.5 m, 1.8 m and 2.4 m) fence in concrete. Set end, corner, and pull posts for 3 foot and 4 foot (0.9 m and 1.2 m) fence and line posts connected by bracing to end, corner, or pull posts in concrete. Drive or set in concrete, line posts on 3 foot and 4 foot (0.9 m and 1.2 m) fence as specified.

Use the footing dimensions and post embedment depths shown in the Detailed Drawings. Crown concrete footings to shed water.

Do not damage posts while driving them. Backfill and compact the voids around posts.

Set line posts placed in solid rock without soil overburden, at least 14 inches (360 mm) deep. When in solid rock, set end, corner, gate, and pull posts at least 20 inches (510 mm) deep. Excavate or drill holes to a minimum width or diameter 1-inch (25 mm) greater than the largest dimension of the post being set.

Cut posts to the required length before installing. The Contractor may use an even post length set deeper into the solid rock at Contractor expense.

For metal posts placed in bored rock holes or consolidated soils, set the post plumb and fill the holes with cement grout that meets the requirements of Subsection 713.04. Work the grout into the holes to eliminate voids. Concrete footings are not required where posts are set in bored holes.

Place posts, set in solid rock covered by soil or loose rock, to the specified depths or to the minimum solid rock depths specified above, whichever is less. When solid rock is encountered before reaching the specified depth, construct concrete footings from the solid rock to the top of the ground on 5 foot, 6 foot and 8 foot (1.5 m, 1.8 m, and 2.4 m) fence and on end, corner, and pull posts for 3 foot and 4 foot (0.9 m and 1.2 m) fence. Grout around that part of the post that is in solid rock.

Check that all posts are solid once they are driven, backfilled, or concrete is placed.

- B. Top Rail or Cable.** Pass the top rails through the line post tops, providing a continuous brace from end-to-end of each fence section. Join top rail sections using sleeve-type couplings. Fasten the top rails to the terminal posts using pressed steel fittings.

Replace the top rails with a 3/8-inch (9.5 mm) diameter galvanized steel cable when fences are placed within 50 feet (15.2 m) from the edge of the nearest driving lane.

- C. Fence Fabric.** Place chain link fabric for 6 foot and 8 foot (1.8 m and 2.4 m) fence on tangents, on the post face away from the highway. On 3 foot, 4 foot, and 5 foot (0.9 m, 1.2 m, and 1.5 m) fence, place the fabric as directed. On curves, place the fabric for all fence heights on the outside face of the posts on curves.

Place the chain link fabric on a straight grade between posts, leveling high points on the ground. Obtain the Project Manager's approval to fill in depressions along the fence line.

Stretch taut and securely fasten the fabric to the posts. Stretching by motor vehicle is prohibited. Use stretcher bars and fabric bands spaced at 1-foot intervals (305 mm) to fasten to end, gate, corner, and pull posts. Cut the fabric and attach each span independently at all pull and corner posts. Fasten fabric to line posts at 14-inch (360 mm) intervals with tie wire, metal bands, or other approved fasteners. Fasten the top edge of the fabric to the top rail or cable with tie wires spaced at 18-inch (460 mm) intervals.

Join rolls of wire fabric by weaving a single strand into the ends of the rolls forming a continuous mesh.

When a winged cattle guard is located in a chain link fence, extend the wire fabric beyond the post supporting the wing and securely fasten it to the wing.

- D. Tension Wire.** Attach a tension wire to the bottom of the chain link fabric using ring fasteners at 24-inch (610 mm) maximum intervals and secure at the terminal posts or pull posts using brace bands.
- E. Gates.** Fasten chain link fabric to the gate frame end bars using stretcher bars and fabric bands, and to the top and bottom of gate frame bars using tie wires for the chain link fence, or by other approved standard methods.

Clean welded connections on steel gate frames with burned spelter coating by wire brushing, to remove all traces of the welding flux and loose or cracked spelter. Paint the cleaned areas with two coats of zinc oxide-zinc dust paint mixed in a weight ratio of one part zinc oxide to four parts zinc dust.

Provide the drop-bar locking device for double metal gates with a 12-inch (305 mm) square by 15-inch (380 mm) deep Class "F" concrete footing crowned at the top. Provide a minimum 6-inch (155 mm) hole in the footing to receive the locking bar.

- F. Panels.** Install panels as shown in the Detailed Drawings.

Double panels at fence corners and angle points consist of one corner post, two line posts, two braces, two truss rods, two top rails, concrete, and other fixtures. Single panels at gates and fence ends consist of one gate or end post, one line post, one brace, one truss rod, one top rail, concrete, and associated fixtures.

607.03.4 Constructing Barbed and Woven Wire Fences

Construct barbed and woven wire farm and Interstate fences meeting the contract requirements and the following.

- A. Posts and Braces.** Excavate post holes, footing excavations, and anchors as shown in the Detailed Drawings.

Wood posts may be driven. Repair or replace all damaged posts at Contractor expense.

Treat cut or trimmed areas on posts and braces with three applications of a copper naphthenate solution containing a minimum of 2 percent copper metal or with chromated copper arsenate (CCA) meeting AWPA M4 requirements.

Securely nail braces to terminal and brace posts.

Metal posts not specified to be set in concrete may be driven. Place and grout metal posts placed in rock as specified.

Backfill and compact post hole material in 6-inch (155 mm) loose lifts.

Dampen holes before placing concrete. Assure the concrete has set before placing and stretching the fence wire or attaching gates to the posts and braces.

B. Placing Wire. After the posts, braces, and footings are set, place the woven wire and/or barbed wire, stretch it tightly, and fasten to the posts.

Apply tension following the wire manufacturer's recommendations with a mechanical or other approved wire stretcher. Do not use motor vehicles to stretch fence.

Diagonally drive U-shaped staples across the wood grain so both points enter different grains. Where wire uplift occurs, drive staples with the points slightly upward. On level ground and over knolls, drive staples slightly downward. Staple the wire tightly at corner, end, and pull posts. The staples on line posts must allow wire movement without damaging the wire.

Place "deadman" as shown in the Detailed Drawings at grade depressions, alignment angles, and other places where stresses might pull posts from the ground or out of alignment.

Install one metal line post in each 500-foot (152.5 m) wood post fence run and in smaller runs between gate post ends for lightening protection.

Construct gates as shown in the Detailed Drawings meeting Subsection 712.02 requirements.

607.03.5 Temporary Fence

Erect temporary fence to keep livestock and traffic out of the work area. Temporary fence may remain in place only during the work or until the fence is directed to be removed.

Use Type F3M as temporary fence for livestock enclosures. Construct all temporary fence from metal posts and materials meeting Section 712. Use the minimum number of braces, panels, deadman, and other accessories for constructing temporary fence.

Undamaged material used in the temporary fence that meets specifications may be used in the permanent fence. Material not used in permanent fencing remains the Contractor's property.

Remove temporary fence at Contractor expense.

607.03.6 Remove and Reset Fence

When removing and resetting a fence, furnish all required materials over and above the usable salvaged fence that are new materials meeting Section 712 requirements. Required new materials are listed in the contract. Use, to the extent practical, materials of the same type and quality as those of the old fence that meet of Section 712 requirements.

Replace rotten, damaged, or broken posts and rusty, unusable wire with new material. Do not use any galvanized materials with abraded or broken coating.

Furnish all additional fence wire required for depressions.

Carefully handle and stockpile, at designated locations, all removed fence determined to be salvageable.

607.04 METHOD OF MEASUREMENT

607.04.1 New Fence

Chain link, Interstate, farm, and temporary fence are measured by the foot (meter) to the nearest foot (0.1 m). The measurements are made on the fence line along the top wire or rail or along a line parallel thereto, from end post to end post including wing fences to structures. Gates, cattle guards, or other openings are measured separately. Double sections of fence erected across depressions are measured for payment. All other temporary closures are included in the measurement of temporary fence. Temporary fence materials ordered by the Contractor but not used in the work will not be measured or paid for. Temporary fence removal is not measured separately.

607.04.2 Remove and Reset Fence

Remove and reset chain link, Interstate, and farm fence is measured by the foot (meter). Measurement of reset fence in place is made under Subsection 607.04.1.

New posts and wire required to reset the removed fence is measured as follows:

1. Wood and metal posts are measured by the unit;
2. Barbed wire is measured by the foot (meter); and
3. Woven wire is measured by the foot (meter).

The post and wire quantity specified in the contract is an estimate only. The actual quantity required to complete the work will be paid for at the contract unit price.

Panels required for remove and reset fence are not measured for payment.

607.04.3 Gates

Gates are measured by the foot (meter) between gate posts.

607.04.4 Fence Panels

Single and double fence panels are measured by the unit.

607.04.5 Deadman

Deadman are measured by the unit. Anchors are not measured for payment.

607.04.6 Dozer Operation

Dozer operation is measured by the hour under Subsection 210.04.1. When dozer operation is not a bid item, it is incidental to and included in other fencing items.

607.04.7 Remove Fence

- A. Replaced with New Fence.** When the removed fence is being replaced with new fence, the existing fence removal is not measured for payment.
- B. Without New Fence.** Remove chain link, Interstate, and farm fence is measured by the foot (meter) in place before removal along the top wire, or on a line parallel thereto, exclusive of gates, cattle guards, and other openings to the nearest foot (0.1 m).

607.04.8 Fence Preparation

Fence preparation is not measured for payment but is incidental to the fencing items.

607.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
New Fence - Chain Link, Interstate, Farm, Temporary	Foot (meter)
Remove and Reset Fence - Chain Link, Interstate, Farm	Foot (meter)
New Wood or Metal Posts	Each
Barbed Wire	Foot (meter)
Woven Wire	Foot (meter)
Gates	Foot (meter)
Fence Panels	Each
Deadman	Each
Dozer Operation	Hour (see subsection 210.05)
Remove Fence	Foot (meter)

When the removed fence is being replaced with new fence, the cost of removing existing fence is included in the contract unit price per foot (meter) of new fence.

Fence preparation is not paid for but is included in the contract unit price of the fencing items.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 608
CONCRETE SIDEWALKS**

608.01 DESCRIPTION

This work is the construction of concrete sidewalks.

608.02 MATERIALS

Furnish materials meeting the following Section and Subsection requirements:

Classes "A" and "D" Portland Cement Concrete	551
Reinforcing Steel	711.01
Joint Materials.....	707.01

608.03 CONSTRUCTION REQUIREMENTS

Construct concrete sidewalks as specified in the contract and as follows.

608.03.1 Subgrade and Forms

Excavate, shape, and compact the foundation to the specified width and grade.
Place and compact aggregate base to the specified thickness.
Use forms and form meeting Section 552 and Subsection 609.03 requirements.

608.03.2 Concrete

Furnish and place concrete meeting Section 551 requirements.
Place reinforcing steel as specified.
Dampen the foundation and forms immediately before placing concrete.
Do not place concrete on a frozen foundation course or subgrade.
Construct sidewalks meeting Subsections 501.03.18 and 501.03.19 requirements.
Construct and install truncated domes as shown on the plans and Detailed Drawings. Use red brick color dye in the concrete mix prior to precasting.

608.04 METHOD OF MEASUREMENT

Concrete sidewalk is measured by the square yard (square meter), including wheelchair ramps.

Truncated domes are measured by the square yard (square meter) to the nearest 0.1 square yard (0.1 square meter).

A. Contracts with Sidewalk Work Not in Conjunction with Roadway Reconstruction.

Reinforcing steel, expansion joint material, bond breaker, excavation or embankment, crushed gravel base, and disposal of material associated with the work are not measured for payment.

B. All Other Contracts. Reinforcing steel, expansion joint material, bond breaker, disposal

of material, and crushed gravel base are not measured for payment. Excavation or embankment associated with the work is measured by the cubic yard (cubic meter).

608.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Sidewalk-Concrete	Square Yard (square meter)
Truncated Domes	Square Yard (square meter)

A. Contracts with Sidewalk Work Not in Conjunction with Roadway Reconstruction.

The cost of reinforcing steel, expansion joint material, bond breaker, excavation or embankment, crushed gravel base, and disposal of material associated with the work are included in the contract unit price of sidewalk.

B. All Other Contracts. The cost of reinforcing steel, expansion joint material, bond breaker, crushed gravel base, and disposal of material associated with the work are included in the contract unit price of sidewalk. Excavation or embankment associated with the work is paid for under the specified type of earthwork.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 609
CURBS AND GUTTERS

609.01 DESCRIPTION

This work is constructing curbs, integral curb and gutter, median curbs, and furnishing and installing precast concrete curbs.

609.02 MATERIALS

Furnish materials meeting the following Section and Subsection requirements:

Air-entrained Class "D" Concrete.....	551
Reinforcing Steel	711.01
Joint Materials.....	707.01
Yellow Traffic Line Paint	714.04
Bituminous Mixtures	401

609.03 CONSTRUCTION REQUIREMENTS

609.03.1 General

Construct curbs and integral curb and gutter having uniform surfaces and true lines. Remove and replace curb sections that prevent drainage or proper joining of subsequent work at Contractor expense.

Material may be placed adjacent to curbs and curbs and gutters 24 hours after the curbs or curbs and gutters are placed as long as no damage is caused. Correct all damages at Contractors expense.

Construct curbs and integral curb and gutter meeting the contract requirements and as follows.

609.03.2 Foundations and Forms

Excavate, prepare and compact cast-in-place curb and curb and gutter foundations meeting the moisture and density requirements of Subsection 203.03.3.

Use full depth metal or straight-grained finished lumber forms, free of warp or irregularities, and having the strength to resist springing or deviation from alignment and grade. Securely stake and brace forms with headers and clamps. Clean and oil form surfaces in contact with concrete before placing the concrete.

609.03.3 Cast-in-Place Curb and Gutter

Moisten the foundations and forms immediately before placing concrete.

Place and consolidate the concrete in uniform layers not exceeding 6-inch (155 mm) loose depth.

Do not place concrete on a frozen foundation course or subgrade.

Construct concrete curb meeting Subsections 501.03.18 and 501.03.19 requirements.

Once the concrete has its initial set, remove the forms and repair honeycombed and rough surfaces using 1:2 mortar. Use wooden floats to remove form marks or other irregularities. Apply a brush finish to the final surface using an approved brush before the concrete sets. Finish all concrete edges, including those at expansion joints, to the required radii.

Water cure concrete or use a curing compound meeting Subsection 551.03.6 requirements. Water cure, keeping the concrete wet for seven days after finishing.

609.03.4 Slip-formed Concrete Curb and Gutter

Concrete curb and gutter may be constructed using a curb forming or slip-form machine.

609.03.5 Precast Concrete Curbs

Furnish precast curb meeting Section 554 requirements and install as specified.

609.03.6 Bituminous Curbs

Clean surfaces receiving bituminous curb and prime with SS-1 emulsified asphalt diluted 1:1 with water. Apply approximately 0.2 gallons per square yard (0.91 L per square meter).

Use the project surfacing bitumen mixed with water in a mixer of at least 3 cubic feet (0.08 cubic meters) capacity that meets Section 401 requirements.

The asphalt quantity in the bituminous curb mixture will be established by the Project Manager and will be at least one percent more than that used in the surfacing mixture.

Feed the bituminous mixture to the extrusion or curb machine at a temperature that prevents sloughing or tearing of the material or surface. Pressurize the mixture through an orifice or plate. The machine must heat and compact the curb as it is produced.

Compact all material not placed and compacted by the curb machine using mechanical tampers.

If other than 60-70 penetration asphalt cement is used, apply a fog coat of SS-1 emulsified asphalt diluted 1:1 with water to the finished curb at approximately 0.2 gallons per square yard (0.91 L per square meter).

609.03.7 Painting Curbs

Paint curbs, island curbs, and median curbs meeting Subsection 620.03.3(C) requirements.

609.04 METHOD OF MEASUREMENT

Curb, integral curb and gutter, and median concrete curb are measured by the foot (meter) to the nearest 0.1-foot (0.1m) along the face of the curb at the flowline.

Reinforcing steel, joint materials, excavation, foundation preparation, and emulsified asphalt for prime coat are not measured for payment.

Paint and painting is measured by the gallon (Liter) under Subsection 620.04.

609.05 BASIS OF PAYMENT

Payment for completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Curb	Foot (meter)
Integral Curb and Gutter	Foot (meter)
Median Concrete Curb	Foot (meter)
Paint	Gallon (liter)

The cost of reinforcing steel, joint materials, excavation, foundation preparation, and emulsified asphalt are included in the contract unit price of curb.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 610
ROADSIDE RE-VEGETATION**

610.01 DESCRIPTION

This work is re-establishing vegetative cover on specified areas by topsoiling, seeding, planting, fertilizing, mulching, soil retention blankets, and sodding.

610.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Water	713.01
Topsoil	713.05
Seed	713.08
Fertilizer	713.09
Mulch	713.10
Sod	713.11
Soil Retention Blankets.....	713.12

610.03 CONSTRUCTION REQUIREMENTS

610.03.1 Topsoiling

Furnish topsoil and pay all royalty, development, smoothing and leveling costs of topsoil removal.

Notify the Project Manager of the proposed topsoil source(s) as soon as possible after the contract award. Topsoil from proposed sources may be used only after sample tests show the material is acceptable.

Complete topsoil areas to the lines, grades, and elevations specified. Do not place topsoil until the designated areas are prepared and all construction work in the area is completed.

Scarify or rip slopes to be topsoiled.

Break up ordinary sod and soil containing grass roots into maximum 2-inch (50 mm) clumps.

Remove and dispose of, at Contractor expense, all clods, rocks, large roots, litter, and other foreign material exceeding 4 inches (100 mm) in its greatest dimension from the topsoil before placing it on the roadway and before final acceptance. Break up the topsoil to an average 4 inches (100 mm) deep.

610.03.2 Seeding, Fertilizing, and Mulching

These requirements apply to establishing vegetation on areas disturbed by the work. Landscaping interchange areas, rest areas, urban areas, and other areas are specified elsewhere in the contract.

A. General. Work the areas to be seeded to the specified line and grade before seeding and fertilizing.

Seed all disturbed areas. Permanent seeding of the finished slopes may require multiple seeding. Fertilizing, mulching, permanent erosion control placement, and seeding are specified in the contract.

B. Seeding Season. The seeding season is October 15 through May 1. Obtain the Department Agronomist's approval to seed outside this period.

C. Condition Seedbed Surface. Condition the seedbed surface area by killing growing weeds, removing or mowing old weedy growth, tilling, discing, harrowing, or scarifying compacted areas, and compacting unstable areas.

Condition all seeding areas unless otherwise directed. The Project Manager may exclude wet, soft or rocky areas from conditioning.

Cultivating, tilling, harrowing, discing, and similar work may, if approved, be performed any time after the contract is awarded.

Break up tight or compacted soils into 2-inch (50 mm) or smaller pieces. Remove or repair discs, harrows, cultipackers, and similar equipment not in good operating condition. Operate discing, harrowing, and soil tilling equipment at right angles to the natural slopes.

Prepare soil using equipment that produces a rough-textured surface ready for seeding and mulching. Operate equipment normal to the natural slopes. The final surface must be 1 inch to 1 1/2 inches (25 mm to 40 mm) below the tops of curbs, catch basins, and other structures.

Rescarify areas to be broadcast seeded within 48 hours before seeding.

D. Seed Distribution.

1. General. Apply seed within 48 hours of the final seedbed conditioning.

Do not broadcast seed or hydraulic seed when weather conditions prevent uniform seed distribution.

Do not cover seed with more than 1/2 inch (13 mm) of soil.

The seed application rate is specified in the contract.

2. Drill Seeding. Drill seed slopes 3:1 and flatter using equipment that regulates the seed application rate and planting depth. Acceptable drills are custom seeders, furrow drills, disc drills, or other approved drills. If seed-sowing equipment does not have press wheels, compact the seed using a cultipacker once the ground has been drilled.

Maintain uniform seed distribution in the drill hopper during the work.

Operate all seeding related equipment at right angles to the slope.

Regulate planting depth with depth bands or coulters. Use a drill box partitioned by dividers a maximum 24 inches (610 mm) apart.

Seed rows a maximum 8 inches (205 mm) apart and at right angles to the slope.

3. Broadcast Seeding. Hand seeding or mechanical seeding of slopes exceeding a 3:1 slope, narrow medians, or small areas is permissible.

4. Hydraulic Seeding. Hydraulic seeding is permissible for slopes steeper than 3:1 or when the seedbed surface is impractical to drill seed.

Perform hydraulic seeding in two operations:

- a. Apply the seed with 1 pound (0.454 kg) of wood or recycled paper mulch per three gallons (11.3 L) of water; and
- b. Apply the remaining mulch, along with fertilizer, if specified. See Subsection 610.03(F)(5).

E. Application of Fertilizer. When broadcasting seed, apply the fertilizer separately.

When drill seeding, do not apply seed and fertilizer in a single mixture. The fertilizer must be applied separately, either broadcast before seed application, or surface banded during seeding.

F. Mulching.

1. General. Use the mulch type specified in the contract.

Apply mulch to seeded areas within 24 hours after seeding without disturbing the seedbed surface.

Do not apply mulch to ground having free surface water or if wind prevents uniform distribution.

2. **Application of Vegetative Mulch.** Uniformly apply vegetative mulch with a mulch spreader at the specified rate once seeding and fertilizing are completed.

Secure all vegetative mulch to the slopes with a non-asphalt based tackifier containing either plant derived hydrocolloid or polymeric materials. Add the tackifier to the fertilizer/mulch slurry when wood cellulose or recycled paper fibers are used as an over-spray onto the straw/hay mulch.

Tuck vegetative mulch on slopes 3:1 or flatter into the seedbed. Use a mulch tiller for tucking. Operate the equipment perpendicular to the slope.

Use mulch tillers having round, notched blades approximately 1/4-inch (6 mm) thick by 18 inches (460 mm) in diameter spaced 8 inches (205 mm) apart that force the vegetative mulch at least 3 inches (75 mm) into the soil. Equip tillers with disc scrapers.

If temporary erosion controls are needed, straw tucking followed by permanent seeding within the seeding season are acceptable measures.

3. **Applying Fabricated Mulch or Netting.** Place fabricated mulch or netting on the specified or directed areas, securing it to the ground using wire staples, wood pegs, or other approved devices. Apply the mulch or netting over the seeded areas.
4. **Applying Wood Cellulose Fiber or Recycled Paper Mulch.** Apply wood cellulose fiber or recycled paper mulch and fertilizer in one operation with a hydraulic distributor using water as the vehicle. Equip the distributor with a continuous agitator keeping the fertilizer and mulch uniformly suspended throughout the distribution cycle. Adjust the pump pressure to maintain a continuous slurry stream. Size the slurry distribution lines to prevent plugging. Equip the discharge line with hydraulic spray nozzles to uniformly distribute the slurry to the seedbed.

Start mulching at the top of the slope and work downward. Use extension hoses to reach the slope extremities.

5. **Finishing.** Re-mulch areas where mulch is weather damaged.

Repair seedbed and seeding damage caused by displaced mulch material and re-seed the areas before re-mulching. Seedbed repair, re-seeding, and re-mulching required due to the Contractor's negligence is at Contractor expense.

610.03.3 Sodding

- A. **Season.** Perform sodding during the normal seeding season or as specified.
- B. **Source of Materials.** Notify the Project Manager of the sod source(s) at least three days before sod cutting begins. Cut and deliver only approved sod to the project.
- C. **Surface Preparation.** Prepare the surfaces to be sodded to the required cross section, grade, and contour. Make the surface smooth and uniform, free of stones, roots, lumps, weeds, and other foreign material. Undercut the prepared surface below the adjacent areas so the top of the new sod is flush with adjacent seedbed or turfed areas and 1 inch (25 mm) below sidewalk and curb tops.

Break the surface up to a fine, granular texture at least 2 inches (50 mm) deep before placing sod.

Fertilize the surface to be sodded a maximum 48 hours before placing sod. Use inorganic fertilizer having minimum active ingredients of 15 pounds of Nitrogen and 40 pounds of P₂O₅ per acre (17 kg of Nitrogen and 44 kg of P₂O₅ per hectare).

- D. **Cutting and Handling Sod.** Machine-cut sod in uniform rectangular sections.

Cut sod to a depth that retains intact, the grasses live dense root system and prevents tearing or breaking of the sod.

Load, unload, and place sod to prevent tearing or breaking of the sod.

E. Placing Sod. Lay sod within 36 hours of cutting. Protect sod from dry or cold weather until placed.

Place and fit sod as close as possible staggering the joints between horizontal rows.

Lay the sod strips horizontally on slopes, starting at the slope bottom and work upwards. On slopes steeper than 3:1, anchor the sod with fasteners spaced a maximum 2 feet (610 mm) apart and driven flush with the sod surface.

In waterways, lay the strips parallel to the flow, staggered, and fitted snug and even with the strips already placed.

Fill gaps between sod strips with sod pieces cut to the gap size and shape.

At slope bottoms, extend the sod edges at least 2 inches (50 mm) into the ground or ditch bottom. Turn all other sod area edges into the ground and cover with topsoil, compact and smooth to blend with the adjacent finished grades.

Roller compact the sod with a roller immediately after placement. Provide a smooth, even surface, free from bumps and depressions.

Thoroughly water the sod and re-roll to insure good soil contact.

F. Sod Maintenance. Water new sodded areas until the sod is firmly rooted.

Maintain the new sod until it is well rooted and replace all dead, dying, and damaged sod as directed at Contractor expense.

610.03.4 Erosion Control Blanket

Prepare, fertilize, and seed the erosion control blanket areas before placing the blanket. Handle and place it following the manufacturer's recommendations. If recommendations are not provided, install as follows:

1. In ditches, unroll the blanket downstream and lap 4 inches (105 mm) over the adjoining blanket. Bury the ends and edges to prevent water and wind undercutting.
2. On slopes, the blanket may be unrolled horizontally or vertically to the slope, then lapped 4 inches (105 mm) over the adjoining blanket and stapled as above. Always lap the blanket in the direction of flow.

610.04 METHOD OF MEASUREMENT

610.04.1 Topsoil

Topsoil is measured by the cubic yard (cubic meter) of loose material level with the haul vehicle box at the point of use on the project. Strike or level loads when directed.

610.04.2 Seeding

Seeding is measured by the acre (hectare), parallel to the ground surface, to the nearest 0.1 acre (0.1 ha).

610.04.3 Fertilizing

Fertilizing is measured by the acre (hectare), parallel to the ground surface, to the nearest 0.1 acre (0.1 ha).

610.04.4 Condition Seedbed Surface

Condition seedbed surface is measured by the acre (hectare), parallel to the ground surface, to the nearest 0.1 acre (0.1 ha).

610.04.5 Mulch

A. Vegetative Mulch and Wood Cellulose Fiber Mulch. Vegetative mulch and wood cellulose fiber mulch is measured by the acre (hectare), parallel to the ground surface, to the nearest 0.1 acre (0.1 ha).

B. Fabricated Mulch and Netting. Fabricated mulch and netting is measured by the square yard (square meter) in place.

C. Bituminous Mulch. Bituminous mulch is measured by the gallon (Liter) for the gallons (liters) applied at the specified rate.

610.04.6 Sodding

Sodding is measured by the square yard (square meter) in place, parallel to the ground surface.

Re-sodded areas damaged from causes not the fault of the Contractor are measured for payment.

610.04.7 Soil Retention Blanket

Soil retention blanket is measured by the square yard (square meter) in place.

610.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Topsoil	Cubic Yard (cubic meter)
Seeding	Acre (hectare)
Fertilizing	Acre (hectare)
Condition Seedbed Surface	Acre (hectare)
Mulch	Acre (hectare)
Fabricated Mulch and Netting	Acre (hectare)
Sodding	Square Yard (square meter)
Soil Retention Blanket	Square Yard (square meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of the work under the contract.

**SECTION 611
CATTLE GUARDS**

611.01 DESCRIPTION

This work is furnishing and installing cattle guards or removing and resetting cattle guards.

611.02 MATERIALS

611.02.1 Concrete

Furnish air-entrained Class "A" portland cement concrete meeting Section 551 requirements for poured-in-place base concrete.

Furnish Class "D" portland cement concrete meeting Section 551 requirements for precast bases.

611.02.2 Steel

Furnish reinforcing steel meeting Subsection 711.01 requirements.

Furnish low-alloy weldable steel meeting ASTM A 572 (A 572M), Grade 45 (300 MPa) requirements for crossbars.

Furnish other steel meeting Section 711 requirements.

611.02.3 Paint

Furnish paint meeting the following Subsection requirements:

Shop (Prime Coat)	710.02(B)(7)
Aluminum Paint (Finish Coat)	710.02(B)(2)

611.02.4 Cattle Guards

Furnish standard pre-fabricated cattle guards meeting the following requirements:

- HS 20 (M 518) Live Loading;
- The Detailed Drawings; and
- Subsections 556.03.2 and 556.03.3.

Submit all fabrication drawings for review before fabrication and footing elevations are set.

611.03 CONSTRUCTION REQUIREMENTS

611.03.1 Excavation

Excavate cattle guard foundations to the specified depth allowing space for formwork.

Complete and compact earth fills meeting Section 203 requirements before excavating for the cattle guard foundation.

611.03.2 Placing Concrete Bases

Construct poured-in-place concrete bases meeting Section 552 and the Detailed Drawings.

Furnish precast concrete bases meeting Section 554 requirements and the Detailed Drawings.

Construct stringer bearing surfaces to provide full bearing under each stringer. Bushhammer uneven surfaces to provide even bearing.

611.03.3 Placing Cattle Guards

Fasten the metal structure to the base as specified.

Attach the metal wings to the cattle guard and to the fence as shown in the Detailed Drawings.

All welding must meet the requirements of Subsection 556.03.10.

Backfill and clean up around the completed structure.

611.03.4 Painting

Apply one shop coat of primer to all metal parts. Apply a prime coat and a finish coat in the shop or in the field.

Perform all painting meeting the applicable requirements of Section 612.

Re-paint damaged painted surfaces at Contractor expense.

611.03.5 Resetting Cattle Guards

Dismantle and reset existing cattle guards at the locations specified in the contract.

611.04 METHOD OF MEASUREMENT

New and reset cattle guards are measured by the unit, including the concrete bases, excavation and backfill.

611.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
New Cattle Guard	Each
Reset Cattle Guard	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 612 PAINTS AND PAINTING

612.01 DESCRIPTION

This work is the surface preparation, furnishing and applying the paint, and protecting the paint coatings, pedestrians, vehicular, or other traffic upon or under the surface being painted.

612.02 MATERIALS

Furnish materials meeting the applicable requirements of Section 710 and Subsection 612.02.1.

612.02.1 Coating System for Structural Steel

Furnish a complete coating system consisting of a self-curing zinc-rich primer, an intermediate coat of high-build epoxy paint and a protective top coat of urethane paint meeting Subsection 710.02.3(C) requirements. The epoxy color must be white and the urethane color is specified in the contract.

612.03 CONSTRUCTION REQUIREMENTS

612.03.1 Coating Systems for Structural Steel

Submit a written description of the coating system for approval.

Include in the written submittal the manufacturer's product information including but not limited to paint characteristics, surface preparation, film thickness recommendation, safety data, repair procedures and application recommendations.

Bring conflicts between the coating system submittal and the specifications to the Engineer's attention for resolution.

Furnish the services of a paint or painting technical representative from the paint manufacturer at the beginning of paint operations and as required during operations.

Shop-apply the primer. Shop or field-apply the intermediate and top coat. Protect all coats from damage during handling, transporting, and unloading. Repair all paint damage following the coating manufacturers recommendations at Contractor expense.

612.03.2 Protection of Structure, Persons, and Property

Protect pedestrian, vehicular, and other traffic upon or under the structure, the super-structure and substructure against damage or disfigurement by spatters, splashes, smirches, or over-spray of paint or paint material. Clean and remove all paint damage at Contractor expense.

A. Pollution Controls. Prevent environmental pollution including stream and air pollution caused by paint, paint spray, paint chips, dust, or other harmful materials meeting all federal, state, and local regulations and requirements.

612.03.3 Surface Preparation

Prepare surfaces to be painted following the paint manufacturer's recommendations, or the following, whichever is most restrictive.

A. Structural Steel for Bridges. Clean oil and grease from surfaces to be coated before blast cleaning. Solvent-clean oil or grease coated surfaces to meet SSPC-SP 1 requirements.

Surface-clean by the centrifugal wheel or the air blast method. Blast-clean meeting SSPC SP-6, Commercial Blast Cleaning requirements.

Hand-clean the steel bridge bearing components containing PTFE (polytetrafluorethylene), stainless steel surfaces, and neoprene pads to prevent surface damage.

Remove fins, tears, slivers, and burred or sharp edges by grinding and re-clean the area as specified before coating.

Remove blast residue from steel surfaces with clean brushes, compressed air, or a commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. Keep steel dry, dust free and prime steel within 24 hours after cleaning.

Clean structural steel that is not shop painted to meet SSPC SP-7 requirements after erection. Guard angles, pier nose angles, deck expansion joints, and other small structural steel elements may be prepared for painting using wire brushes, scrapers, chisels, or sand blasting as approved.

- B. Galvanized Metal Surfaces.** Treat galvanized metal surfaces to be painted using phosphoric acid solutions of the zinc phosphate and phosphate chromate types formulated for this use. Dry the treated surfaces 20 minutes, then rinse with water. Begin painting within 24 hours.
- C. Previously Painted Surfaces.** Clean to meet SSPC SP-7 requirements.
- D. Steel Not to be Painted.** Steel may be cleaned before or after erection.

612.03.4 Removing Lead Based Paint

- A. Work Plan.** Submit a work plan that meets OSHA and EPA regulations, for lead paint removal work.

Work plans will be reviewed for acceptance within 10 working days of receipt. The Project Manager will notify the Contractor in writing of the work plan acceptance or rejection. Rejected work plans may be re-submitted but must be approved by the Project Manager at least ten working days before beginning any lead paint removal work.

Have the work plan prepared by an individual who has experience with, and worked under, OSHA and EPA regulations. That individual must supervise the work covered by the plan. Include the individual's resume listing qualifications, experience, and references.

Work plans consisting only of copies of specifications and regulations will be rejected. Address the following items in the written work plan:

- 1. Worker Protection.** Meet the OSHA lead standards of Title 29, CFR 1926.62. Describe medical surveillance, exposure monitoring, respiratory protection, personal hygiene, employee training, employee access to records, hazard communication and a compliance program to reduce lead exposure to within the Permissible Exposure Limits (PELs). Exposure monitoring must meet NIOSH Method 7082.

Provide the Engineer copies of pulmonary capacity tests, copies of employee training certificates, and the blood test results from all workers involved in the paint removal. Take one test before beginning work, then every four weeks thereafter until the work is complete. The Engineer may adjust the frequency based on the tests results. Take the final blood test within two weeks of completing the paint removal.
- 2. Environmental Protection.** Design a containment system meeting SSPC 1,2 or 3 "Guide for Containing Debris Generated During Paint Removal" requirements except that permeable wall materials cannot be used. The containment system may be located on or off the project site. Submit shop drawings and design calculations for containment systems attached to the structure. Include design calculations that address all load conditions on the structure resulting from the containment system including debris.

Specify ventilation and negative pressure equipment capacity, layout, and related calculations.

- B. Air Quality.** Test and monitor air quality for particulate and lead matter under Part 40 CFR 50. Sample air quality before construction for background particulate matter. Monitor air quality during construction until four consecutive samples show emissions not exceeding 400 µg per cubic meter of PM10 over an 8-hour period. If emissions exceed 400µg per cubic meter, stop work until the containment system is corrected to meet the required air quality level. Use high volume monitors placed upwind for background levels and downwind of the work and near the right of way line for monitoring emissions.

Sample air quality for lead before and during construction. Test background levels before construction by placing the monitor upwind of the project.

Take four consecutive samples when construction starts from monitors placed downwind and near the right of way line to determine emission levels. The maximum allowable emission in an 8-hour period is calculated by the following formula:

$$AE = 90/PD \times 1.5 \mu\text{g}/\text{m}^3 \times 3$$

Where:

AE = 8-hour allowable emission in µg/m³

PD = project duration in days

The maximum and minimum value for PD is 90 and 30 respectively.

Stop work when samples exceed the allowable AE until the containment system is corrected and emissions fall within the acceptable limits.

- C. Soil Quality.** Do not contaminate the soil with lead. The Department will take soil samples before and after construction for contamination testing. The Contractor is responsible for all work and costs to restore the soil to the condition represented by the pre-construction sample.
- D. Water Quality.** Do not contaminate any water system with lead debris (spent abrasive, paint chips, etc). The Department will take sediment samples below and downstream of the project before and after work begins for contamination testing. The Contractor is responsible for all work and cost to restore the water system to the condition represented by the pre-construction sample.
- E. Disposal.** Contain and store the material meeting the approved plan. The Department is responsible for disposal.

612.03.5 Application of Paint

- A. General.** Do not paint when weather conditions would cause unsatisfactory work. Follow the paint manufacturer's recommendations for surface temperature and dewpoint/temperature requirements. The Project Manager may stop painting at any time if current or impending weather conditions could cause unsatisfactory coating performance.

Correct failures or damage to new painted surfaces at Contractor expense. Provide a minimum dry film thickness of 1.5 and 1.0 mils (35 µm and 25 µm) respectively for each primer and succeeding field coat of paint over metal unless the paint manufacturer recommends otherwise.

Provide the Inspectors ready and safe access to the work at all times. The Project Manager will suspend work for unsafe or inadequate access facilities. Assure all fabrication inspections are complete before beginning painting.

B. Painting Structural Steel.

1. **Application.** Apply three coats of paint to new structural steel specified to be painted. This includes but is not limited to steel and metal structures such as bridge rail, sign posts, and sign structures exposed to the weather. Paint in a neat and workmanlike manner.

Follow the paint manufacture's recommendation when brush or spray painting to produce a uniform, even coat to the metal or previous paint coat. Brush paint thoroughly coating the surface irregularities and brush out and smooth to produce an even paint film thickness. Equip spray pressure tanks with an agitator that thoroughly stirs the paint.

Stir the paint as recommended by the manufacturer before removing it from the containers and during application. The Project Manager may approve hand mixing when each coat of paint is 5 gallons (20 L) or less.

Follow the manufacturer's recommendations for paint thinning.

Paint surfaces inaccessible to paint brushes with sprayers or daubers made for that use.

Protect painted surfaces from adverse weather until the paint has dried or weather permits removing the cover.

Remove and replace unsatisfactory paintwork at Contractor expense.

2. **Shop Paint.** Apply one coat of zinc rich primer to all steel surfaces specified to be painted, except surfaces in contact after erection. Apply the shop coat immediately after the fabrication, shop inspection, and shop cleaning are complete and the work has been accepted.

Do not paint metal surfaces that are in contact with other items after erection except as specified in Subsection 612.03.5(C)(1). Do not pack or ship materials until the paint is dry. Field coats may be applied in the fabrication shop only if approved in writing by the Engineer.

Make erection marks for the field identification of members on painted surfaces. Assure erection marks, fabricator's name, or other identification does not show through the final coat of paint. Use marking paint that is compatible with the shop coat and first field coat.

Shop coat machined-finished surfaces, excluding abutting chord splices, column splices, and column and truss shoe bases as soon as practical after acceptance with a zinc-rich primer coat. Machine finished iron and steel casting surfaces to remove scales, scabs, fins, blisters, and other surface deformations must be painted with a zinc-rich primer.

3. **Field Cleaning.** Remove all rust, scale, dirt, grease, unacceptable shop paint and other foreign material following the paint manufacturers recommendations when erection work is complete.
4. **Field Painting.**
 - a. **Application Conditions.** Apply paint following the manufacturers recommendations for temperature (air, surface, material), relative humidity and substrate temperature or as follows, whichever is more restrictive.

Do not apply paint when the ambient temperature is 40 °F (5 °C) or is expected to drop below 40 °F (5 °C) within 2 hours of application.

Do not apply paint when rain, snow, or condensation is expected within two hours after application at the painting location. The Project Manager may stop paint operations when impending weather could harm freshly applied paint. Do

not apply paint when the relative humidity is greater than 85 percent or when temperature and humidity cause condensation on the surface to be painted.

Do not apply paint to metal with surface temperatures that exceed 110 °F (40 °C) or when the surface temperature causes the paint to blister or produce a porous paint film.

- b. Accessory Preparations and Spot Painting.** Thoroughly clean masonry and sole plates, the outside faces of end floor beams, the bottom of expansion devices, and all parts of steel work inaccessible for painting after erection of all foreign material. Spot coat and apply two field coats. Perform the painting on site and allow it to thoroughly dry before assembling. Handle painted material to prevent paint damage. Repair and repaint damaged surfaces at Contractor expense.

Apply only the primer shop coat to the exposed surfaces of bridge deck and approach slab guard angles, expansion devices, and armored joints embedded in the roadway surface. Apply two coats of field paint to the entire curb or sidewalk portion of these members as specified elsewhere in this Section.

After erection and field cleaning is approved, apply the spot coat to the edges of the plates, rolled shapes and angles, to the heads of all field rivets, pins, nuts and areas where the shop coat has been damaged. The Project Manager may require a complete shop coat reconditioning or replacement on damaged surfaces at Contractor expense.

Re-seal small cracks and cavities left by the first coat with a zinc paste before applying the second field coat.

- c. Field Coating.** Once the field cleaning is complete and the spot coat is thoroughly dried, apply one field coat of epoxy paint to all metal and the finish coat of urethane paint. Do not apply the urethane until the epoxy has dried as recommended by the paint manufacturer.
- d. Painting Season.** Field painting season for structural steel, metal posts or poles, and bridge rail is from May 1 to October 31, unless otherwise approved in writing by the Project Manager.

C. Painting Bridge Rail.

- 1. Metal Bridge Rail.** Prepare metal bridge rail to be painted meeting the applicable requirements of Subsection 612.03.3.

Apply the spot coat and the first and second field coats before erection and fit-up to the following contact surfaces:

- a.** Rail to post contact surfaces;
- b.** Bridge rail expansion sleeves; and
- c.** Bridge rail post base plates.

Apply the first and second coat to the rest of the rail after erection, fit-up, and final adjustment of the rail to line and grade.

Repair coating damage to galvanized members with an approved zinc-rich paint.

- 2. Wood Rail and Posts.** Primer and paint for wood rail and posts are specified in the contract. Apply paint meeting the applicable requirements of Subsection 612.03.05.

612.04 METHOD OF MEASUREMENT

Paints and painting is not measured separately but is incidental to the items being painted.

612.05 BASIS OF PAYMENT

Paints and painting is not paid for separately but is included in the cost of the item painted and includes all materials and resources necessary to complete the work.

**SECTION 613
RIPRAP AND
SLOPE AND BANK PROTECTION**

613.01 DESCRIPTION

This work is the construction of protective rock, stones, gravel, or concrete coverings as specified.

Riprap is a cover of stone or fragmented rock, with or without grout, placed along embankment slopes, stream banks, culvert inlets and outlets, foundations, bridge berms, dikes, and other specified locations.

Bank protection is a cover of rock or coarse gravel placed on the side slopes of structure channels and other specified locations.

Concrete slope protection is a cover of portland cement concrete placed on slopes at structure ends.

613.02 MATERIALS

Furnish materials meeting the following Section and Subsection requirements:

Handlaid, Random, and Grouted Riprap.....	701.06
Cement Grout	713.04
Bedding Material	701.04.1
Bank Protection	701.07
Class "D" Portland Cement Concrete	551
Sand-gravel Cushion	701.08

613.03 CONSTRUCTION REQUIREMENTS

613.03.1 Riprap

A. General. Place the riprap at the locations specified in the contract.

Key the riprap ends into the embankment slopes at least 2 feet (610 mm) from the outer face of the riprap for the full height of the riprap.

B. Handlaid Riprap. Bed the stones at right angles to the slope with the larger stones used in the lower courses. Lay the stones in close contact with staggered vertical joints and placed so each stone rests on the embankment slope instead of the underlying stones. Fill the spaces between the stones with smaller stones or rock, securely placed.

Finish the work to present an even, tight plane varying no more than 3 inches (75 mm) from the general contour of the revetment.

Provide a minimum riprap thickness of 12 inches (305 mm), measured perpendicular to the slope, or as specified.

C. Random Riprap. Place the stones on the slopes to form the specified cross section. Uniformly distribute the smaller stones throughout the work. Manipulate the stones by hand or machine to provide a uniform surface and stable mass.

Provide the riprap thickness specified on the plans.

Place the riprap around pipe openings without damaging the pipe. Repair damaged pipe at Contractor expense.

D. Grouted Riprap. Provide a minimum riprap thickness of 9 inches (230 mm) measured perpendicular to the slope, or as specified.

Place one or more layers of bedding material before placing the riprap as specified. Place each bedding layer on the prepared surface to the specified thickness in one

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operation without segregating the layer. Finish the top layer to produce an even surface free from mounds or ridges. Do not inter-mix the materials of each layer.

Fill the voids between stones with spalls or small stones so all stones are wedged or keyed. Prevent earth and sand from filling the spaces between the stones.

Finish the final surface to provide an even, tight surface with the plane not varying more than 3 inches (75 mm) from the general contour.

Wet the riprap surface and fill the crevices and openings with at least 3-inches (75 mm) of mortar. Immediately sweep the surface with a stiff broom.

Grouting may begin when the ambient temperature is at least 35 °F (2 °C) and rising and must stop when the ambient temperature is 30 °F (-1 °C) and falling.

Keep finished grout work moist for three days.

613.03.2 Bank Protection

Bank protection may be hand-placed or machine placed and leveled. Construct the finished bank protection to be stable with no voids larger than the smallest stone used in the work.

Use rock spalls or gravel to fill the voids. Not more than five percent of the total bank protection volume may be earth, sand, or rock material smaller than 3/16-inch (5 mm) for filling voids.

Bed the bank protection as shown in the contract.

613.03.3 Concrete Slope Protection

Trench, shape, compact, and trim the slopes as specified before starting concrete work. Excess excavated material may be used elsewhere in the work or disposed of by the Contractor.

Construct the concrete slope protection as specified or directed.

613.03.4 Concrete Drainage Chute

Construct concrete drainage chutes as shown in the Detailed Drawings.

613.04 METHOD OF MEASUREMENT**613.04.1 Riprap**

A. Handlaid and Random Riprap. Handlaid and random riprap is measured by the cubic yard (cubic meter) to the nearest cubic yard (cubic meter) complete in place. The volume measured for payment is that bounded by the staked length and height and the plan thickness.

Excavation is incidental to the riprap and not measured for payment.

B. Grouted Riprap. Grouted riprap is measured by the square yard (square meter) to the nearest square yard (square meter) on the face of the revetment.

Excavation is incidental to the riprap and not measured for payment.

Bedding material is measured by the cubic yard (cubic meter) to the nearest cubic yard (cubic meter).

613.04.2 Bank Protection

Bank protection is measured by the cubic yard (cubic meter) to the nearest cubic yard (cubic meter) complete in place. The volume measured for payment is that bounded by the staked length and height and the plan thickness.

Excavation and bedding material are not measured for payment.

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613.04.3 Concrete Slope Protection

Concrete slope protection is measured by the square yard (square meter) to the nearest 0.1 square yard (0.1 square meter). Measurement is made parallel to the surface of the exposed surface area including the surfaces of curbs and head walls.

Excavation is incidental to the item and not measured for payment.

Sand-gravel cushion is measured by the cubic yard (cubic meter) compacted in place.

613.04.4 Concrete Drainage Chute

Concrete drainage chutes are measured by the cubic yard (cubic meter) and include the excavation, concrete placement, and bank protection at the chute ends.

613.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

Pay Item

Handlaid and Random Riprap
 Grouted Riprap
 Bank Protection
 Concrete Slope Protection
 Bedding Material
 Sand-gravel Cushion
 Concrete Drainage Chute

Pay Unit

Cubic Yard (cubic meter)
 Square Yard (square meter)
 Cubic Yard (cubic meter)
 Square Yard (square meter)
 Cubic Yard (cubic meter)
 Cubic Yard (cubic meter)
 Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 614
RETAINING WALLS

614.01 DESCRIPTION

This work is constructing concrete and metal bin-type retaining walls.

614.02 MATERIALS

Furnish materials meeting the following Section and Subsection requirements:

Concrete	551
Reinforcing Steel	711.01
Metal Bin-Type Retaining Walls.....	711.21
Backfill For Metal Bin-Type Retaining Walls.....	701.09

614.03 CONSTRUCTION REQUIREMENTS

614.03.1 Foundations

Excavate and prepare foundations for concrete retaining walls meeting the applicable requirements of Subsection 209.03.

Construct metal bin-type retaining wall foundations to the established lines and grades and compact meeting Subsection 203.03.3 requirements.

The Project Manager will inspect and approve all foundations before subsequent work.

614.03.2 Concrete Retaining Walls

Construct concrete retaining walls as specified in the contract. Perform concrete work meeting the applicable requirements of Section 552.

Remove all deleterious material from the footings before placing concrete. Prepare the footing surface meeting the requirements for bonding construction joints in Subsection 552.03.7. Make vertical construction joints as specified in Subsection 552.03.7.

614.03.3 Bin-type Retaining Walls

Assemble the wall parts following the wall manufacturer's recommendations.

If approved, the wall height and depth may be varied but can not exceed the maximum dimension shown.

Two or more retaining wall designs may be used in the same wall, using standard split columns to make the stepback connection.

614.03.4 Backfill

A. Concrete Structures. Furnish the backfill material specified in the contract. Place backfill as specified in Subsection 203.03.2(B).

B. Metal Bin-type Retaining Walls. Follow the manufacturer's recommendations for placing and compacting backfill material. If no recommendations are made, bring the backfill up equally inside and outside the bins as follows:

- For backfill material outside the bins, use roadway excavation and place it as specified in Subsection 203.03.2(B).
- Furnish backfill material for inside the bins meeting Subsection 701.09 requirements.
- Place the backfill in 8-inch (205 mm) maximum compacted lifts, completely filling in all corrugations. Compact backfill as specified in Subsection 203.03.3. Hollow sounding corrugations in the bin wall face detected by the Inspector is cause to remove, replace, and re-compact the backfill at Contractor expense.

614.04 METHOD OF MEASUREMENT**614.04.1 Concrete**

Concrete is measured by the cubic yard (cubic meter) under Subsection 552.04.

614.04.2 Reinforcing Steel

Reinforcing steel is measured by the pound (kilogram) under Subsection 555.04.

614.04.3 Metal Retaining Walls

Metal bin-type retaining walls are measured by the nominal square foot (square meter) of facial area of wall.

614.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made as follows:

Pay Item

Concrete

Reinforcing Steel

Metal Retaining Wall

Pay Unit

Cubic Yard (cubic meter)

Pound (kilogram)

Square Foot (square meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 615
IRRIGATION FACILITIES
AND HEADWALLS**

615.01 DESCRIPTION

Irrigation facilities and headwalls is furnishing and constructing irrigation structures meeting these specifications and the contract requirements.

615.02 MATERIALS

Furnish material meeting the contract and the following Section requirements:

Concrete, Class "DD"551

615.03 CONSTRUCTION REQUIREMENTS

Construct irrigation facilities and headwalls meeting the contract requirements and the following.

Excavate meeting the applicable Section 209 requirements. Construct and install concrete structures meeting the applicable Section 552 requirements. Place reinforcing steel as shown in the contract. Moisten all surfaces where concrete is to be placed before the concrete is placed.

615.04 METHOD OF MEASUREMENT

Concrete is measured under Subsection 552.04. Reinforcing steel and excavation are incidental to concrete and not measured for payment.

615.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

Pay Item
Concrete

Pay Unit
See Subsection 552.05

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the contract.

SECTION 616
CONDUITS AND PULL BOXES

616.01 DESCRIPTION

This work is furnishing and installing plastic and steel electrical conduit, including fittings, junction boxes, pull boxes, and accessories.

616.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Conduit	703.02
Pull Boxes	703.03

616.03 CONSTRUCTION REQUIREMENTS

616.03.1 General

Install conduit and pull boxes meeting the National Electric Code (NEC) requirements.

Conduit lengths in the contract are estimated, and may require changes, approved by the Project Manager, to avoid underground obstructions. Refer to Subsection 107.18 regarding locating of underground utilities before excavation.

Provide the specified conduit size, or substitute a larger size conduit at Contractor expense. Do not change conduit size within any conduit run. Use minimum 2-inch (53 mm) diameter conduit between pull boxes and adjacent standard bases.

Install pull boxes and conduits as specified with the pull box covers flush with the concrete facing or as directed.

Compact backfill material for conduit trenches constructed outside of the roadbed sections to the density of the adjacent material.

Restore existing surfaces disturbed by conduit or pull box installations to the original type and condition.

616.03.2 Plastic Conduit

Excavate trenches for plastic conduit a minimum 24 inches (610 mm) deep. Tamp the trench bottom and bed with 2 inches (50 mm) of sand before laying the conduit. Once the conduit is placed, place and compact sand, or soil free of rocks or hard lumps, 6 inches (155 mm) above the pipe. Complete the backfill using material passing a minus 3-inch (75 mm) screen.

Join conduit using a solvent-welded slip-fitter coupling to provide a watertight joint.

Separate plastic parallel and perpendicular conduit runs from each other with at least 3 inches (75 mm) of sand or soil cushion. Cap open ends of conduit to prevent moisture, dirt, or rocks from entering the conduit.

Terminate plastic conduit runs at least 9 inches (230 mm) from the pullbox or foundation with a plastic threaded adaptor. Thread a rigid steel conduit bend into the adaptor for the pullbox or foundation entry. Use insulated bushings and electrically bond the steel conduit ends.

For plastic conduit runs 300 feet (91 m) or longer, leave one end disconnected or insert an "O" ring expansion coupling near one end of the run.

616.03.3 Steel Conduit

Install rigid conduit meeting the National Electrical Code Article 346.

Use the size and type of conduits and fittings specified in the contract.

Make field cuts square and true so that the ends join full circumference. Ream the conduit ends to remove burrs and rough edges.

Slip joints or running threads are not permitted for coupling conduit. Use an approved threaded union coupling when a standard coupling cannot be used.

Coat any new threads on conduit with a cold galvanizing compound before making couplings.

Tighten couplings until the conduit ends are brought together making a good electrical connection throughout the entire conduit run.

Paint damaged conduit coating with a cold galvanizing compound.

Thread and cap conduit with standard pipe caps until the wiring is placed. Install insulated grounding bushings when caps are removed.

Terminate conduit in standard or pedestal foundations at least 3 inches (75 mm) from the foundation top. Keep conduit within foundations at least 6 inches (155 mm) from the foundation face.

Have conduit enter the foundation at least 24 inches (610 mm) from the top. Conduit stubs on structures are specified in the contract. Paint conduit stubs, caps, and exposed threads with rust-preventative paint.

Mark the conduit end locations in structures and at curbs directly above the conduit end by cutting a minimum 3-inch (75 mm) "Y" into the curb face, gutter, or wall.

Make conduit field bends having a minimum radius of six times the inside diameter of the conduit. Factory conduit bends must not crimp or flatten the conduit and use the longest practical radius.

Place and securely hold in position conduit ends, anchor bolts, and other fittings set in concrete until the concrete sets.

Lay conduit a minimum of 18 inches (460 mm) below the curb grade in sidewalk areas and not less than 24 inches (610 mm) below the finished grade in all other areas.

Install conduits under railroad tracks to railroad company requirements. Notify the Department and the railroad company at least 48 hours before starting work on railroad property.

Place conduits installed under an existing roadway as specified.

Jack or drill conduits without damaging the roadway surface.

Open cut highways only if other methods have failed and if approved by the Project Manager. The Project Manager may approve cutting small test holes in the roadway surface to locate obstructions. Keep jacking and drilling pits at least 2 feet (610 mm) away from the roadway surface edge. Do not undermine the roadway surface or soften subgrade when using water.

When approved by the Project Manager, trench across paved roadways without disturbing or injuring the paved surface on both sides of the trench.

Cut asphalt pavements leaving a straight cut face. Excavate, install conduit, and backfill with approved material. Fill the top 1 foot (305 mm) of the trench with compacted plant mix or as directed. Replace all damaged pavement.

Compact backfill material in the roadbed section to at least 95 percent of maximum density at optimum moisture content meeting Subsection 203.03.3 requirements.

Extend conduit terminating in standards or pedestals above the foundation and slope it towards the handhole opening. Terminate conduit entering concrete pull boxes 2 inches (50 mm) inside the box wall, at least 2 inches (50 mm) above the bottom, and slope it to aide cable pulling. Locate conduit entrances in pull box bottoms near the end walls leaving most of the box clear. Install conduit outlets in the box from the direction of the run. Seal conduit leading into socket walls, lights, or fixtures below the pull box grade using a watertight sealing compound.

Install a pull wire in all unused conduits over 10 feet (3 m) long. Double at least 2 feet (610 mm) of pull wire back into the conduit at each termination point for runs over 100 feet (30.5 m); double 1 foot (305 mm) back for shorter runs.

Install a conduit expansion joint, detailed in the contract, where the conduit crosses a fixed or structure expansion joint. Equip each expansion fitting with a grounding strap jumper. Thoroughly clean contact areas before clamping grounding straps.

Secure all conduit bonds, lighting bracket anchor bolts, and bridge rail anchor bolts to form a continuous mechanical and electrical system.

Clean out existing underground conduit incorporated into new conduit with compressed air and mandrel for size if required.

616.03.4 Pull Boxes and Manholes

Construct and install pull boxes and manholes as specified. The Contractor may install additional pull boxes to aide the work at its expense. Install pull boxes and manholes with covers level with curbs, sidewalks, and surrounding ground. Bed the box bottoms in concrete or crushed rock as specified.

616.04 METHOD OF MEASUREMENT

616.04.1 Lump Sum Basis

When a conduit system or portion thereof is specified in the contract on a lump sum basis, the system is measured by the lump sum.

616.04.2 Conduit

Conduit is measured by the foot (meter) to the nearest 1 foot (0.1 m).

616.04.3 Pull Boxes and Manholes

Pull boxes and manholes are measured by the unit.

616.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Conduit System	Lump Sum
Conduit	Foot (meter)
Pull Box	Each
Manhole	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 617
TRAFFIC SIGNALS AND
LIGHTING**

617.01 DESCRIPTION

This work is installing or modifying of traffic signal(s), lighting, and other electrical systems.

617.02 MATERIALS

Furnish materials meeting the following Section requirements:

Lighting and Signal Materials.....	703
Paints.....	710
Class "D" Portland Cement Concrete	551

617.03 CONSTRUCTION REQUIREMENTS

617.03.1 General

Obtain daily, safety circuit clearance from the servicing utility before starting work on existing series street lighting circuits. Pull cut-out plugs and place worker signs at cut-out boxes before work is started.

Pick up State-furnished material and equipment from the Department of Transportation, Traffic Engineering Section, 2701 Prospect Avenue, Helena, Montana, and transport to the project as part of the contract unit price. Provide the Traffic Engineering Section at least 48 hours advance notice before arriving to take delivery.

Repair or replace all existing improvements and equipment disturbed, damaged, or removed in performing the work at Contractor expense.

The locations in the contract for signal and light standards, controller pedestals, conduit runs, pull boxes, illuminated signs, and appurtenances are approximate. The Project Manager will establish the exact field locations.

Furnish and install all incidental parts not specified but necessary to complete or modify the traffic signal, lighting, or other electrical systems at Contractor expense.

Make arrangements with the serving utility for providing service to the project.

Pay all fees and energy costs up to the time the project is accepted. The Department will pay for the energy costs to operate signals and lighting for public benefit, when ordered by the Project Manager.

All systems must be complete and operable when the work is completed.

See Section 703 for additional construction requirements.

617.03.2 Equipment Lists and Drawings

Submit the following to the Electrical Section of the Traffic and Safety Bureau for approval after award:

1. A complete list of the proposed equipment and material. Include the quantity, description, size, name of the manufacturer, and catalog number of each item. Indicate which items are on the Department's Qualified Products List (QPL).
2. Manufacturer's catalog sheets for each item of equipment and material listed that are not on the Department's QPL. The catalog sheets must have the specific items to be used underlined in red include item specifications.
3. Shop drawings, design calculations, and welding procedures for all metal signal and luminaire standards that are not on the Department's QPL. Check and approve the shop

drawings and design calculations before submitting, and show the Contractor's approval on the drawings.

4. Documentation required by the QPL for items that are on the approved QPL list.
5. Certified mill test report's for pole material and the manufacturer's certification that pole material and galvanizing meets specifications.

Materials and equipment listed as approved on the QPL at the time that the list of proposed equipment and materials is submitted, may be accepted as a pre-approved QPL item in lieu of the normal submittal and approval process outlined in this section.

Obtain further information and requirements on the QPL website, located at <http://www.mdt.mt.gov> contracting/consultant link.

The Department has 15 Working Days after receipt to approve the submittals. Upon receipt of the approved list of equipment and material, immediately order the materials and submit copies of the dated purchase orders for major items. Re-submit any disapproved items for Department review within 20 working days of notification of disapproval.

Submit copies of the invoices showing the shipping dates within 10 calendar days of the invoice dates.

The calendar date or the number of working days allowed for completion of the contract will be adjusted by the number of days the Department's review of submittal's overrun the Department's review time, if the Departments delay affects the Contractors operation as shown on the current work schedule.

The Department is not liable for any material purchased, labor performed, or work delay (except as stated above) before approval of the required submittals.

All material is subject to inspection after delivery to the project and during installation on the project. Failure by the Project Manager to note defective material or faulty workmanship during construction does not relieve the Contractor of responsibility for removing or replacing defective material or redoing work at Contractor expense. Inspection or sampling of certain materials may be made at the factory or warehouse before delivery to the site at the Project Manager's discretion. No material rejected before delivery, is to be delivered to the project, and all material rejected on the project must be removed from the work.

Submit all equipment guaranties and warranties.

Comply with the requirements of Subsection 106.09.

617.03.3 Maintenance of Signals

Maintain existing traffic signals that are moved or modified once work begins.

The responsibility for existing traffic signals continues with the agency normally responsible for the traffic signals until work begins.

Be responsible for new or modified traffic signals placed in service until the project is accepted. Provide in writing the names and phone numbers of the persons responsible for the operability and maintenance to the jurisdictional law enforcement agency and the Project Manager in case of signal malfunction.

617.03.4 Excavating and Backfilling

Excavate for conduit, foundations, other equipment and materials as specified. Excavate trenches to the width necessary to install electrical equipment, materials, and foundations. Saw cut all existing pavements before excavating.

Do not start excavation until the conduit, equipment, and materials are on site.

Place excavated material without obstructing vehicular or pedestrian traffic or surface drainage. Remove and dispose of surplus excavated material at the end of each workday.

Backfill excavations meeting Subsection 209.03.6 requirements. Bring excavations up level with the adjacent surface or grade to drain as required until permanent repairs are made.

When construction is suspended each day, clear all equipment and material from the roadway for public use as specified in Section 618.

Restore sidewalks, pavement, and landscaping at each intersection before starting work at other intersections. Restrict only one traffic lane for excavations in streets and highways at any time, following the approved traffic control plan.

617.03.5 Removing and Replacing Improvements

Replace or re-construct existing sidewalks, curbs, gutters, pavement, bituminous surfacing, base material, and other improvements removed, broken, or damaged by the Contractor with equal or better quality materials.

Cut concrete sidewalk and pavement borders to be removed without damaging the adjacent surface. Whenever a part of the existing concrete sidewalk, driveway or pavement is broken or damaged, remove the entire square or slab and replace the concrete as specified.

Repair or remove and replace all existing improvements damaged by the Contractor at its expense.

617.03.6 Foundations

Construct post, standard, controller cabinet, and pull box concrete encasing pad foundations using Class "D" portland cement concrete meeting the applicable requirements of Section 551.

Place the concrete foundation bottoms on undisturbed ground. Mono-lithically pour foundations where practical. Form the exposed faces. Assure forms are rigid and braced true to line and grade. Finish the footing tops for posts and standards, except special foundations, to the curb or sidewalk grade or as directed. Position and hold in place conduit ends and anchor bolts using a template until the concrete has set.

Install luminaire and Type 1 signal foundations to ensure that no portion of the foundation or base that is non-breakaway projects more than 4 inches (100 mm) above the ground line.

Apply an ordinary surface finish to the exposed concrete surfaces meeting Subsection 552.03.12.

Where obstructions prevent the construction of planned foundations, the Contractor may propose an alternate foundation construction method.

Posts, poles, standards, and pedestals may be erected, plumbed and raked after the foundation concrete has cured at least 72 hours.

617.03.7 Conductors and Wiring

Install wiring meeting the National Electric Code requirements.

Neatly arrange and lace wiring in cabinets, junction boxes, and the like.

Run conductors in conduit except inside poles. Remove all dirt and moisture from the conduit runs before pulling wiring. Use powdered soapstone, talc, or other approved lubricant when placing conductors in conduit.

Run signal light conductors without splices from a terminal block located in the cabinet, compartment, or signal head to a similarly located terminal block.

Splice conductors only where specified using approved watertight connectors. Locate connectors in pole bases to be easily accessible through the handhole.

Leave at least 2 feet (610 mm) of slack for each conductor at each standard and pull box.

Use a conductor separate from the signal light circuit for all 24-volt circuits, such as pedestrian push-button circuits.

When conductors and cables are pulled through conduit, tape the conductor and cable ends to seal out moisture until the splices are made or terminal appliances attached. Tape the ends of spare conductors.

Tag cables at controller cabinets and poles to show routing. Provide color-coded wire diagrams for individual wire routing.

617.03.8 Span Wire-mounted Signals

Install span wire suspended signals on overhead guys providing a sag of five percent of the total span distance.

Raise overhead guys with the signals attached, to the specified sag. Adjust the guy mounting height at either or both poles, or the sag, or the rake of steel poles so that the signals are at the specified height with the proper sag and the poles are plumb when completed. Do not pull guys beyond the specified sag.

617.03.9 Bonding and Grounding

Make metallic cable sheaths, conduit, and metal poles and pedestals mechanically and electrically secure to form a continuous grounded system. Use copper wire or strap of equal cross sectional area to an AWG No. 6 conductor for bonding and grounding jumpers. Use a No. 6 copper bonding strap, to bond standards and pedestals, attaching it to an anchor bolt and all conduit. Use a bare copper AWG No. 6 solid wire connected between the grounding lug on the standard or pedestal and the bonding strap. Ground one side of the secondary circuit of series-multiple transformers.

Ground conduit and neutrals at service points meeting the Electrical Code or this Section, except use AWG No. 6 conductor or equal for grounding.

Furnish and install nonferrous ground rods or approved equals of at least 5/8 inch x 8 feet (16 mm x 2.4 m) at each service point. Install ground rods meeting the contract and Code requirements. Bond the service equipment to the ground rod using a ground clamp and a bare AWG metal No. 6 solid copper wire or equal enclosed in a 3/4-inch (21 mm) diameter schedule 80 plastic conduit.

617.03.10 Service Connections

Service pole locations shown in the contract are approximate. The Contractor, Project Manager and serving utility will jointly determine the exact locations. The utility must specify the riser location when the Contractor is to install the lower section of a riser on a utility pole.

617.03.11 Conduit and Pull Boxes

Refer to Section 616.

617.03.12 Painting

Perform painting meeting Section 612 requirements.

Clean standards, frames, signal bridges, fittings, and other metal parts to be painted following the paint manufacturer's recommendations before applying paint.

Apply two coats of cold galvanizing compound to breaks, abrasions, and damaged galvanized surfaces. Undamaged, shop-coated metal parts do not require field priming.

Prepare galvanized surfaces to be painted following the paint manufacturer's recommendations or as follows if no recommendations are made:

- Dissolve 2 ounces (59 mL) each of copper chloride, copper nitrate, and sal ammoniac in 1 gallon (3.8 L) of water in a glass container.
- Add 2 ounces (59 mL) of commercial muriatic acid. Apply the solution to the galvanized surface with a wide, flat brush.

- Apply one coat of primer after the surface develops a grey film.
- Spot coat damaged surfaces with primer, once installed.
- Apply two coats of enamel of the color specified below.

Factory-enameled signal heads and fittings of black or dark olive-green in good condition must not require painting. Apply one coat of primer and two coats of enamel to signal heads that are un-painted or when directed.

Use the same color for like components in the same intersection.

Apply one coat of primer to the backplates.

Apply two coats of flat black enamel to hood interiors and front faces of backplates.

Factory-enameled controller cabinet exteriors in good condition do not require painting. Paint unpainted cabinet exteriors with one coat of primer and two coats of aluminum enamel.

Galvanized poles must not require painting except for repairing damaged surfaces.

Apply paint by hand brushing or spray equipment. The Project Manager will require brush painting if spraying produces unsatisfactory results.

617.03.13 Field Test

Conduct the following tests on traffic signal and lighting circuits with the Project Manager present before completing the work:

1. Test each circuit for continuity;
2. Test each circuit for grounds;
3. Perform a megger test on each vehicle detector loop between the loop and ground before and after sealing. The megger readings must exceed 10 megohms; and
4. A functional test that demonstrates the system functions as specified.

617.03.14 Salvaging and Reinstalling Electrical Equipment

A. Salvaging Electrical Equipment. Remove, clean, salvage, and stockpile or re-install existing electrical equipment as specified.

Underground conduit, conductors, and foundations not reused are the Contractor's property and must be removed. The materials may, with written approval, be abandoned in place.

Replace all electrical equipment damaged or destroyed during salvage operations at Contractor expense.

B. Reinstalling Salvaged Electrical Equipment. Furnish and install all necessary materials and equipment to complete the new installation.

C. Remove and Reset Existing Poles and Standards. Remove the specified poles and standards, including their attachments from the existing locations and reset them at the specified new locations. Remove the existing foundation, backfill and compact the hole, and dispose of the old foundation. Remove the existing wiring from the poles and standards and replace with new wiring, making all connections. Furnish four high strength anchor bolts, as specified, and two nuts and two washers for each bolt for the new foundation. Ensure the top 12 inches (300 mm) of the bolt is galvanized. Install a new foundation meeting Subsection 703.05 at the specified locations. Meet all the applicable Section 617 requirements for the reset installation.

617.03.15 Road Closure Gate Assemblies

Furnish and install road closure gate assemblies meeting the contract requirements and as shown in the Detailed Drawings.

617.04 METHOD OF MEASUREMENT**617.04.1 Lump Sum Basis**

When a traffic signal and lighting system or portion thereof is specified in the contract on a lump sum basis, the system is measured by the lump sum.

617.04.2 Traffic Signals and Lighting

Measurement for traffic signals and lighting is made as follows:

1. Conduit and pull boxes are measured under Subsection 616.04.
2. Concrete foundations are measured by the cubic yard (cubic meter) based on plan dimensions. Deductions are not made for the concrete displaced by reinforcing steel, anchor bolts, and conduit. Foundation work includes backfill, furnishing reinforcing steel, electrical bonding, and restoring the surface around the foundation.
3. Cables, conductors, and treated timber poles are measured by the foot (meter) to the nearest foot (0.1 m), in place.
4. The following items are measured by the unit:
 - Standards
 - Controller Cabinet Pedestals
 - Controllers
 - Luminaire Assemblies
 - Service and Control Assemblies
 - Photoelectric Controls
 - Traffic Signals
 - Pedestrian Signals
 - Signal Standards
 - Detector Loops
 - Detector Loop Amplifiers
 - Pedestrian Push Buttons
 - Emergency Pre-emption Systems
 - Road Closure Gate Assemblies
 - Remove and Reset Existing Pole (foundation measured separately)
 - Other component parts as specified in the contract

617.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Traffic Signal and Lighting System	Lump Sum
Conduit and Pull Boxes	See 616.05
Concrete	Cubic Yard (cubic meter)
Cables	Foot (meter)
Conductors	Foot (meter)
Treated Timber Poles	Foot (meter)
Pull Boxes	Each
Standards	Each
Controller Cabinet Pedestals	Each
Controllers	Each
Luminaire Assemblies	Each
Service and Control Assemblies	Each
Photoelectric Controls	Each

Traffic Signals	Each
Pedestrian Signals	Each
Signal Standards	Each
Detector Loops	Each
Detector Loop Amplifiers	Each
Pedestrian Push Buttons	Each
Emergency Pre-emption Systems	Each
Road Closure Gate Assembly	Each
Remove and Reset Existing Pole	Each
Other Components as specified in the contract	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract and to furnish and operational system.

SECTION 618
TRAFFIC CONTROL

618.01 DESCRIPTION

This work is the furnishing, installing, and maintaining of traffic signs, barricades, lights, signals, pavement markings, and other specified traffic control devices. It includes flagging and pilot car operation and furnishing and applying water for dust control.

618.02 MATERIALS

Furnish materials meeting the contract, the MUTCD, and the following Subsection requirements:

Reflective Sheeting.....	704.01.10
Letters, Symbols and Accessories.....	704.01.11
Temporary Pavement Marking Tape	714.01
Temporary Pavement Marking Tabs.....	714.02
Preformed Plastic Pavement Markings.....	714.03
Temporary and Interim Traffic Paint	714.04
Signs and Channelizing Devices	715.01
Portable Sign Support Assemblies	715.02
Advance Warning Arrow Panels	715.03
Warning Lights.....	715.04
Flagger Ahead Warning Signs.....	715.05

Provide work zone traffic control devices that meet the National Cooperative Highway Research Council test Report 350 (NCHRP 350) crash test requirements.

618.03 CONSTRUCTION REQUIREMENTS

618.03.1 Purpose and Prosecution of Work Zone Traffic Control

Schedule construction and provide work zone traffic control to accomplish the following:

1. To provide the protection, safety, and convenience for motorists, pedestrians and for construction personnel protection and safety; and
2. To advance the project work in the most beneficial manner to the public.

Provide work zone traffic control for all construction activities on the roadway and within the clear construction zone and other specified areas. The construction clear zone is the area within 30 feet (9.2 m) of the edge of a traffic lane.

Furnish work zone traffic control meeting the contract requirements, the MUTCD, and the approved traffic control plan.

618.03.2 Traffic Control Plan

The Detailed Drawings and the Manual of Uniform Traffic Control Devices provide traffic control requirements for the contract.

Furnish a proposed traffic control plan.

The traffic control plan must consist of; copies of the Detailed Drawings with notations indicating permanent or temporary sign mounting, sign location modifications as necessary, or Contractor generated traffic control drawings. Indicate on the plan the location and purpose of flaggers and pilot car use. Include in the plan proposed measures to deal with traffic delays due to emergencies, highway incidents within the project limits, emergency vehicles, mail delivery, and scheduled school bus runs.

Obtain the Project Managers approval of the plan, and changes to the plan, before its use.

Furnish documentation that each type of traffic control device to be used on the project meets NCHRP 350 requirements with the proposed traffic control plan.

618.03.3 Traffic Control Conference

Attend a work zone traffic control conference organized by the Project Manager before starting work that alters the public's use of any roadway. The provisions for traffic control proposed for each stage of construction will be reviewed.

618.03.4 Traffic Control Reviews

Designate personnel to be responsible for traffic control work and its continuous surveillance. The designees must be available 24 hours a day to respond to calls concerning damage to traffic control devices from any cause. Provide the names of the persons responsible for the surveillance.

The Project Manager and the designees will conduct periodic reviews of the traffic control throughout the work to insure compliance with the traffic control plan. The reviews will be conducted at night, during adverse weather conditions, when construction work is active and inactive, and at other times as necessary.

618.03.5 Traffic Control General Requirements

Meet all traffic control plan requirements before starting work affecting the roadway. Use devices that are new or like new in condition.

Properly maintain, clean, and operate devices when in use. Immediately remove the devices when they are no longer applicable to the work. Cover with opaque material or remove all non-applicable signs from the work.

Remove portable traffic control devices when not in use.

Immediately remove existing signs and other traffic control devices on the present traveled way or on connecting state or federal routes to be abandoned when they no longer apply. Assure roadways are always appropriately signed. Turn removed signs over to the Department.

Provide functional traffic lanes with signing and channelizing appropriate to the roadway condition at the close of each work day.

Provide the traffic an un-obscured view of the traffic control devices at all times.

Store or park construction equipment, vehicles, materials, and debris at least 10 feet (3 m) behind guardrail or outside the clear zone. When this is impractical, use approved warning devices and protective measures to delineate the item. Only equipment and materials for immediate use or incorporation into the work may be placed within the clear zone.

Store unused traffic control devices outside the clear zone.

Contractor furnished traffic control devices are the Contractor's property. Traffic control devices furnished by the Department or installed on a force account basis are the Department's property.

Repair or replace all damaged traffic control devices at Contractor expense.

If the Contractor fails to provide the required traffic control, the Project Manager will provide the work and deduct the costs from monies due or that may become due the Contractor.

618.03.6 Access Breaks

Submit a written proposal on the "Request for Access Break Approval" form, available from the Project Manager, for temporary breaks in Interstate access control or right-of-way fences for approval. See the form for access breaks requiring FHWA approval. Include all information requested on the form.

Provide a written narrative that describes how the traffic control plan addresses traffic safety and minimizes delay to the mainline traffic. Ensure the plan meets the MUTCD and the departments Detailed Drawings requirements.

Do not begin work on the access break until the Department has returned an approved proposal. Obtain the Project Manager's approval for all modifications to the original plan and submit the changes in writing.

Assume all costs associated with the access break including the traffic controls and the restoration of the area once the access break is removed.

618.03.7 Crossing, Entering, and Using Roadways

A. General. Construct temporary approaches and crossings with 10:1 side slopes and include drainage provisions.

Remove all temporary approaches and median crossings once the work is complete. Restore and re-seed disturbed areas.

Do not use areas within the right-of-way as borrow sources or disposal areas for the construction or restoration of temporary approaches.

Operate hauling units with the flow of traffic. Do not operate hauling units on roadway shoulders.

B. Limited Access and Multiple-lane Roadways. Use frontage roads and interchanges for equipment access to the Interstate roadway whenever possible.

Do not stop the general traffic on one-way roadways for the convenience of haul units. Use interchanges or a series of appropriate lane closures at temporary access breaks and median crossings for haul-unit operations on one-way roadways.

Haul unit turning movements are restricted to right-turn movements only, when there is access to the project by frontage roads and where left-turn movements by hauling units would pose a hazard to the traveling public.

Submit temporary median crossing proposals for approval. Include the applicable information detailed in Subsection 618.03.7.

Temporary median crossings may be permitted subject to the following guidelines:

1. The distance between any two median crossings, including interchanges, authorized vehicle median crossings, and temporary median crossings must be at least 2 miles (3.2 km).
2. Median crossings must be at least 1,000 feet (305 m) from structures and have a minimum 1,500 feet (458 m) of sight distance at 3.5 feet (1.1 m) above the pavement.
3. Sign median crossings as specified in the contract.
4. When not in use, protect crossings through median barriers by one of the following methods:
 - a. Place an approved impact attenuator at each end of the barrier opening.
 - b. Close the inside lanes to traffic with a controlled lane closure.
 - c. Close the opening by replacing and pinning the median barrier.

C. Two-lane Roadways. Always provide at least one functional lane for traffic. Meet Table 618-1 requirements.

TABLE 618-1
TRAFFIC CONTROL REQUIREMENTS FOR HAULING
UNITS ENTERING OR CROSSING 2-LANE ROADWAYS

ADT/LOAD FREQUENCY	TRAFFIC CONTROL REQUIREMENT
Less than 2000 ADT	Stop hauling units for traffic
2000 to 5000 ADT/ Less than 50 loads per shift	Stop hauling units for traffic
2000 to 5000 ADT/ More than 50 loads per shift	Provide flaggers to control traffic
More than 5000 ADT	Provide flaggers to control traffic

The Project Manager may adjust the ADT or load frequency at which flagging is required in Table 618-1.

Where flaggers are not required by Table 618-1, the Contractor may use flaggers and traffic control, with Project Manager approval, at Contractor expense.

Limit the number or locations at which flagging is provided at roadway crossings or entrances to:

1. One location per material or plant site; or
2. The number of locations required by an indicated materials source.

618.03.8 Traffic Control at Drop-off Areas

When existing slopes are 3:1 or flatter, temporarily fill constructed drop-offs within 30 feet (9.2 m) of the edge of travel lanes used by traffic to a 3:1 slope or flatter at the close of work each day. Furnish and install, at Contractor expense, traffic control devices for slopes not temporarily filled to a 3:1 or flatter.

When existing slopes are steeper than 3:1, temporarily fill constructed drop-offs within 30 feet (9.2 m) of the edge of travel lanes used by traffic that matches or is flatter than the existing slope at the close of work each day. Furnish and install at Contractor expense, traffic control devices for slopes not temporarily filled to match, or that are steeper than the existing slope.

Temporary filling of drop-offs protected by positive barriers is not required.

Determine device spacing using the following formula:

$$\text{Factor in Feet (meters)} = \frac{(A \times C \times W)}{(S \times D)}$$

Where:

A = Average Daily Traffic Adjustment

C = Degree of Curvature (metric radius factor)

W = Recoverable Width, 4:1 or flatter, in feet (meters) from the drop-off to the far edge of the adjacent traffic lane(s) with the same direction of traffic

S = Posted Speed in MPH (km/h)

D = Average Drop-off Depth in inches (mm)

Use the C factors in Table 618-2 for drop-offs outside of horizontal curves.

TABLE 618-2

C - FACTORS FOR DROP-OFFS ON THE OUTSIDE OF HORIZONTAL CURVES

DEGREE OF CURVE	C	METRIC RADIUS	C
Less than 2	5800	Greater than 900m	241,000
2 to less than 4	5200	900m to more than 450m	218,000
4 to less than 6	4900	450m to more than 300m	203,000
6 or greater	4500	300m or less	188,00

Use the C - factor for curves with a degree of curve less than 2 (greater then 900 m) for drop-offs on the inside of horizontal curves.

Use the Average Daily Traffic (ADT) adjustment from Table 618-3.

TABLE 618-3

AVERAGE DAILY TRAFFIC ADJUSTMENT FACTOR

ADT	A
Under 750	1.50
750 - 1499	1.30
1500 - 5999	1.00
Over 6000	0.90

Round the computed spacing to the nearest 10 feet (3 m).

Use Table 618-4 to determine the device type using the spacing factor.

TABLE 618-4

TRAFFIC CONTROL DEVICE BASED ON SPACING FACTOR

SPACING FACTOR	DEVICE TYPE
400 feet (122 m) or greater	Flexible guideposts or standard delineators
40 feet (12 m) to 390 feet (119 m)	Type 2 object marker
20 feet (6 m) to 30 feet (9 m)	Type C steady burn warning lights on alternate panels
Less than 20 feet (6 m)	Positive barrier, if 48 hours will lapse before filling

Space devices at the spacing factor. If the recoverable width (W) is less than 14 feet (4 m), do not exceed spacing in feet (m) that is double the posted speed in miles per hour.

Do not space Type 2 object markers less than 40 feet (12 m).

618.03.9 Traffic Control for Paving and Milling Operations

Provide flaggers at paving and milling machines. Locate the flagger 100 feet to 150 feet (30 m to 46 m) upstream from the machines.

Meet the following requirements for night paving operations:

- A. Place a 48-inch x 48-inch (1,220 mm x 1,220 mm) "NIGHT PAVING AHEAD" warning sign in advance of each warning sign series.
- B. Assure all personnel working on or adjacent to traveled lanes are wearing reflectorized vests or reflectorized exterior clothing. The reflectorized area must be at least 50 square inches (32,260 square mm) of material visible from any direction.

618.03.10 Reserved

618.03.11 Traffic Control for Seal Coat Operations

A. Two-lane Two-way and Multiple-lane Two-way Roadways. Place "LOOSE GRAVEL" (W8-7) signs, each with a 30-inch x 30-inch (760 mm x 760 mm) advisory speed plate "35 MPH" (W13-1), at the beginning of each work zone. Place the same sign combination for each direction of travel at 2-mile (3.2 km) intervals within the work zone. Leave the signs in place until all sweeping and pavement markings within the zone are completed.

Control traffic with pilot cars for up to 72 hours. The 72-hour period for each completed section begins once the seal and cover has been placed and rolling is complete. For this work, a section is defined as the area of seal coat completed in each day of production.

Traffic control beyond 72 hours, unless ordered by the Project Manager, is at Contractor expense.

Provide a roadway free of loose cover material. In curb and gutter sections, remove and dispose of all loose cover material. Correct surface irregularities affecting the ride quality at Contractor expense. Remove all loose cover material and place pavement markings (centerline and edge lines) before terminating pilot car use. If pavement markings are not placed within 72 hours of completion of the seal coat work, the Department will have the work performed and deduct the costs from monies due the Contractor.

Apply final pavement markings as specified elsewhere in the contract.

B. Interstate Highways. Use lane closures and lane control devices for seal and cover operations on Interstate highways. Do not use pilot cars unless approved by the Project Manager.

Place "LOOSE GRAVEL" (W8-7) signs, each with a 30-inch x 30-inch (760 mm x 760 mm) advisory speed plate "45 MPH" (W13-1), at the beginning of each work zone. Sign both sides of the roadway.

Remove all loose cover material and place pavement markings (centerline and edge lines) within 72 hours of seal coat completion. If pavement markings are not placed within 72 hours of completion of the seal coat work, the Department will have the work performed and deduct the costs from monies due the Contractor. Apply final pavement markings as specified elsewhere in the contract.

Provide a roadway free of loose cover material. In curb and gutter sections, remove and dispose of all loose cover material. Correct surface irregularities affecting the ride quality at Contractor expense.

Traffic control beyond 72 hours, unless ordered by the Project Manager, is at Contractor expense.

618.03.12 Traffic Control for Striping Operations

Provide the following traffic control for striping operations.

- A.** Furnish a shadow vehicle to follow the pavement striping vehicle within 500 feet to 1,000 feet (152 m to 305 m).
- B.** Equip shadow vehicles with an arrow board facing rear-approaching traffic.
- C.** On multiple-lane roadways, place the arrow board display in the sequential arrow mode (lane shift).
- D.** On two-lane two-way roadways, place the arrow board in a hazard warning mode not displaying the lane-shift mode.
- E.** Furnish and operate a shadow truck equipped with a truck-mounted attenuator meeting the National Cooperative Highway Research Council (NCHRP) 350 standards and the appropriate test level. Use the truck to follow within 150 feet to 300 feet (45 m to 90 m) of

pavement marking removal and application, placing and removing traffic cones that protect the pavement markings. Include all costs associated with this work in the respective bid item.

618.03.13 Traffic Control Device Location and Installation

Lay out the standard distances for traffic control devices to within an accuracy of plus or minus 5 percent. The Project Manager may direct adjustments to the device locations to fit site conditions.

Display all signs with the legend not more than 5 degrees (1 inch per foot) (25 mm per 305 mm) from the horizontal plane.

Display the signs at the required mounting height with the hinged signs closed or non-hinged signs removed when not applicable.

Use only one type of reflective sheeting in each sequence or group of signs or devices.

Stabilize sign trailers to prevent movement by wind or passing vehicles.

Assure the G20-1 ("ROAD CONSTRUCTION NEXT (X) MILES) and G20-2 (END CONSTRUCTION) signs do not conflict with other construction signing. Remove these signs when directed.

Post-mount work zone traffic control devices to remain at the same location for more than three consecutive days. Trailer-mounted W20-7a (flagger ahead) signs with generators are excluded from this requirement.

Install work zone traffic control devices sequentially toward the work area beginning with the device located farthest from the work area. Remove sequentially in the opposite direction.

Use arrow boards in the sequential or flashing-arrow mode to supplement channelizing devices and standard signing when one or more lanes of a multiple-lane roadway are closed.

Do not use arrow boards in the sequential or flashing-arrow mode for lane closures or at flag stations on two-lane two-way roadways.

Do not use flexible guide posts in place of the specified hazard identification devices for shoulder drop-offs or other hazards adjacent to the travel lanes. Refer to Subsection 618.03.8.

Flexible reflectorized warning signs are acceptable for daylight hour use.

Do not use traffic cones for channelization devices.

Do not use steel barrels for work zone traffic control.

Ensure that construction zone and work zone speed limits signs comply with the desired minimum speed limit values in Table 618-5. The Project Manager may direct adjustments to the speed limits or device locations to fit the conditions.

Submit a written recommendation if the Contractor's proposed limits differ from those in Table 618-5. Give the locations and reasons for limits differing from those provided in Table 618-5. Reasons should be based upon the conditions of the roadway and the ability of traffic to flow safely and uniformly through the construction zone or activity area. The Project Manager will provide a written response to the recommendation, detailing the speed limit signs to be used.

**TABLE 618-5
TRAFFIC CONTROL SPEED LIMITS IN CONSTRUCTION ZONES**

SPEED LIMIT	ACTIVITY DESCRIPTION
Normal Limit	Construction activities are 30 feet (9.2 m) beyond the edge of the traveled way and construction vehicles are not crossing the traveled way.
65 mph	Two way traffic on Interstates.
45 mph	Two and four-lane roadways with construction activity adjacent to roadway but not encroaching on the roadway surface (shoulders and driving lanes).
35 mph	Seal and cover for two-lane two-way and multiple-lane two-way roadways.
35 mph	Four-lane roadways with construction activity in one lane or two-lane roadways with activity on the shoulders (only applies within construction activity areas).
45 mph	Seal and cover for Interstate.
35 mph	Paved roadways with a short temporary detour over a gravel surface. This speed limit only applies within detour areas. The design speed of the detour geometrics should be at least 35 mph.
35 mph	In advance of flagging stations.
25 mph	Two or four-lane roadways in an urban area with construction activity in a lane.
25 mph	Survey crew activity when survey crew has to occupy a portion of the traveled way.
35 mph	Survey crew activity requires occupying a portion of the shoulder. This speed limit only applies within the survey activity areas.
Normal Limit	Survey crew activities are not on the highway or parking shoulder.

618.03.14 Flagging Operations

Provide flaggers that are currently certified by the Montana flagger training program, the ATSSA flagger program, or Idaho, Oregon, or Washington state flagger training programs.

Provide flaggers that are competent and equipped as required in the Department's booklet "Flaggers Handbook" furnished by the Department.

Maintain constant radio contact between flaggers at each end of a work zone and pilot vehicles when visual contact is not possible. Use two-way V.H.F. or U.H.F. FM radios, operable in the terrain.

Place the W20-7a (flagger ahead) warning sign signals so they are visible 2,000 feet (610 m) in advance of the sign. Place and operate the sign only when a flagger is at the flag station.

Use reflectorized flagger devices and garments for night work. Furnish lighting that makes the flaggers clearly visible from 500 feet (153 m).

Provide a second flagger when more than 10 vehicles are stopped at a flag station 50 percent of the time to advise traffic of the delay. Place an additional W20-7a sign 500 feet to 1,000 feet (153 m to 305 m) ahead of the average end of the stopped vehicle line.

618.03.15 Pilot Car Operations

Use pilot cars as specified. Equip the cars with amber flashing lights, flags, and the G20-4 sign designated in Part VI of the MUTCD. Mount the sign in a conspicuous position on the vehicle with the bottom sign edge at least 6 feet (1.8 m) above the ground.

Schedule and cycle pilot vehicles to depart each flag station at maximum 15-minute intervals.

618.03.16 Water for Dust Control

Furnish, haul, and apply dust control of water using tank trucks equipped with spray systems that uniformly distributes the water over the application area. Discontinue watering as directed.

618.04 METHOD OF MEASUREMENT

The estimated contract quantities for traffic control devices, temporary pavement markings, flagging, and pilot car operation are an estimate only and may vary from the actual quantities used or required in the contract. No additional compensation is considered or allowed due to these quantity differences.

618.04.1 Traffic Control Devices

Traffic control devices are measured by the units of traffic control devices used and accepted. A unit of traffic control device is the base value used for establishing the relative value of each type of traffic control device. The relative value of each traffic control device in units is shown in the "Traffic Control Rate Schedule" included in the contract.

Signs and devices must be in new or like-new condition to be measured for payment.

618.04.2 Reserved**618.04.3 Flagging**

Flagging is measured by the hour for the actual number of approved flagging hours provided on the project for each flagger used.

Travel time for flaggers to and from the project is not measured for payment.

618.04.4 Pilot Car Operation

Pilot car operation is measured by the hour for the approved number of hours of operation for each properly equipped pilot car.

618.04.5 Water for Dust Control

Dust control water is measured by the 1000 gallon (1 KL) unit used and accepted.

Measurement will be by an approved meter, load counter or by manual count of the number of loads of a known quantity applied on the roadway.

No measurement is made of water used other than for dust control for environmental compliance and convenience for the traveling public.

618.04.6 Items Not Eligible for Separate Payment

The following items are not measured or paid for separately:

- Amber flashing or strobe lights on equipment, vehicles, and hauling units;
- Impact attenuators for median barrier openings;
- Permits and costs relating to project access;
- Construction, drainage, maintenance, removal, restoration and reseeded of areas used for temporary roads, approaches, and crossovers;
- Radios for flaggers and pilot vehicles;
- Illumination of flag stations and work areas;
- Reflectorized safety equipment, garments, and headgear;
- Vehicle-mounted arrow boards on stripers and shadow vehicles;
- Replacing temporary pavement marking tabs and tape destroyed by traffic;
- Temporary pavement marking tabs used for seal coat operations;
- Costs to clean and maintain installed traffic control devices;
- Covering or removing non-applicable signs or signs not in use; and

- Other miscellaneous materials and equipment required for proper traffic control that are not included in the "Traffic Control Rate Schedule".

618.05 BASIS OF PAYMENT

618.05.1 Traffic Control Devices

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Traffic Control Devices	Unit
Temporary Pavement Markings	Mile (kilometer)

Traffic control devices are paid for at the contract unit price per unit of traffic control devices. The units of each type of traffic control device paid for are calculated by multiplying the measured quantity of each device by the value per each unit shown in the traffic control rate schedule.

Traffic control devices are bid competitively. If the actual quantities required for traffic control devices exceed the plan quantity on the project by more than 15 percent, the price paid per unit for all quantities that exceed 115 percent of plan quantity will be the lesser of the contract unit price or \$0.80.

Payment for traffic control devices is made for each setup directed by the Project Manager. The following devices are not eligible for payment:

1. Devices placed beyond 1,500 feet (458 meters) of the work termination point for that day.
2. Adjustments or moving of devices that were initially installed improperly.
3. Adjustments or moving of devices for the convenience of the Contractor.

Replacing properly installed traffic control devices destroyed by traffic is paid for at the contract unit price per unit of traffic control devices.

Payment for barricades and drums includes the required ballast.

Payment for signs mounted on barricades is made only for the original mounting.

Payment for flashing arrow boards is made only for the actual hours of operation approved by the Project Manager. Payment includes the cost of operating the trucks or trailers on which the arrow boards are mounted.

Paint stripe removal is paid for at the contract unit price per unit of traffic control devices.

Store devices in approved staging areas with a maximum of one staging area per three-mile segment of roadway. Detail the staging areas in the traffic control plan submitted for the Project Manager's approval. All devices not stored in the approved staging areas will be paid for at category #2 payment amounts and all portable signs not stored in approved staging areas will be paid for at 50 percent of the contract unit price.

Payment for traffic control devices will be made under one of the following two categories:

1. **Category #1 - Standard Installation.** The initial setup for the project or a new operation, or the moving of a device, and the setup of the device requires it be loaded in a truck (vehicle) or hitched to a truck (vehicle) for moving to a new location.
2. **Category #2 - Adjustments.** The manual moving of a device conducted by dragging, carrying, etc. of the device required to move it to a new location of a traffic control operation.

Payment for traffic control devices will be paid for at the rates listed in Table 618-6 according to the category and device type.

TABLE 618-6
TRAFFIC CONTROL RATES BASED ON CATEGORY AND DEVICE TYPE

CATEGORY #	DEVICE	PAYMENT AMOUNT PERCENT
1	Flexible Guide Post	100
1	Barrels	100
1	Portable Signs	100
1	Type III Barricades	100
1	Portable Vertical Panels	100
1	Other	100
2	Flexible Guide Posts	50
2	Barrels	50
2	Type III Barricades	25
2	Portable Vertical Panels	50
2	Other	50

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 619
SIGNS, DELINEATORS, AND GUIDEPOSTS

619.01 DESCRIPTION

This work is furnishing, fabricating, erecting, removing, and resetting signs, delineators, and guideposts.

619.02 MATERIALS

Furnish materials meeting the Detailed Drawings and the following Subsection requirements:

Signing Material	704.01
Guideposts.....	704.03
Delineators.....	Detailed Drawings

619.03 CONSTRUCTION REQUIREMENTS

619.03.1 Definitions

The following definitions apply to the signing work in the contract.

- A. New.** Signs designated "New" are to be furnished new and erected on new supports at the specified locations.
- B. Reuse.** Signs designated "Reuse" are to be removed from the existing supports and remounted on new supports at the specified locations.
- C. Replace.** Signs designated "Replace" are to be removed and replaced with the specified new signs, including new supports, at the existing or specified new locations.
- D. Replace Sign Face.** Signs designated "Replace Sign Face" are to be removed from the supports and replaced with the specified new signs using the existing supports.
- E. Use As Is.** Signs designated "Use As Is" are to be left in place.
- F. Reset.** Signs designated "Reset" are to be removed and reset at the specified locations using the existing sign faces and supports.
- G. Remove.** Signs designated "Remove" are to be removed, including the sign or sign assembly and sign supports.

619.03.2 Design Calculations and Shop Drawings

The Department will furnish the sign design calculations for the project at the pre-construction conference. The furnished sign design calculations must include the calculations for the specified guide signs, special design signs, and other signs shown in the Montana Sign and Sign Materials book but not include those signs in the FHWA Standard Highway Signs Book.

Submit Contractor approved (stamped) shop drawings and welding procedures for sign bridges, and overhead cantilever sign structures. Submit shop drawings on minimum size 11-inch x 17-inch sheets (A3 paper); welding procedures on 8 1/2-inch x 11-inch (A4 paper) sheets.

The Department has 15 working days upon receipt of the drawings for drawing review. Drawings returned to the Contractor for corrections or additional information must be re-submitted within 15 working days of receipt.

After the structural steel shop drawings and welding procedures have been reviewed and checked by the Department, all required corrections will be returned to the Contractor who must make the corrections and re-submit ten copies of the corrected drawings and welding procedures for final review and approval within 15 days. All final drawings must be stamped "Approved" by the Department before fabrication begins.

Submit shop drawings and current approved weld procedures for tubular sign posts and structural steel sign posts.

The Department Inspector will compare the drawings and weld procedures to the posts during post inspection at the point of fabrication. Submit weld procedures for approval every six months or whenever they are changed or modified.

Submit shop drawings and welding procedures at one time in a complete package for the Department's initial and subsequent reviews. Individual parts of the submittals will not be accepted for review.

619.03.3 Fabrication and Erection

Fabricate the signs and sign legends before delivery to the project, except for signs too large to transport in one piece to the project.

Fabricate all signs using the hole spacing specified in the FHWA Standard Highway Signs Book or the Detailed Drawings.

The lengths of poles and steel posts shown in the contract are estimated lengths. The Project Manager will furnish the required length of each pole and steel post prior to fabrication.

Locate and erect signs as specified or directed. The Project Manager may change sign locations due to field conditions. Erect signs so the sign face is vertical and aligned as specified. Sign supports must not project above the sign faces.

Submit two copies of the manufacturers installation instructions for all sign post breakaway devices installed on the project to the Project Manager at least 15 calendar days prior to installation.

After the sign is installed and adjustments are made, jam the threads of the mounting bolts or use vandal resistant nuts for ground-mounted sign faces 25 square feet (2.3 square meters) and smaller.

The specified foundation depth for timber poles is a minimum depth. Field cut the poles to the correct length or bury the extra length to provide the specified mounting.

Excavate or bore foundation holes for sign supports at least 8 inches (205 mm) larger than the largest diameter of post placed in each hole.

Backfill foundation holes for timber posts and poles as follows:

- Combine and thoroughly mix the material excavated from the foundation with portland cement using a mix ratio of 10 parts excavated material to 1 part cement.
- Do not mix in the hole. Add water to make the soil-cement mixture.
- Place the sign post or pole in the hole without the sign attached.
- Backfill the hole with the soil-cement mixture in 8-inch (205 mm) maximum lifts.
- Compact each lift by hand tamping or using mechanical methods.
- Allow the foundation to cure for seven days before mounting the sign face to the support.

Foundation holes for wooden sign supports may be backfilled with Class "F" portland cement concrete using the specifications for backfilling foundations for steel sign posts as follows.

Backfill foundations for steel sign posts with Class "A" or "D" concrete finished flush with the adjacent surface. Signs may be post mounted after the concrete has set seven days.

Weld metal joints and post breaks meeting Section 556 requirements.

619.03.4 Inspection

The completed signs will be inspected at the fabricator's plant and on the project before they are installed. Defects including but not limited to cracks, tears, splits, crazing, gouges or curled edges of the background sheeting or legend are cause for rejecting the sign. The installed signs

will be inspected at night for nighttime reflectivity and readability. Adjust signs exhibiting specular reflection, as directed.

619.03.5 Sheet Aluminum Overlay

Meet the contract requirements for sheet aluminum overlays.

Install the sign legend and other components plumb and level. Match the color, shade, and type of existing reflective sheeting used as a background for partial overlays. Fully cover the existing legend and symbols with partial overlay backgrounds. Match the size of the existing sign with complete overlay backgrounds.

619.03.6 Replace, Reuse, and Reset Signs

Use new materials meeting Section 704 requirements for that required over and above those materials salvaged from signs to be reset or reused.

Install breakaway devices on existing posts when specified.

Reset signs meeting Subsection 619.03.3 requirements.

Repair or replace all Contractor sign damage resulting from dismantling, moving, and resetting at Contractor expense.

With no exception, remount or reset within one hour all removed warning, regulatory signs and route markers. Re-install guide signs within five hours and only during daylight hours. Re-display warning, regulatory, and guide signs by dusk.

Remove foundation material left after removing the existing signs to at least 1 foot (305 mm) below groundline. Fill resulting holes level with the adjacent ground.

Existing signs and supports specified for removal are the Contractor's property. Disassemble and store signs specified to remain the Department's property at the designated location.

Erect the new sign and support before removing the existing sign being replaced. Do not display conflicting signs together. Do not obscure existing signs when placing new signs.

Re-erect existing multiple support signs to be removed and reset using the original post spacing.

619.03.7 Installation Date Tags and Route Markers

Install date tags and route identification tags on all highway signs before final acceptance.

Meet the contract requirements for design, color, and installation.

619.03.8 Delineators

Furnish and install new delineators at the locations specified and marked by the Project Manager. Remove delineators conflicting with new construction as specified.

Removed delineators are the Contractor's property.

619.03.9 Guideposts

Install guideposts at the specified locations.

619.03.10 Acceptance

Signs and traffic guide devices are accepted for payment individually or in lots as completed work once installed.

Delineator posts with reflectors are accepted in lots of 100 or more units.

Guide, directional, and warning signs with a surface area of up to 10 square feet (0.93 square meters) on one side are accepted in lots of 25 or more.

Signs with a surface area of up to 30 square feet (2.8 square meters) on one side are accepted in lots of five or more.

Overhead structures and signs larger than 30 square feet (2.8 square meters) in sheeting area are accepted individually.

The Department will assume maintenance responsibility for signs and other traffic guide devices once accepted and in place.

Repair or replace signs and devices, at Contractor expense, that are damaged or destroyed by the Contractor's operations.

619.03.11 Permanent Barricade

Furnish and install permanent barricades as specified and shown in the Detailed Drawings.

619.04 METHOD OF MEASUREMENT

619.04.1 Aluminum and Plywood Signs

Aluminum sheet, aluminum sheet increment, and plywood signs are measured by the square foot (square meter) to the nearest 0.1 square foot (0.1 square meter) of sign face.

619.04.2 Metal Posts

Metal posts are measured by the pound (kilogram). The pay weight is calculated by multiplying the nominal weight per foot (meter) by the installed length of each post from the top of the breakaway device up.

If there is no breakaway system bid item, include in the post weight the breakaway device, fuse plate, and stub post including the embedment length.

Breakaway systems, bid as a separate item, are measured per each and include the breakaway device, fuse plate, and stub post including the embedded length.

619.04.3 Treated Timber Poles and Posts

Treated timber poles and posts are measured by the foot (meter) in even 2-foot (610 mm) increments. When the measurement falls between increments, the measured length for payment is the next higher 2-foot (610 mm) increment.

619.04.4 Delineators and Reference Markers

Delineators and reference markers of each type specified are measured by the unit and include the reflector, reference sign, mounting hardware, and post, complete in place.

Removal of the existing delineators and reference markers is not measured for payment.

619.04.5 Guideposts

Guideposts of each type specified are measured by the unit.

619.04.6 Reset Signs

Guide and reset signs - warning, regulatory, and route markers are measured by the unit for each sign removed and reset in a new location.

Sign groups of two or more signs mounted on a single support or multiple supports are measured as a single sign.

When there is not a bid item in the contract for reset sign, this work is incidental to other items of the contract.

619.04.7 Remove Signs

Remove signs - guide and remove signs - warning, regulatory, and route markers are measured by the unit for each sign removed including supports.

Sign groups of two or more signs mounted on a single support or multiple supports are measured as a single sign.

619.04.8 Replace Signs

New materials for signs designated "Replace" are measured under Subsections 619.04.1, 619.04.2, and 619.04.3.

Removal of existing signs designated "Replace" are measured under Subsection 619.04.7.

New materials for signs designated "Replace Sign Face" are measured under Subsection 619.04.1.

619.04.9 Reuse Signs

New material for supports for signs designated "Reuse" is measured under Subsections 619.04.2 and 619.04.3.

Removal of existing signs designated "Reuse" is measured under Subsection 619.04.7.

619.04.10 Sheet Aluminum Overlay

Sheet aluminum for signs designated "Sheet Aluminum Overlay" is measured by the square foot (square meter) to the nearest 0.1 square foot (0.1 square meter) of sign face complete in place.

619.04.11 Lump Sum Basis

When a signing system or portion thereof is specified in the contract on a lump sum basis, the system is measured by the lump sum.

619.04.12 Permanent Barricade

Permanent barricade, as shown in the Detailed Drawings, is measured by the foot (meter) of the barricade width and includes all materials for the barricade.

619.05 BASIS OF PAYMENT

Payment for the completed and accepted work is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Aluminum and Plywood Signs	Square Foot (square meter)
Metal Sign Post	Pound (kilogram)
Breakaway System	Each
Timber Sign Post	Foot (meter)
Delineator and Reference Markers	Each
Guideposts	Each
Reset Signs	Each
Remove Signs	Each
Sheet Aluminum Overlay	Square Foot (square meter)
Sign System	Lump Sum
Permanent Barricade	Foot (meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work, including excavation and backfill, concrete foundation, miscellaneous hardware, welding, date tag and route identification tags and installation under the contract.

SECTION 620
PAVEMENT MARKING APPLICATION

620.01 DESCRIPTION

This work is the application of temporary, interim and final pavement markings.

Temporary pavement markings consist of the centerline markings for two-lane two-way roadways; lane line markings for divided four-lane two-way Interstates, and centerlines and lane lines for two-way undivided three or more lane urban roadways. Divided roadways are roadways where the paved surface for each direction of travel is physically separated by an unpaved section.

Interim pavement markings consist of all longitudinal pavement markings (centerlines, edge lines (shoulder lines), lane lines, etc.) and words and symbols identical to the final pavement marking configuration.

620.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Temporary Pavement Marking Tape	714.01
Preformed Plastic Pavement Marking Material.....	714.03
Temp and Interim Traffic Paint.....	714.04
Epoxy Pavement Marking	714.08
Reflective Glass Beads.....	714.05
Reflective Thermoplastic Pavement Markings.....	714.06

Furnish hot inlaid hydrocarbon-based thermoplastic for all plastic pavement marking bid items unless otherwise specified.

620.03 CONSTRUCTION REQUIREMENTS

620.03.1 General

Furnish a manufacturer's material certification. Do not apply materials that do not meet the contract requirements. The Project Manager may request a manufacturer's sample or take field samples for testing. Furnish a material sample weighing at least 2 pounds (0.91 kg). Provide five calendar days advance notice before striping work begins.

620.03.2 Layout of Pavement Markings

Be responsible for establishing all horizontal controls for line placement. The Project Manager will check the layout of the final striping before placement begins.

Establish and maintain pavement marking control lines within 0.25 feet (75 mm) of the true line.

Apply the centerline and shoulder lines within 0.30 feet (90 mm) of the true line. Ensure the stripe does not deviate by more than 0.15 foot (50 mm) in 500 feet (152 m).

The Project Manager will select a random location for each mile to check accuracy of the applied markings.

Remove and replace out of specification pavement markings as directed at Contractor expense.

620.03.3 Temporary and Interim Pavement Markings

A. Materials. Furnish materials meeting Subsection 714.04 requirements.

B. Equipment. Use equipment manufactured to apply the material type. Ensure the equipment prevents paint spray or bead loss outside the specified line width. Equip the

pavement-marking machine with a flow meter and totalizer that measures paint quantities in gallons (liters), to the nearest 0.1 gallon (0.1 L). Calibrate the flow meter before use on the project and when directed. Locate the flow meter in the flow line to the spray nozzles. Locate the totalizer where it can be easily read. Ensure the calibration adjustment is accessible without meter removal or using a calibration adjustment device.

Marking material quantities will be verified by measuring equipment's calibrated paint tank(s) and the tank manufacturer's measuring device. The Project Manager will visually witness tank stabs at the beginning and end of each work shift, any time additional paint is added to the tank, at the beginning and end of each route/road segment on contracts with multiple route/road segments, at the beginning and end of each certified paint lot, and at other intervals as necessary. In the event that there is a difference between the totalizer and tank stab measurements, the lesser quantity will be used for payment.

Submit calibration certificates from an independent agent for the paint tank. Re-certify the tank at the beginning of each year before using the equipment on Department contracts. The Project Manager may inspect the tank before each use and as determined necessary.

Stop bars, crosswalks, and symbols may be applied with hand-operated equipment.

Terminate marking application when the equipment fails to apply the markings meeting the contract requirements. Make equipment adjustments and resume striping.

- C. Surface Preparation and Weather Limitation.** Clean the surface to be painted meeting the paint manufacturer's recommendations. Inform the Project Manager and modify, when required, the surface preparation to ensure optimal bonding of the marking to the surface and to provide the specified marking requirements.

Apply the material following the paint manufacturer's recommendations.

Apply pavement markings during daylight hours only. Obtain approval to apply pavement markings any other time.

- D. Application.** Apply the markings to within $\pm 1/4$ inch (6 mm) of the specified width.

- 1. Temporary Pavement Markings.** Apply a 10 mil \pm 1 mil (0.254 mm \pm 0.025 mm) thick wet film immediately followed by applying at least 6 lbs/gallon (0.72 kg/L) of glass beads to temporary pavement markings on all sections of newly constructed pavement before opening to traffic. This includes detours, transitions, and all pavement lifts open to traffic. Temporary pavement markings may be used for a maximum 10 calendar days on pavements under traffic.

Remove, at Contractor expense, all temporary pavement markings that conflict with interim or final pavement markings. Remove conflicting temporary stripe(s) the same day the interim or final markings are applied.

- 2. Interim Pavement Markings.** Apply a 16 mil \pm 1 mil (0.406 mm \pm 0.025 mm) thick wet film immediately followed by applying at least 8 lbs/gallon (0.96 kg/L) of glass beads. Apply interim pavement markings no later than 10 calendar days after the application of temporary pavement markings.

Stripe newly constructed pavements, including partially completed sections. Apply the interim pavement markings matching the final pavement marking configurations and locations. Interim pavement markings placed prior to chip seal may be offset as approved by the Project Manager.

The Project Manager will suspend all remaining contract work if the interim striping is not applied within the time specified above.

620.03.4 Pavement Marking Tape

Furnish Materials meeting subsection 714.01. Follow the tape manufacturer's recommendations for road surface preparation and installation. Install the tape meeting the contract requirements.

620.03.5 Preformed Plastic Pavement Marking Materials

Apply pavement markings up to 8 inches (205 mm) wide in a single application to the specified width. Apply pavement markings over 8 inches (205 mm) wide in 6-inch or 8-inch (155 or 205 mm) multiple applications and minimum fractional 4-inch (100 mm) applications.

Apply the marking material at the thickness specified in the contract.

Cut and true the marking material edges.

Apply inlaid plastic pavement marking materials into the new asphalt pavement just before final compaction and roll it flush with the roadway surface during the final plant mix compaction.

620.03.6 Epoxy Pavement Markings

A. Materials. Furnish Materials meeting Subsection 714.08 requirements.

B. Equipment. Ensure the epoxy application equipment accurately meters the two components and produces and maintains the mixing head temperature, all meeting the epoxy manufacturer's specifications. Ensure the application equipment is acceptable to the marking manufacturer.

Use equipment manufactured to apply the material type. Ensure the equipment prevents paint spray or bead loss outside the specified line width. Equip the pavement-marking machine with a flow meter and totalizer that measures paint quantities in gallons (liters), to the nearest 0.1 gallon (0.1 L). Calibrate the flow meter before use on the project and when directed. Locate the flow meter in the flow line to the spray nozzles. Locate the totalizer where it can be easily read. Ensure the calibration adjustment is accessible without meter removal or using a calibration adjustment device.

Marking material quantities will be verified by measuring equipment's calibrated paint tank(s) and the tank manufacturer's measuring device. The Project Manager will visually witness tank stabs at the beginning and end of each work shift, any time additional paint is added to the tank, at the beginning and end of each route/road segment on contracts with multiple route/road segments, at the beginning and end of each certified paint lot, and at other intervals as necessary. In the event that there is a difference between the totalizer and tank stab measurements, the lesser quantity will be used for payment.

Submit calibration certificates from an independent agent for the paint tank. Re-certify the tank at the beginning of each year before using the equipment on Department contracts. The Project Manager may inspect the tank before each use and as determined necessary.

Stop bars, crosswalks, and symbols may be applied with hand-operated equipment.

Terminate marking application when the equipment fails to apply the markings meeting the contract requirements. Make equipment adjustments and resume striping.

C. Surface Preparation and Weather Limitation.

1. General. Clean the surface to be painted meeting the paint manufacturer's recommendations. Inform the Project Manager and modify, when required, the surface preparation to ensure optimal bonding of the marking to the surface and to provide the specified marking requirements.

Apply pavement markings during daylight hours only. Obtain approval to apply pavement markings any other time.

Grind all surfaces within 10 calendar days before applying the pavement marking.

Grinding is surface abrasion 30 mils \pm 10 mils (0.762 mm \pm 0.254 mm) deep to provide a roughened surface free of loose paint chips, loose seal aggregate and surface debris. Removal depth is measured vertically, from the bottom of a three-foot (0.92 meter) or longer straight edge placed on the roadway surface, to the ground surface. Immediately stop grinding if the depth exceeds 40 mils (1.016 mm) and make adjustments to meet the specified grind depth.

2. **Concrete Surfaces.** Prepare existing concrete surfaces meeting (1) above. Grind concrete surfaces 20 mils \pm 10 mils (0.508 mm \pm 0.254 mm) deep to provide a roughened surface free of loose paint chips and surface debris. Do not grind and apply pavement markings on concrete until 15 calendar days after new concrete has been placed.
3. **Removal Limits.** Meet the following removal limits:
 - Do not grind more than 1 inch wider (25 mm) than the existing stripe.
 - Do not grind more than 4 inches (100 mm) from the beginning or end of the stripe being removed.
4. **Disposal.** Collect and dispose of all removed material and new traffic marking materials spilled during the work. Process, handle, transport, and dispose of the materials meeting the current applicable solid waste laws and regulations.

D. Application.

1. Apply epoxy pavement markings a minimum of 30 calendar days, and a maximum of 45 calendar days, after seal coat operations through sweeping are completed. When epoxy pavement markings are the only remaining item of work on the project, contract time assessment will be suspended until either, beginning epoxy pavement marking application, or 45 calendar days elapse after seal coat operations are completed.
2. Submit a copy of the manufacturer's instructions for surface preparation and material application.

Include in the instructions:

- Equipment Requirements
- Approved Work Methods and Procedures
- Material Application Range
- Ambient & Surface Temperature Requirements
- Weather Limitations
- Precautions
- All other requirements for successful application and material performance.

Do not place materials before furnishing complete instructions to the Project Manager.

Apply a 20-mil \pm 2 mil (0.508 mm \pm 0.051 mm) thick wet film immediately followed by applying at least 25 lbs/gallon (3 kg/L) of glass beads to the epoxy.

Immediately terminate striping application if the applied stripe(s) are less than 18 mils thick. Grind all 18-mil and thinner striping meeting Subsection 620.03.6(C) and replace the striping meeting the contract requirements at Contractor expense. Correct all deficient striping before continuing with the remaining striping work. The Project Manager will identify deficient stripe thickness by comparing the tank quantities measured and used against the length, width, and application rate of the applied stripe.

Apply the epoxy pavement marking material when the pavement is dry and the ambient temperature is 40 °F (4.4 °C) and rising or follow the manufactures surface and temperature requirements, whichever is more restrictive.

Match the existing pavement marking configuration unless otherwise specified or directed.

- E. Marking Protection.** Furnish all traffic control necessary to protect the new stripe until it does not track. Include the traffic control costs in the contract unit price of the pavement marking.

620.03.7 Thermoplastic Pavement Marking

- A. General.** The applicable requirements of Subsection 620.03.1 apply to placing thermoplastic marking material.

- B. Material Acceptance.** Furnish a copy of the manufacturer's product specification data.

Do not place materials before furnishing complete specifications.

Do not apply materials not meeting the contract requirements.

The Project Manager may request a manufacturer's sample or take field samples at the point of application for testing.

The Department may test samples for one or any combination of the specified requirements.

Remove and replace material represented by failing samples at Contractor expense.

- C. Manufacturer's Instructions.** Submit the manufacturer's instructions for surface preparation and material application.

Include the following:

- Equipment Requirements;
- Work Methods and Procedures;
- Material Application Temperature Range;
- Ambient and Surface Temperature Requirements;
- Weather limitations;
- Precautions; and
- All other requirements necessary for successful application and satisfactory performance.

Do not place materials before furnishing complete instructions to the Project Manager.

- D. Surface and Temperature Requirements.** Prepare the surface before application and apply the marking material meeting the manufacturer's recommendations.

Meet the following unless otherwise recommended by the manufacturer:

1. Apply the material when ambient air and pavement surface temperature is at least 60 °F (16 °C).
2. Ensure the pavement surface, including grooved pavement for inlay applications, is dry during application.

The Inspector will perform a visual sight and touch inspection to ensure the surface is free of moisture. If a question exists concerning the pavement dryness, the following test may be performed. Tape a piece of aluminum foil, roofing paper, or clear plastic wrap to the pavement surface. Wait approximately 15 minutes. Do not apply markings if moisture appears beneath the material.

- E. Temperature Monitoring and Heating Equipment.** Equip melting and application equipment for marking material with permanently attached, easily read thermometers that provide a true, continuous, representative temperature of the material.

Use a heating kettle that provides indirect heat to melt the marking material.

Ensure the pre-melting kettles have rotating agitators that stir the marking material during heating.

- F. Surface Preparation.** Follow the manufacturer's surface preparation instructions.
- G. Primer/Sealer.** Follow the pavement marking manufacturer's recommendations for primer/sealer application. If no recommendations are made, apply a thin, uniform coat of SS-1 or CSS-1 on the pavement surface and grooved areas before applying the pavement marking. Insure the emulsion has broken before application of the pavement markings.
- H. Application.** Apply thermoplastic pavement markings a minimum of 30 calendar days, and a maximum of 45 calendar days, after seal coat operations through sweeping are completed. When thermoplastic pavement markings are the only remaining item of work on the project, contract time assessment will be suspended until either, beginning thermoplastic pavement marking application, or 45 calendar days elapse after seal coat operations are completed.

**TABLE 620-1
THICKNESS OF INLAID THERMOPLASTIC MARKINGS**

THICKNESS	
400 Mils (10 mm)	275 Mils (7 mm)
Words and Symbols	Median Borders
Crosswalks	Continuous Centerline
Stop Bars	Dashed Centerline
8" White Lane Lines	Dashed Lane Lines
Dotted or Skip Lines	Shoulder Lines

Produce thermoplastic markings having straight and uniform edges that adhere to the pavement.

Finish the extruded lines, including words and symbols at least 1/4 inch (6 mm) wider than the groove widths at each edge and within the ranges shown in Table 620-2.

**TABLE 620-2
ALLOWABLE MARKING WIDTH/GROOVE WIDTH
TOLERANCE RANGES**

SPECIFIED WIDTH inches (mm)	GROOVE WIDTH inches (mm)	FINISHED MARKING WIDTH ¹ inches (mm)
4 (100)	3 1/2-4 (90-100)	4-4 1/2 (100-115)
8 (205)	7 1/2-8 (190-205)	8-8 1/2 (205-215)
24 (610)	23 1/2-24 (600-610)	24-25 1/2 (610-650)

Notes:

1. Ensure the finished marking does not exceed 1/4-inch (6 mm) wider than the finished width.

Match the FHWA manual "Standard Alphabets For Highway Signs and Pavement Markings" for words and symbols. Produce the markings within 1/4 inch (6 mm) per 4 inches (100 mm) of width.

Use templates to extrude words and symbols that are larger than the grooves and meet the tolerance ranges in Table 620-2 to provide the required edge sealing.

Clean the grooves before placing the thermoplastic material. Meet the surface requirements in Subsection 620.03.5(D).

Apply thermoplastic material in grooves within 24 hours of grooving.

Keep traffic out the grooves and re-clean them as necessary before applying the thermoplastic material.

- I. Glass Bead Application.** Apply glass beads by drop-on methods immediately after the thermoplastic material application meeting Subsection 620.03.5(H) requirements.

Apply glass beads using at least 6 pounds per 100 square feet (0.30 kg per square meter) of thermoplastic material. The Project Manager may increase the glass bead application rate.

- J. Marking Protection.** Protect the thermoplastic pavement markings from traffic until it has set as specified in Article 4.3.2 of AASHTO M 249.

- K. Markings - Dimensional Tolerances.** Finish the markings to the specified minimum cross sectional hardened thickness.

Trim lines, words, and symbols to produce sharp, neat lines on all sides and ends.

Meet a linear tolerance of plus or minus 6 inches (155 mm) over each cycle on specified broken-line patterns.

Meet Table 620-2 tolerances for finished line widths.

- L. Joints.** Meet the following requirements for joints in the finished extruded thermoplastic markings:

1. Extrude transverse markings full width with a maximum of one transverse joint per length of line.
2. Apply words and symbols free of joints within each symbol, letter, or numeral. Letters made with one or more straight legs (A, L, N, T, etc.) and combination arrows (through and right or through and left, etc.) may be applied with one pass per leg. Combination arrows may be applied with one pass for each arrowhead of the marking.
3. Extrude 4-inch and 8-inch (100 mm and 205 mm) longitudinal lines full width in one pass with no transverse joints. Transverse joints are acceptable only for lines exceeding 100 feet (30.5 m) in length and lines shorter than 100 feet (30.5 m) that require a change of direction in the application equipments path.
4. Extrude lines 24 inches (610 mm) wide full width in one pass with a maximum of one transverse joint per length of line.

Finish joints to form neat lines without gaps or unevenness and that are moisture proof.

- M. Patching and Repairing.** Use material from the same batch of thermoplastic material used in the original work. The patching or repair may be performed mechanically or manually. Re-apply the beads as specified. Meet all specified dimensional tolerances and match the original lines.

- N. Cleaning and Trimming of Markings.** Remove irregularities in finished markings without chipping, cracking, or other damage to the markings or causing delaminations or separations between the pavement and marking material. Follow the manufacture's recommendations for marking cleaning and trimming. Do not damage the pavement or thermoplastic material.

620.03.8 Pavement Marking on Concrete Curbs

Clean the concrete surfaces meeting the paint manufacturer's recommendations. Do not apply pavement markings on concrete until 15 calendar days after the concrete has been placed.

Paint the tops and traffic sides of curbs at restricted parking locations as specified.

Apply yellow pavement markings to the tops and traffic sides of all island curbs, median curbs, and other similar curbs.

For estimating purposes, 100 feet (30.5 m) of curbing equals approximately 115 square feet (10.7 square meters) of curb surface to be painted.

620.03.9 Marking Protection

Protect markings until dry. Correct smeared or damaged markings at Contractor expense.

620.03.10 Pavement Marking Removal

Remove existing temporary and final pavement markings using any of the following:

- Sand blasting with air or water;
- High-pressure water;
- Steam or super-heated water; or
- Mechanically grinding, sanding, scraping, brushing.

Submit the method or methods to be used. The Contractor may submit written proposals for other removal methods. An approved method may be subsequently disapproved if it damages the marking surface or inadequately removes existing markings.

Remove sand or other material on the surface left by the removal as the work progresses.

Satisfactorily repair surfaces damaged by marking removal at Contractor expense.

620.04 METHOD OF MEASUREMENT

620.04.1 Temporary and Interim Pavement Marking Quantities

Temporary pavement markings are measured by the mile (kilometer) to the nearest 0.1 mile (0.1 kilometer).

Interim pavement markings are measured by the gallon (liter) to the nearest whole gallon (liter).

Only those pavement markings represented by a Manufacturer's Material Certification at the time of application, and actually used and witnessed on the project are eligible for payment.

620.04.2 Epoxy Pavement Markings

Epoxy pavement markings are measured by the gallon (liter) to the nearest whole gallon (liter). Only those pavement markings represented by a Manufacturer's Material Certification at the time of application, and actually used and witnessed on the project are eligible for payment.

Should the actual quantity measured by the Project Manager using tank stabs or totalizer exceed the quantity calculated using an application rate of 22 mils times the width and length of line applied, the lesser quantity will be paid for.

620.04.3 Preformed Plastic and Thermoplastic Pavement Markings

Preformed plastic and thermoplastic pavement striping are measured by the foot (meter) to the nearest 0.1 foot (0.1 meter).

Words and symbols are measured by the square foot (square meter) to the nearest 0.3 square feet (0.1 square meter).

620.04.4 Painted Pavement Markings and Curbs

Painted pavement striping, words and symbols, stop bars, crosswalks, hash marks, and other striping not applied by a striping truck are measured by the gallon (liter) to the nearest whole gallon (liter). Painting curb is measured by the gallon (liter) to the nearest whole gallon (liter).

Quantity measurements are based on flow meter/totalizer readings taken before and after each run or if a calibrated tank is used, tank measurements are taken before and after each run. Computerized quantity print outs will be compared against tank stabs.

The amount of paint measured for payment is the difference between the start up readings and the end readings. All readings that measure paint for payment will be taken by the Project Manager. Provide all necessary assistance to make the readings including sufficient notice before the paint work begins.

620.04.5 Removal of Pavement Markings

Pavement striping removal is measured by the foot (meter) based on a 4-inch (100 mm) width, measured to the nearest whole foot (0.1 meter) for the actual quantity of striping removed. Lines wider and narrower than 4 inches (100 mm) are converted to the equivalent linear feet (meter) of 4-inch (100 mm) wide line.

Removal of words and symbols is measured by the square foot (square meter) to the nearest whole square foot (0.1 meter) and converted to the equivalent linear feet (meter) of 4-inch (100 mm) wide line.

620.04.6 Line Control

Establishing line control for pavement markings is not measured for payment.

620.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Preformed Plastic/ Thermoplastic Pavement Striping	Foot (meter)
Preformed Plastic/Thermoplastic Markings	Square Foot (square meter)
Truck-applied Painted Pavement Markings	Gallon (liter)
Words, Symbols, Stop Bars, Hash Marks	Gallon (liter)
Painted Curb Markings	Gallon (liter)
Temporary Pavement Markings	Mile (kilometer)
Interim Pavement Markings	Gallon (liter)
Remove Pavement Markings	Foot (meter) or Square Foot (square meter)

Line control is not paid for separately, but is included in the cost of the pavement markings.

Make a written request to the Project Manager to adjust the contract unit price of temporary and interim pavement markings when seasonal factors warrant a change in the material type from the original bid material. Furnish invoice prices that the bid was based on and invoice prices for the material furnished and applied.

Interim stripe applied over temporary stripe is measured and paid for as interim stripe.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 621
REMOVE, RESET, AND
ADJUST FACILITIES**

621.01 DESCRIPTION

This work is removing, resetting, or adjusting facilities and items as specified.

621.02 MATERIALS

Use the materials specified in the contract. Materials not specified and used in the work must be equal and comparable to those found in the existing work.

Obtain the Project Manager's approval before using material substitutions.

621.03 CONSTRUCTION REQUIREMENTS

Be responsible for the condition and care of each facility from the time removal starts until resetting is completed.

Do not damage facilities when removing and resetting.

Lower or raise existing manholes, catch basins, inlets, water valve boxes, gas and water shut-offs, and similar structures to grade as specified or directed. Make adjustments without damaging adjacent structures.

Construct masonry tops for manholes to the specified line and grade before placing the ring and cover.

Restore existing facilities to a structurally solid condition as specified.

Make height adjustments to water valve boxes without using an extension if possible.

Adjust manholes, catch basins, inlets, water valve boxes, and other similar structures to temporary grade before placing base course material. Make final adjustment of structures to match the grade of the new pavement. Replace and set to grade cast iron rings and covers once the pavement is placed.

Backfill around structures meeting Section 604 requirements.

Backfill holes left by removed facilities.

Reusable materials from removed structures or facilities may be used to rebuild the work. Stockpile all removed material not reused as specified. The material is the facility owner's property.

621.04 METHOD OF MEASUREMENT

Remove, reset, and adjust facilities is measured by the unit.

621.05 BASIS OF PAYMENT

The item description for Remove and Reset is abbreviated to Reset.

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Reset Facilities	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 622 GEOTEXTILES

622.01 DESCRIPTION

This work is furnishing and installing geotextiles.

622.02 MATERIALS

Furnish materials meeting the following Subsection requirements:

Separation Geotextile	716.1 and 716.2
Stabilization Geotextile	716.1 and 716.3
Subsurface Drainage Geotextile Filter	716.1 and 716.4
Permanent Erosion Control Geotextile	716.1 and 716.5
Temporary Silt Fence Geotextile	716.6

622.02.1 Classification

A geotextile is defined as any permeable polymeric textile used with foundation, soil, rock, earth, or any other geotechnical engineering related material, as an integral part of a civil engineering project, structure, or system.

- A. Separation/Stabilization Geotextile.** Use to prevent mixing of a subgrade soil and an aggregate cover material.
 - 1. Separation Geotextile.** Use separation geotextile for unsaturated firm subgrade conditions.
 - 2. Stabilization Geotextile.** Use stabilization geotextile for soft, wet, saturated subgrade conditions.
- B. Subsurface Drainage Geotextile Filter.** Use against soil to allow long-term passage of water into a subsurface drain system while retaining the in situ soil.
- C. Permanent Erosion Control Geotextile.** Use as a filter between energy absorbing armor systems (riprap) and the in situ soil to prevent soil erosion and hydraulic uplift pressures.
- D. Silt Fence.** Use between the edge of construction disturbance and a water resource, and at a critical resource or right-of-way line that is adjacent to construction activity. Use silt fence to assist in sediment control by retaining some of the eroded soil particles and slowing the runoff velocity to allow particle settling.

622.02.2 Source Approval

Submit the following information regarding each geotextile proposed for use:

- Manufacturer's name and current address;
- Full product name/number;
- Geosynthetic material and structure; and
- Proposed geotextile use(s).

Submit a sample to the Project Manager for evaluation. Product acceptance is determined by comparing the average test results of all specimens within a given sample to the Minimum Average Roll Values (MARV) listed in Section 716.

Install geotextiles only after the material has been tested and accepted. Replace all geotextiles installed prior to acceptance that do not meet specifications at Contractor's expense.

622.02.3 Sampling

Cut a sample from the geotextile roll with the minimum dimensions of 4 feet (1.2 m) by the full width of the roll beyond the first wrap. After the sample and the required information have been submitted to the Project Manager, allow 30 calendar days for evaluation.

622.02.4 Identification, Shipment and Storage

Conform to ASTM D 4873, *Standard Guide for Identification, Storage, and Handling of Geotextiles*. Clearly label each roll of geotextile shipped to the project with the name and address of the manufacturer, full product name/number, quantity, and roll number. Submit a manufacturer's certificate of compliance signed by an authorized manufacturer's official. The certificate must attest that the geotextile meets all the Minimum Average Roll Value (MARV) requirements specified in Section 716 as evaluated under the manufacturer's quality control program.

The Project Manager will reject materials that are mislabeled or misrepresented.

Wrap each roll with a material that protects the geotextile, including ends of the roll, from damage due to shipment, water, sunlight, and contaminants. Maintain the protective wrapping during periods of shipment and storage.

Do not damage the geotextile or wrapping when unloading or transferring from one location to another. Do not drag the rolls.

During storage, elevate geotextile rolls off the ground and adequately cover to protect them from the following:

- Site construction damage;
- Precipitation;
- Ultraviolet radiation including sunlight;
- Chemicals that are strong acids or strong bases;
- Flames including welding sparks, temperatures in excess of 140 °F (60 °C); and
- Mud, dirt, dust, debris and any other environmental condition that may damage the physical property values of the geotextile.

622.03 CONSTRUCTION REQUIREMENTS

622.03.1 General

Prepare the surface on which the geotextile is to be placed so that no damage occurs to the geotextile. Do not drive construction equipment on the geotextile. Dispose of material with defects, rips, holes, flaws, deterioration, or other damage. Do not use defective material in the work.

If sewn seams are used for seaming the geotextile, use thread that consists of high strength polypropylene or polyester. Do not use nylon thread. For erosion control applications, use thread that is resistant to ultraviolet radiation. Use thread that is of contrasting color to that of the geotextile itself.

For seams that are sewn in the field, provide at least a 10-foot (3 meter) length of sewn seam for sampling by the Project Manager before the geotextile is installed. For seams that are sewn in the factory, provide samples as directed and witnessed by the Project Manager at random from any roll of geotextile that is used on the project.

For seams that are field sewn, use the same equipment and procedures for both the sampling and production seams. If seams are to be sewn in both the machine and cross-machine direction, provide samples of seams from both directions.

Submit the seam assembly description along with the sample of the seam. Include in the description the seam type, stitch type, sewing thread, and stitch density.

622.03.2 Separation/Stabilization Geotextile

Prepare the installation site by clearing, grubbing, and excavating or filling the area to the design grade. This includes removal of topsoil or vegetation. The Project Manager will identify soft spots and unsuitable areas during site preparation. Excavate these areas and backfill with approved granular material and compact as specified. Grade the area to be covered by the geotextile to a smooth, uniform condition, free from ruts, potholes, and protruding objects such as rocks or sticks.

Spread the geotextile immediately ahead of the covering operation. Lay the geotextile smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Remove wrinkles and folds by pulling the geotextile taut as required. Use soil piles or the manufacturer's recommended method (as approved by the Project Manager) to hold the geotextile in place until the specified cover material is placed. Overlap, sew or join adjacent geotextile rolls and roll ends as shown on the plans or as directed by the Project Manager. Overlap in the direction shown on the plans. Overlap in accordance with the requirements of Table 622-1, or as specified on the plans or in the special provisions.

**TABLE 622-1
OVERLAP REQUIREMENTS**

UNDRAINED SHEAR STRENGTH OF SUBGRADE	MINIMUM OVERLAP
> 2,000 psf (> 95 kPa)	1 foot (0.3 m)
500-2,000 psf (25-95 kPa)	3 feet (0.9 m) or Sewn
< 500 psf (< 25 kPa)	Sewn
All roll ends	3 feet (0.9 m) or Sewn

On curves, cut or fold the geotextile to conform to the curve. Fold or overlap in the direction of construction and hold in place using pins, staples, or piles or fill or rock.

Do not cover the geotextile until inspected for damage by the Project Manager. Repair or replace all damaged geotextile at Contractor's expense. Make repairs following the manufacturer's recommendation or use a patch of the same material placed over the damaged area, overlapped at least 3 feet (0.9 m) from the edge of any part of the damage. Sewing repairs are an acceptable alternative.

Place fill over the geotextile by dumping onto previously placed material and pushing the material into place. Do not operate any construction equipment directly on the geotextile under any circumstances. Place the fill material in uniform layers so that there is the minimum specified lift thickness between the geotextile and equipment tires or tracks at all times. The minimum thickness of the first lift is 8 inches (200 mm). Do not allow construction equipment to turn on the first lift of material above the geotextile. Do not blade the first lift placed over the geotextile. If the subgrade is very soft with an undrained shear strength less than 500 psf (25 kPa) minimize pile heights to less than 3 feet (0.9 m) and spread piles as soon as possible after dumping to minimize the potential for localized subgrade failure due to overloading of the subgrade.

Do not use sheepsfoot or studded compaction equipment on the first lift placed over the geotextile. Stop vibrator on compaction equipment if pumping occurs. Do not operate any construction equipment that results in rutting in excess of 3 inches (75 mm) on the first lift. If rutting exceeds 3 inches (75 mm), decrease the construction equipment size and/or weight or increase the lift thickness. Use only rubber-tired rollers for compaction if any foundation failures occur when placing subsequent lifts. Compact all lifts to the moisture and density requirements for earth embankment specified in Subsection 203.03.3. Do not blade material down to remove ruts. Fill any ruts or depressions with additional material and compact to the specified density.

622.03.3 Subsurface Drainage Geotextile Filter

Excavate trench in accordance with the project plans. Do not allow large voids to occur in the sides and bottom of the trench. Grade the surface to be smooth and free of debris.

Place the geotextile loosely with no wrinkles or folds, and with no void space between the geotextile and the ground surface. Press the geotextile into the corners of the trench. Overlap successive sheets of geotextiles a minimum of 1 foot (0.3 m), with the upstream sheet overlapping the downstream sheet.

Place a sufficient width of geotextile to entirely cover the perimeter of the trench and allow for the required overlap. In trenches equal to or greater than 1-foot (0.3 m) width, after placing the drainage aggregate, fold the geotextile over the top of the backfill material in a manner to produce a minimum overlap of 1 foot (0.3 m). In trenches less than 1 foot (0.3 m) wide, but greater than 4 inches (0.1 m) wide, overlap the geotextile the entire width of the trench. Where the trench is less than 4 inches (100 mm) wide, sew or otherwise bond the geotextile in accordance with the manufacturer's recommendations, as approved by the Project Manager. All seams will be subject to the approval of the Project Manager.

If the geotextile is damaged during installation or aggregate placement, place a geotextile patch over the damaged area extending beyond the perimeter of the damaged area a distance of 1 foot (300 mm) or the specified seam overlap, whichever is greater.

Place the drainage aggregate immediately following geotextile placement. Cover the geotextile with a minimum of 12 inches (300 mm) of loosely placed aggregate prior to compaction. If a perforated collector pipe is to be installed in the trench, place a minimum of a 6 inch (150 mm) bedding layer of drainage aggregate below the pipe, with the remainder of the aggregate placed to the minimum required construction depth.

Compact all placed aggregate to a minimum of 95 percent of the maximum standard Proctor density determined in accordance with MT-210.

622.03.4 Permanent Erosion Control Geotextile

Place the geotextile on a smooth graded surface approved by the Project Manager. Place the geotextile loosely and anchor it in place with sand bags, soil piles, or steel pins. Place the geotextile in such a manner that placement of the riprap does not stretch or tear the geotextile. Place the riprap from the bottom of the slope up to the top of the slope. After placement of the riprap, key the geotextile at least 18 inches (450 mm) into the ground at the top of the embankment. Do not key the geotextile in until all of the riprap has been placed on the slope. Secure the geotextile at the toe by lapping the material back and securing with riprap.

Limit atmospheric exposure to a maximum of 14 days following lay down to minimize damage potential.

Place the geotextile with the machine direction parallel to the direction of water flow, which is normally parallel to the slope (downslope) for erosion control runoff and wave action, and parallel to the stream or channel in the case of streambank and channel protection. Join adjacent geotextile sheets by either sewing or overlapping. Overlap seams of roll ends a minimum of 1 foot (300 mm) except where placed under water or on slopes 3:1 or steeper. Overlap seams of roll ends placed under water or on slopes 3:1 or steeper a minimum of 3 feet (900 mm). Overlap adjacent rolls a minimum of 1 foot (300 mm) in all instances. For slopes flatter than 3:1, use pins or staples to hold the overlap in place during placement of riprap. Pin the geotextile loosely so it can easily conform to the ground surface and give when riprap is placed. Do not use pins at overlaps for slopes 3:1 or steeper.

Overlap successive sheets of the geotextile upstream over downstream, and/or upslope over downslope. In cases where wave action or multidirectional flow is anticipated, sew all seams perpendicular to the direction of flow.

Avoid damaging the geotextile as a result of the installation process. If the geotextile is damaged during installation, place a patch over the damaged area extending a minimum of 3 feet (900 mm) beyond the perimeter of the damaged area.

Begin riprap placement at the toe and proceed up the slope. Avoid stretching and subsequent tearing of the geotextile. Do not drop riprap and heave stone from a height of more than 1 foot (300 mm). Do not allow stones weighing more than 200 lbs (90 kg) to roll down the slope.

Do not drop slope protection and smaller sizes of stone material from a height exceeding 3 feet (900 mm), unless the Project Manager approves the procedure following a demonstration showing the geotextiles are not damaged by the procedure.

In underwater applications, key the geotextile in at the bottom of the slope. Develop and demonstrate to the Project Manager a method of underwater placement to secure the geotextile in place without damaging the geotextile. Place the geotextile and the backfill material in the same day. Backfill all void spaces in the riprap with smaller stone to ensure full coverage of the geotextile.

After placement of the riprap, no grading of the slope is allowed if it results in movement of the riprap directly above the geotextile.

Replace any geotextile damaged during backfill placement as directed by the Project Manager at the Contractor's expense.

622.03.5 Silt Fence

Install silt fence in accordance with this specification and with the Detailed Drawings. The maximum cut or fill slope for a silt fence is 2:1 (horizontal: vertical). For cut or fill slopes steeper than 2:1, use alternative methods of soil stabilization Best Management Practices (BMPs).

Use fence posts having a minimum length of 48 inches (1220 mm). Drive fence posts a minimum of 18 inches (450 mm) into the ground. Use fence posts having a sufficient strength to resist damage during installation and to support the applied loads due to material build up behind the silt fence.

There are two types of silt fence installations:

- 1. Unstabilized.** Silt fence supported with either wood or metal fence posts.
- 2. Stabilized.** Silt fence supported with metal posts and with woven wire backing.

For stabilized silt fence, use woven wire having a maximum of 6-inch (150 mm) mesh spacing and a minimum of 14.5 gauge wire.

Excavate a trench at least 6 inches (150 mm) wide by 6 inches (150 mm) deep at the base of the silt fence. The vertical entrenchment component consists of burying the silt fence a minimum of 6 inches (150 mm) below the ground surface. Vertical and horizontal entrenchment of the silt fence consists of placing the silt fence in a "J" configuration in the trench extending a minimum of 6 inches (150 mm) below the ground surface and a minimum of 6 inches (150 mm) horizontally along the bottom of the trench. The initial silt fence installation requires only the vertical entrenchment component unless the Project Manager determines both vertical and horizontal entrenchment components are necessary. If the fence requires replacement due to failure from pullout or undercutting, the subsequent entrenchment must include both vertical and horizontal entrenchment components in a "J" configuration. Backfill the trench with the excavated material and compact.

Splice the geotextile with a sewn seam or overlap two sections of fence in accordance with the detailed drawings.

Place the posts at a minimum spacing of 4 feet (1.2 m) and at a maximum spacing of 8 feet (2.4 m). Securely fasten the silt fence geotextile to the upslope side of the fence post.

Place silt fence continuous and transverse to the flow. Follow the contours of the site as closely as possible. Place the fence so that water cannot run off and around the end of the fence.

Inspect all temporary silt fences immediately after each rainfall and at least daily during prolonged rainfall. Immediately correct any deficiencies at the Contractor's expense.

Make a daily review of the location of silt fences in areas where construction activities have altered the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist as determined by the Project Manager, install additional silt fence as directed by the Project Manager.

Repair or replace damaged silt fence promptly.

Remove sediment from behind the silt fence when it occurs to one-third the original height.

Leave the silt fence in place until the Project Manager directs to remove it. Either grade and seed, or remove the sediment deposits prior to removal of the fence.

622.04. METHOD OF MEASUREMENT

Geotextiles are measured by the square yard (square meter) as staked by the Project Manager, except silt fence, which is measured by the yard (meter) of fence. Measurement excludes laps, seams, and joints.

622.05. BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Geotextile, Separation/Stabilization	Square Yard (square meter)
Geotextile Filter, Subsurface Drainage	Square Yard (square meter)
Geotextile, Erosion Control	Square Yard (square meter)
Geotextile, Silt Fence	Yard (meter)

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

SECTION 623
MAILBOXES

623.01 DESCRIPTION

This work is the furnishing and installation of mailboxes and crash-worthy supports at the specified locations or as directed.

623.02 MATERIALS

Furnish Rubbermaid™ rubberized mailboxes, measuring at least 6 1/2 inches wide x 7 1/2 inches high x 18 1/2 inches long (165 mm x 190 mm x 470 mm), not exceeding 13 pounds (5.9 kg) in weight that meet the Postal Service requirements.

Furnish a crashworthy mailbox support as shown in the Detailed Drawings, a mailbox support identified in the current edition of the AASHTO *Guide for Erecting Mailboxes on Highways*, or other commercially manufactured crash tested mailbox support.

623.03 CONSTRUCTION REQUIREMENTS

Install the mailbox and support meeting the contract requirements.

623.04 METHOD OF MEASUREMENT

The mailbox and its support are measured as a unit.

623.05 BASIS OF PAYMENT

Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Mailbox	Each

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the contract.

**SECTION 701
AGGREGATES**

701.01 AGGREGATE FOR CONCRETE

These specifications describe the quality and size of fine and coarse aggregate for portland cement concrete pavements and bases, highway bridges, and incidental structures.

The following test methods are used to evaluate the quality of aggregates for concrete:

Fineness Modulus of Fine Aggregate	AASHTO M 6
Sieve Analysis for Fine and Coarse Aggregate	MT-202
Wear Test	MT-209
Sulfate Soundness.....	AASHTO T 104 or ASTM C-88
Mortar-making Properties	AASHTO T 71
Organic Impurities.....	AASHTO T 21
Coal and Light Particles.....	AASHTO T 113
Clay Lumps.....	AASHTO T 112

When wear factors are specified in the contract, the term "aggregate surfacing" includes the coarse aggregate for concrete.

701.01.1 Fine Aggregates for Concrete

A. General Requirements. Fine aggregate is natural sand having hard, strong, durable particles meeting the gradation requirements in Table 701-2.

Other approved inert material with similar characteristics or combinations of the above materials may be used, if the materials meet these specifications.

Do not mix or store in the same pile fine aggregate from different sources or use alternately in the same class of construction or mix without the Project Manager's written permission.

The deleterious substances and soundness specified in (B) and (C) below will be waived for aggregate used in structures or portions of structures not exposed to weather.

B. Deleterious Substances. Meet the deleterious material limits in Table 701-1.

**TABLE 701-1
LIMITS ON DELETERIOUS MATERIAL
IN FINE AGGREGATE**

MATERIAL	MAXIMUM % BY WT
Coal and Lightweight Pieces	1.00
Clay Lumps	1.00

The material must not contain other deleterious material, such as shale, alkali, mica, coated grains, and soft, flaky particles.

C. Soundness. When fine aggregate is subjected to five cycles of the sodium or magnesium sulfate soundness test, the total corrected loss cannot exceed 10 and 15 percent by weight respectively.

D. Organic Impurities. Aggregate subjected to the colorimetric test for organic impurities and producing a color darker than the standard will be rejected unless the aggregates pass the mortar strength test specified in (E) below. Do not use aggregates showing a darker color than that of samples originally approved for the work until tested to determine whether the increased color indicates a harmful quantity of deleterious material.

- E. Mortar-making Properties.** The fine aggregate, when mixed with Type I or II cement and tested using the mortar making property test, must develop at seven days, a minimum compressive strength of 95 percent of the strength developed by a mortar made with the same cement under AASHTO T 71.
- F. Grading.** The gradation requirements in Table 701-2 are the outer acceptance limits for use from all supply sources. The gradation must be uniform from any one source and not change from the low to the high gradation limits.

The fineness modulus of samples taken from proposed sources must be a minimum 2.50 and a maximum 3.10 when tested under AASHTO M 6. Fine aggregate from a source with a fineness modulus variation greater than plus or minus 0.20 from the design fineness modulus of the sample may require a concrete mix redesign. Applying the 0.20 variation does not permit the fineness modulus to be less than 2.50 or more than 3.10.

TABLE 701-2

TABLE OF GRADATIONS - FINE AGGREGATE FOR CONCRETE

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
Sieve Size	Percent Passing
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	95-100
No. 8 (2.36 mm)	80-100
No. 16 (1.18 mm)	50-85
No. 30 (0.600 mm)	25-60
No. 50 (0.300 mm)	5-30
No. 100 (0.150 mm)	0-10
No. 200 (0.075 mm)	0-3

A maximum 45 percent of the fine aggregate can be retained between any two consecutive sieves.

701.01.2 Coarse Aggregate for Concrete

- A. General Requirements.** Coarse aggregate is crushed stone, gravel, or blast-furnace slag having hard, strong, durable pieces, free from adherent coatings. Other approved inert materials with similar characteristics or combinations of the above materials may be used, provided they meet these specifications.

The limits for deleterious material and soundness specified in (B) and (C) below will be waived for aggregate used in structures or portions of structures not exposed to the weather.

- B. Deleterious Substances.** Meet the deleterious material limits in Table 701-3.

TABLE 701-3
LIMITS ON DELETERIOUS SUBSTANCES
IN COARSE AGGREGATE

SUBSTANCE	MAXIMUM % BY WT
Coal and Lignite	1.00
Clay Lumps	0.25
Soft Fragments	5.00
Thin or elongated pieces having a length greater than five times average thickness	15.00
Material passing the No. 200 sieve	1.00 ¹

Notes:

1. In crushed aggregates, if the material finer than the No. 200 sieve consists of fracture dust essentially free from clay or shale, the maximum limit may be increased to 1.5 percent.

The material must not contain other deleterious material, such as shale, alkali, mica, coated grains, and soft, flaky particles.

- C. Soundness.** When the coarse aggregate is subjected to five cycles of the sodium or magnesium sulfate soundness test, the total percentage loss cannot exceed 12 and 18 percent by weight respectively.
- D. Percentage of Wear.** Furnish coarse aggregate having a wear factor not exceeding 40 percent.
- E. Reserved.**
- F. Grading.** Furnish 1 1/2-inch (37.5 mm) aggregate meeting the gradations in Table 701-4 for No. 4 (4.75 mm) to 1 1/2-inch (37.5 mm), furnished in two separate sizes respectively meeting the gradations for No.4 (4.75 mm) to 3/4-inch (19 mm) and 3/4-inch to 1 1/2-inch (19 mm to 37.5 mm) size material.

Furnish 3/4-inch (19 mm) aggregate meeting the gradations for No 4 (4.75 mm) to 3/4-inch (19 mm) material.

Furnish coarse aggregate uniformly graded between the limits specified in Table 701-4.

The aperture shape used for coarse aggregate acceptance has no relation to the size and shape of the aperture or screen type used in producing the material.

TABLE 701-4
TABLE OF GRADATIONS - COARSE AGGREGATE FOR CONCRETE

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES DESIGNATED SIZES				
Sieve Size	No. 1	No. 2	No. 3	No.4
	No. 4 to 1 1/2" (4.75 to 37.5 mm)	No. 4 to 3/4" (4.75 to 19mm)	No. 4 to 1 1/2" (4.75 to 37.5 mm)	No. 4 to 1/2" (4.75 to 12.5 mm)
2" (50 mm)	100		100	
1 1/2" (37.5 mm)	95-100		90-100	
1" (25 mm)		100	20-55	
3/4" (19 mm)	35-70	90-100	0-15	100
1/2" (12.5 mm)				90-100
3/8" (9.5 mm)	10-30	20-55	0-5	40-70
No. 4 (4.75 mm)	0-5	0-10		0-15
No. 8 (2.36 mm)		0-5		0-5

Notes:

- Nos. 1, 2, 3, and 4 correspond to AASHTO/ASTM designations 467, 67, 4, and 7 respectively.

701.02 AGGREGATE FOR SURFACING

701.02.1 General Requirements

The following test methods, as applicable, are used to evaluate the surfacing aggregate quality:

Sieve Analysis For Fine And Coarse Aggregate	MT-202
Wear Test	MT-209
Liquid Limit, Plastic Limit, Plasticity Index	MT-208
Fracture	MT-217
Volume Swell of Bituminous Mixtures.....	MT-305
Sulfate Soundness.....	AASHTO T-104 or ASTM C-88

Sulfate soundness will be tested by the Department for source approval. If the test fails the Contractor may not use the source to produce coarse surfacing aggregate.

Meet the following sulfate soundness requirements:

- Sodium or Magnesium sulfate soundness test, five cycles.
- Coarse aggregate, 12 percent and 18 percent maximum respectively.

A. Acceptance. If the test results indicate the aggregate does not meet the requirements, the Contractor may make a written request for an independent laboratory to retest the material in question. The Contractor and the Department must agree upon the choice of the independent laboratory before release of the sample for testing. The Department will maintain and provide the original sample in the event of a retest. The independent laboratory results will be averaged with the results provided by the Department and the averaged results will be binding on both parties for acceptance of the material in question. The Contractor must pay the cost of duplicate testing if the average results in a failing test. The Department will pay the cost of duplicate testing if the average results in a passing test.

Furnish aggregate that does not contain wood and other plant material.

Do not use scoria (fired clay commonly found in conjunction with burned coal in the lignite fields of the State) as aggregate. Sources of scoria are common but not limited to Daniels,

Sheridan, Roosevelt, McCone, Dawson, Prairie, Wibaux, Custer, Fallon, Rosebud, Treasure, Bighorn, Powder River, and Carter counties.

That portion of the aggregate retained on the No. 4 (4.75 mm) sieve is coarse aggregate, and that passing the No. 4 (4.75 mm) sieve is fine aggregate.

When wear factors are specified in the contract, the term "aggregate surfacing" includes all aggregates specified in Subsections 701.02.4 through 701.02.9.

The Department has 30 calendar days from submission of the sulfate soundness test sample to furnish the test results. Contract time will be increased, working day for working day, for each day the test results are delayed beyond the 30-day review period, if the Departments delay affects the Contractor's operation as shown on the current work schedule. Contract time will not be extended if the delay occurs from November 16 through April 15, unless the Contractor is being charged contract time under Subsection 108.07.3.

701.02.2 Select Surfacing

Furnish select surfacing, including added binder or blending material, meeting Table 701-6 gradation requirements.

**TABLE 701-6
TABLE OF GRADATIONS - SELECTED SURFACING**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES						
Sieve Size	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
4 inch (100 mm)	100					
3 inch (75 mm)		100				
2 1/2 inch (63 mm)			100			
2 inch (50 mm)				100		
1 1/2 inch (37.5mm)					100	
1 inch (25 mm)						100
No.200 (0.075)	15 max.					

The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 30 and 6 respectively.

701.02.3 Sand Surfacing

Furnish sand surfacing meeting Table 701-7 gradation requirements.

**TABLE 701-7
TABLE OF GRADATIONS - SAND SURFACING**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
Sieve Size	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
1 1/2 inch (37.5 mm)	100				
1 inch (25.0 mm)		100			
3/4 inch (19.0 mm)			100		
1/2 inch (12.5 mm)				100	
No.4 (4.75 mm)					100
No.10 (2.00 mm)	65 min.	65 min.	65 min.	50 min.	50 min.
No.200 (0.075)	20 max.				

The liquid limit for the material passing the No. 40 sieve is 25 maximum, and the plasticity index cannot exceed 0.

701.02.4 Crushed Base Course Type "A"

Furnish crushed base course Type "A," including added binder or blending material, meeting Table 701-8 gradation requirements. Glass Cullet meeting Subsection 701.11 requirements may be used as blending material.

**TABLE 701-8
TABLE OF GRADATIONS - CRUSHED BASE COURSE TYPE "A"**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES				
Sieve Size	Grade 5A		Grade 6A	
	Job Mix Target Limits	Job Mix Tolerance	Job Mix Target Limits	Job Mix Tolerance
2 inch (50 mm)	100			
1 1/2 inch (37.5 mm)	97	± 3	100	
3/4 inch (19.0 mm)	78-80	± 8	82-88	± 8
3/8 inch (9.5 mm)	58-62	± 8	52-64	± 12
No. 4 (4.75 mm)	42-50	± 8	36-48	± 12
No. 40 (0.425)	14-22	± 8	16-24	± 10
No. 200 (0.075)	3-5	± 3	3-5	± 3

Meet the following requirements for crushed base course Type "A":

1. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 25 and 6 respectively;
2. Dust ratio limitations do not apply;
3. A wear factor not exceeding 50 percent at 500 revolutions;
4. Furnish binder meeting Subsection 301.02.2 requirements; and
5. At least 35 percent by weight of the aggregate retained on the No. 4 sieve has at least one mechanically fractured face for Grade 5 and 25 percent for Grade 6.

701.02.5 Crushed Base Course Type "B"

Furnish crushed base course Type "B", including added binder or blending material, meeting Table 701-9 gradation requirements.

**TABLE 701-9
TABLE OF GRADATIONS - CRUSHED BASE COURSE TYPE "B"**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES			
Sieve Size	Grade 1	Grade 2	Grade 3
2 inch (50 mm)	100		
1 1/2 inch (37.5 mm)		100	
1 inch (25 mm)	50-80		100
No. 4 (4.75 mm)	20-50	25-55	30-60
No. 10 (2.00 mm)			20-50
No. 200 (0.075 mm)	8 max.	8 max.	8 max.

Meet the following requirements for crushed base course Type "B":

1. The liquid limit for the fine aggregate passing the No. 40 must not exceed 35, while the plasticity index cannot exceed 10;
2. Dust Ratio: The portion passing the No. 200 sieve must not exceed two-thirds of the portion passing the No. 40 sieve;
3. A wear factor not exceeding 50 percent at 500 revolutions;
4. Up to five percent by weight of material one grade larger than that being produced is allowed. For example, when producing 1 1/2-inch (37.5 mm) material, up to five percent of the total weight of material produced may be 2-inch (50 mm) material;
5. Furnish binder meeting Subsection 301.02.2 requirements; and
6. At least 20 percent by weight of the aggregate retained on the No. 4 sieve must have one mechanically fractured face.

701.02.6 Crushed Top Surfacing Type "A"

Furnish crushed top surfacing Type "A", including added binder or blending material, meeting Table 701-10 gradation requirements.

**TABLE 701-10
TABLE OF GRADATIONS - CRUSHED TOP SURFACING TYPE "A"**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
Sieve Size	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
1 inch (25 mm)	100				
3/4 inch (19.0 mm)		100			
5/8 inch (16.0 mm)			100		
1/2 inch (12.5 mm)				100	
3/8 inch (9.5 mm)					100
No. 4 (4.75 mm)	40-70	40-70	40-70	40-70	50-80
No. 10 (2.00 mm)	25-55	25-55	25-55	25-60	35-70
No. 200 (0.075 mm)	2-8	2-8	2-8	2-8	2-8

Meet the following requirements for crushed top surfacing Type "A", including added binder or blending material:

1. Dust Ratio: the portion passing the No. 200 sieve cannot exceed two-thirds of the portion passing the No. 40 sieve;
2. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve is 25 and 6 respectively;
3. The composite aggregate does not contain adherent films of clay and other matter that prevents thorough coating with bituminous material. Bituminous material must remain adhered to the material upon contact with water;
4. When the aggregate is to be bituminized, both the material source and the composite aggregate must have a volume swell not exceeding 10 percent, and not show cracking or disintegration;
5. Do not remove intermediate sizes from the material during production, unless authorized in writing;
6. Have a wear factor not exceeding 50 percent at 500 revolutions; and
7. At least 35 percent by weight of the aggregate retained on the No. 4 sieve must have at least one mechanically-fractured face.

701.02.7 Crushed Top Surfacing Type "B"

Furnish crushed top surfacing Type "B", including added binder or blending material, meeting Table 701-11 gradation requirements.

TABLE 701-11

TABLE OF GRADATIONS - CRUSHED TOP SURFACING TYPE "B"

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES			
Sieve Size	Grade 1	Grade 2	Grade 3
1 1/2 inch (37.5 mm)	100		
1 inch (25 mm)		100	
3/4 inch (19.0 mm)			100
1/2 inch (12.5 mm)			
No. 4 (4.75 mm)	40-80	40-80	40-80
No. 10 (2.00 mm)	25-60	25-60	25-60
No. 200 (0.075)	5-20	5-20	5-20

Meet the following requirements for crushed top surfacing Type "B", including added binder or blending material:

1. Dust Ratio: the portion passing the No. 200 sieve cannot exceed two-thirds of the portion passing the No. 40 sieve;
2. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve must not exceed 35, while the plasticity index may vary from 3 to 10;
3. A wear factor not exceeding 40 percent at 500 revolutions; and
4. At least 20 percent by weight of the aggregate retained on the No.4 sieve must have one fractured face.

701.02.8 Crushed Cover Aggregate - Cover Material

Furnish cover material meeting the gradation requirements of Table 701-12.

**TABLE 701-12
TABLE OF GRADATIONS - COVER MATERIAL**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES					
Sieve Size	Grade 1A	Grade 2A	Grade 3A	Grade 4A	Grade 5A
5/8 inch (16.0 mm)	100				
1/2 inch (12.5 mm)		100	100		
3/8 inch (9.5 mm)	33-55	40-100	95-100	100	100
No. 4 (4.75 mm)	0-15	0-8	0-30	0-15	9-50
No. 8 (2.36 mm)	0-5	—	0-15	—	2-20
No. 200 (0.075 mm)	0-2	0-1	0-2	0-2	2-5

Meet the following requirements:

1. The material for Grades 1A through 4A must be non-plastic. For Grade 5A the liquid limit and plasticity index for the material passing the No. 40 (0.425 mm) sieve cannot exceed 25 and 6 respectively;
2. The composite aggregate must not have adherent films of clay, vegetable matter, frozen lumps, and other extraneous matter that prevents thorough coating with bituminous material. Bituminous material must remain adhered to the material upon contact with water. No combination of shale, clay, coal, and soft particles can exceed 1.5 percent;
3. The aggregate must have a wear factor not exceeding 30 percent at 500 revolutions; and
4. A minimum of 70 percent by weight of the coarse aggregate for Grades 1A through 4A must have at least one fractured face. A minimum of 50 percent by weight of the coarse aggregate for Grade 5A must have at least one fractured face.

701.02.9 Aggregate for Portland Cement Treated Base

Furnish aggregate for portland cement treated base; including added blending material, meeting Table 701-13 gradation requirements.

**TABLE 701-13
TABLE OF GRADATIONS - AGGREGATE FOR CEMENT TREATED BASE**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
Sieve Size	Job Mix Target Limits
3/4 inch (19.0 mm)	100
No. 4 (4.75 mm)	40-70
No. 10 (2.00 mm)	25-55
No. 200 (0.075)	4-12

Meet the following requirements:

1. The maximum liquid limit and plasticity index for the material passing the No. 40 sieve must be 30 and 7 respectively; and
2. The material used to produce the aggregate must have a wear factor not exceeding 50 percent at 500 revolutions.

701.03 AGGREGATE FOR BITUMINOUS MIXTURES

701.03.1 General Requirements

The following test methods will be used to evaluate the quality of aggregate to be bituminized:

Sieve Analysis For Fine And Coarse Aggregate	MT-202
Wear Test	MT-209
Liquid Limit, Plastic Limit, Plasticity Index	MT-208
Fracture	MT-217
Volume Swell Of Bituminous Mixtures.....	MT-305
Plastic Fines In Graded Aggregates	MT-213
Sulfate Soundness.....	AASHTO T-104 or ASTM C-88

Sulfate soundness will be tested by the Department for source approval. If the test fails the Contractor may not use the source to produce coarse aggregate to be bituminized.

Meet the following sulfate soundness requirements:

- Sodium or Magnesium sulfate soundness test, five cycles.
- Coarse aggregate, 12 percent and 18 percent maximum respectively.

A. Acceptance. If the test results indicate the aggregate does not meet the requirements, the Contractor may make a written request for an independent laboratory to retest the material in question. The Contractor and the Department must agree upon the choice of the independent laboratory before release of the sample for testing. The Department will maintain and provide the original sample in the event of a retest. The independent laboratory results will be averaged with the results provided by the Department and the averaged results will be binding on both parties for acceptance of the material in question. The Contractor must pay the cost of duplicate testing if the average results in a failing test. The Department will pay the cost of duplicate testing if the average results in a passing test.

Furnish aggregate that does not contain wood and other plant material.

Do not use scoria (fired clay commonly found in conjunction with burned coal in the lignite fields of the State) as aggregate to be bituminized. Sources of scoria are common but not limited to Daniels, Sheridan, Roosevelt, McCone, Dawson, Prairie, Wibaux, Custer, Fallon, Rosebud, Treasure, Bighorn, Powder River, and Carter counties.

The portion of the aggregate retained on the No. 4 (4.75 mm) sieve is defined as coarse aggregate, and that passing the No. 4 (4.75 mm) sieve is defined as fine aggregate.

The Department has 30 calendar days from submission of the sulfate soundness test sample to furnish the test results. Contract time will be increased, working day for working day, for each day the test results are delayed beyond the 30-day review period, if the Departments delay affects the Contractor's operation as shown on the current work schedule. Contract time will not be extended if the delay occurs from November 16 through April 15 unless the Contractor is being charged contract time under Subsection 108.07.3.

701.03.2 Aggregate for Plant Mix Surfacing

Furnish aggregate for plant mix surfacing, including mineral filler when required, meeting Table 701-15 gradation requirements.

**TABLE 701-15
TABLE OF GRADATIONS - AGGREGATE FOR PLANT MIX SURFACING**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES				
	Grade A		Grade B	
Sieve Size	Job Mix Target Limits	Job Mix Tolerance	Job Mix Target Limits	Job Mix Tolerance
3/4 inch (19.0)	100		100	
1/2 inch (12.5)	87-93	± 8	86-90	± 7
3/8 inch (9.5)	77-83	± 8	75-79	± 7
No. 4 (4.75)	52-58	± 7	51-57	± 7
No. 10 (2.00)	36-41	± 6	32-40	± 6
No. 40 (0.425)	19-21	± 5	14-16	± 4
No. 200 (0.075)	6-8	± 2	4.5-6.5	± 1.5

Meet the following requirements:

1. A wear factor not exceeding 40 percent at 500 revolutions using Montana Test MT-209;
2. For Grade A aggregate at least 50 percent by weight of the coarse aggregate particles must have at least one mechanically fractured face. For Grade B aggregate at least 60 percent by weight of the coarse aggregate particles must have at least two mechanically fractured faces;
3. The maximum liquid limit for the aggregate passing the No. 40 sieve is 25. The maximum plasticity index for Grade A aggregate is 6. Grade B aggregate must be non-plastic;
4. The final produced aggregate, including treated aggregate, must have a volume swell not exceeding 10 percent and cannot show cracking or disintegration; and
5. The aggregate must not contain adherent films of clay and other matter that prevents thorough coating with bituminous material.

The target Marshall field density is established from test results using MT-311 on specimens molded with 50 blows per side.

- A. Plant Mix Bituminous Surfacing - Grade D.** Furnish plant mix bituminous surfacing Grade D meeting all the specifications for Grade B except as modified below.

TABLE 701-15 A**TABLE OF GRADATIONS - AGGREGATE FOR PLANT MIX SURFACING**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES		
	Grade D	
Sieve Size	Job Mix Target Limits	Job Mix Tolerance
3/4 inch (19.0)	100	
1/2 inch (12.5)	79-83	± 7
3/8 inch (9.5)	68-72	± 7
No. 4 (4.75)	44-50	± 7
No. 10 (2.00)	27-33	± 6
No. 40 (0.425)	12-15	± 4
No. 200 (0.075)	4.5-6.5	± 1.5

At least 60 percent of coarse aggregate particles by weight must have at least two mechanically fractured faces as determined by MT-217.

Aggregate used in the mix consists of crushed particles. Separate natural fines before crushing. Do not exceed five percent of minus No. 4 sieve material in the crusher feed.

The target Marshall field density is established from results of tests made using MT-311 from specimens molded with 75 blows per side.

701.04 FOUNDATION AND BEDDING MATERIAL FOR STRUCTURES

701.04.1 Bedding Material

Furnish bedding material for minor drainage structures and culvert foundations. Glass Cullet meeting Subsection 701.11 requirements may be used as blending material.

Furnish bedding material that is reasonably free of clay, silt, and other deleterious material and meets Table 701-17 gradation requirements.

TABLE 701-17**TABLE OF GRADATIONS - BEDDING MATERIAL**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
Sieve Size	Percent Passing
4 inch (100 mm)	100
No. 4 (4.75 mm)	25-60
No. 200 (0.075 mm)	12 max.

Notes:

- Use minus 1 1/2-inch (37.5 mm) aggregate in the top 3 inches (75 mm) of bedding material.

701.04.2 Foundation Material

Foundation material is one or more aggregate material courses to provide a stable foundation for culvert and drainage structure installations in unstable areas.

Use shot rock, pit-run aggregate, crushed aggregate, or any combination of these materials. The largest rock or rock fragment allowed may be as great in dimension as the thickness of the

lift being placed. In the top 1 foot (305 mm) of the foundation, the largest rock or rock fragment cannot exceed 8 inches (200 mm). Use well-graded material in the top 1 foot (305 mm) of foundation material. A maximum 40 percent by weight of the foundation material must pass a No. 4 sieve.

701.05 FILTER MATERIAL

Furnish filter material meeting Table 701-18 gradation requirements.

**TABLE 701-18
TABLE OF GRADATIONS - FILTER MATERIAL**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES		
Sieve Size	No. 1	No. 2
2 inch (50 mm)		100
1 1/2 inch (37.5 mm)		95-100
3/4 inch (19.0 mm)		35-70
3/8 inch (9.5 mm)	100	10-30
No. 4 (4.75 mm)	95-100	0-5
No. 8 (2.36 mm)	80-100	
No. 16 (1.18 mm)	50-85	
No. 30 (0.60 mm)	25-60	
No. 50 (0.30 mm)	5-30	
No. 100 (0.15 mm)	0-10	

701.06 RIPRAP

Furnish stone that is hard, durable, and angular in shape, resistant to weathering and water action, free from overburden, spoil, shale, structural defects, and organic material.

Each stone must have its greatest dimension not greater than three times its least dimension.

Do not use rounded stone or boulders from a streambed source as riprap. Do not use shale or stone with shale seams.

The stone will be accepted based on visual analysis, the Department's riprap evaluation form, or both. Submit samples before placing the riprap.

701.06.1 Handlaid Riprap

Furnish stone or rock fragment at least 3 inches (75 mm) thick, a minimum 1/2 cubic foot (0.014 cubic meters) in volume, weighing at least 75 pounds (34 kg), excluding rock spalls.

Extend all stones and fragments through the revetment, except spalls used to chock larger stones and fill voids between the larger stones.

701.06.2 Random Riprap

Furnish the specified random riprap meeting Table 701-19 requirements.

**TABLE 701-19
TABLE OF GRADATIONS - RANDOM RIPRAP**

CLASS	WEIGHT OF STONE	EQUIVALENT SPHERICAL DIAMETER¹	% OF TOTAL WT THAT MUST BE SMALLER THAN GIVEN SIZE
I	100 pounds (45 kg)	1.05 feet (320 mm)	100
	60 pounds (27 kg)	0.88 feet (270 mm)	70-90
	25 pounds (11 kg)	0.66 feet (200 mm)	40-60
	2 pounds (0.90 kg)	0.27 feet (80 mm)	0-10
II	700 pounds (318 kg)	2.00 feet (610 mm)	100
	500 pounds (227 kg)	1.79 feet (545 mm)	70-90
	200 pounds (91 kg)	1.32 feet (400 mm)	40-60
	20 pounds (9.0 kg)	0.61 feet (190 mm)	0-10
III	2000 pounds (909 kg)	2.82 feet (860 mm)	100
	1400 pounds (635 kg)	2.53 feet (770 mm)	70-90
	700 pounds (318 kg)	2.00 feet (610 mm)	40-60
	40 pounds (18 kg)	0.77 feet (235 mm)	0-10

Notes:

1. Based on unit weight of 165 pounds per cubic foot (2,675 kg/cubic meter).

701.06.3 Grouted Riprap

Furnish stone for grouted riprap meeting Subsection 701.06.2 requirements.

701.07 BANK PROTECTION

Furnish rock that is hard, dense, and durable. Use either quarried rock or natural coarse gravel. Rock may be obtained from adjacent roadway excavation. Do not use rock obtained from streambeds.

Furnish the specified bank protection meeting Table 701-20 requirements.

**TABLE 701-20
SIZE REQUIREMENTS - BANK PROTECTION**

TYPE	1	2	3	4
Nominal Thickness	24 inch (610mm)	18 inch (460 mm)	12 inch (305 mm)	Coarse gravel
Overall Thickness Including Bedding	30 inch (760mm)	24 inch (610 mm)	18 inch (460 mm)	As specified in the contract
Largest Rock Permissible	1/4 cubic yd. (0.19 m ³)	1/8 cubic yd. (0.09 m ³)	1 cubic ft. (0.03 m ³)	1/8 cubic ft. (0.003 m ³)
Smallest Rock Permissible	1/10 cubic ft. (0.003 m ³)	1/10 cubic ft. (0.003 m ³)	1-1/2" (40 mm)	3/16" (5 mm)

701.08 SAND-GRAVEL CUSHION

Furnish sand-gravel cushion for concrete slope protection meeting Subsection 701.04.1 requirements for bedding material except that all the material must pass a 1 1/2 inch (38 mm) sieve.

701.09 BACKFILL FOR METAL BIN-TYPE RETAINING WALLS

Furnish backfill for the bins specified by the bin manufacturer. If not specified, use a gravel-type soil with 95 percent passing the 2-inch (50 mm) sieve and not more than 10 percent passing the No. 200 sieve. The material volume swell cannot exceed 10 percent and must have a plasticity index not exceeding 10.

701.10 DRAIN AGGREGATE

Furnish drain aggregate that is rounded to sub-rounded aggregate meeting Table 701-21 gradation requirements.

**TABLE 701-21
TABLE OF GRADATIONS - DRAIN AGGREGATE**

PERCENTAGE BY WEIGHT PASSING SQUARE MESH SIEVES	
Sieve Size	Percent Passing
6 inch (152 mm)	100
3/4 inch (19 mm)	0-10
No.4 (4.75 mm)	0-5

701.11 GLASS CULLET FOR SOIL-AGGREGATE FILLER

When requested and approved as an aggregate blending material, furnish and blend Glass Cullet meeting AASHTO M-318. Meet the following requirements for the glass cullet and the blended product:

- A.** Furnish glass cullet containing no more than five percent cullet originating from non-beverage container glass. Furnish the Project Manager certification that the cullet meets this limit before it is used. If the cullet exceeds this limit, submit a laboratory test plan that meets the requirements of the appendices of AASHTO M-318. Approval of the cullet will be based on the approved testing plan and the test results;
- B.** Have the glass cullet tested to ensure it meets the physical properties and deleterious substances requirements in AASHTO M-318. Furnish the Project Manager copies of the test results before using the glass cullet;
- C.** Produce a glass cullet/ aggregate blended product that meets all requirements for the specified aggregate; and
- D.** Limit the glass cullet content to no more than 20 percent of the total blended product.

**SECTION 702
BITUMINOUS MATERIALS**

702.01 BITUMINOUS MATERIALS

Furnish bituminous materials meeting the requirements of the following tables. The MDT tables are located at the end of this Section.

Asphalt Cement	702-3
Rapid Curing Liquid Asphalt (RC).....	702-4
Medium Curing Liquid Asphalt (MC).....	702-5
Slow Curing Liquid Asphalt (SC).....	702-6
High Float Emulsions.....	702-7
Emulsified Asphalt	AASHTO M 140, Table 1 or AASHTO M 208, Table 1

Meet the requirements for bituminous materials specified in the contract.

702.02 TESTING AND ACCEPTANCE

A. All Properties Except Asphalt Cement Penetration. Bituminous materials are accepted on the test results of samples selected and tested by the Department or its authorized representative. Collect samples as specified in Subsection 402.03.2 and tested using the applicable AASHTO method. The Project Manager may permit using bituminous materials before the test results are available, if the test results of material previously furnished by the refiner have consistently been satisfactory. Bituminous materials used before receipt of the test results and permitted by the Project Manager does not waive the Department's right to accept or reject materials under these specifications.

B. Asphalt Cement Penetration. Asphalt cement penetration is sampled and accepted under Subsections 402.03.2 and 402.03.5(B).

**TABLE 702-1
BASIS FOR ACCEPTANCE OF BITUMINOUS MATERIALS**

SAMPLE TESTED	SPECIFICATION LIMITS ¹		TOLERANCE LIMITS		REMARKS
	Test Results Within Limits	Test Results Outside Limits	Test Results Within Limits	Test Results Outside Limits ³	
Original Sample	Accept Material	Apply Tolerance Limits ²	Accept Material	Test Retained Sample	Retained sample may be tested only if test results of original sample are outside tolerance limits.
Retained Sample	Accept Material	Apply Tolerance Limits ²	Accept Material	Accept Material at Reduced Price or Reject	

Notes:

1. See specification for bituminous materials.
2. Tolerance limits are applied to the minimum and maximum specification values of specification tables. See Table 702-2 for Schedule of Tolerances.
3. Pay adjustments will be applied under QA.

If test results of both the original and retained samples are not within the tolerance limits, the average of the two values will determine the basis for acceptance of the material.

Exception: If either of the two test values are outside the applicable ASTM Repeatability Range, then the test value numerically nearest the specification requirement will be used as the basis for acceptance. In the event a material fails more than one test requirement, that requirement with the greatest violation will determine the basis for acceptance. See Subsection 402.03.5(C) for the method of calculating price reductions.

TABLE 702-2
SCHEDULE OF TOLERANCES

TEST	ALLOWABLE VARIATION		REMARKS
	From Min. Specification Requirement	From Max. Specification Requirement	
Flash Test Asphalt Cement Cutback Asphalt	-5% -10%		
Penetration Liquid Asphalt Distillation Residues	-10%	+10%	
% Residue from Distillation	5%		% of Total Distillate: 2 ml may be added or subtracted at any distillation temp. before calculating the % recovered
Ductility	-10%		
Solubility	-0.5%		
Viscosity Cutback Asphalts Emulsified Asphalts	-10% 0%	+10% +25%	Emulsified asphalt in violation of the minimum specification requirement subject to rejection and removal from the work or 50% price reduction at the Engineer's discretion.
% Residue of 100 pen.	-5%	—	
Thin Film Oven Test % loss in wt. % retained pen.	— -2%	+10% —	
Demulsibility and Sieve Tests	-10%	+10%	
Spot Test	NO TOLERANCE - Materials in violation of spec. subject to standard price reduction.		
Water	NO TOLERANCE - Materials in violation of spec. subject to rejection or 50% price reduction at the Engineer's discretion.		
Particle Charge	NO TOLERANCE - Materials in violation of spec. and any aggregate used in conjunction with its use will, at the Engineer's discretion, be either rejected or paid for at a unit rate not to exceed 50% of the cost of the materials.		

**TABLE 702-3
SPECIFICATION FOR ASPHALT CEMENT**

	PENETRATION GRADE									
	40-50		60-70		85-100		120-150		200-300	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Penetration, 100 g, 5 sec. at 77 °F (25 °C), dmm	40	50	60	70	85	100	120	150	200	300
Flash Point, (Cleveland open-cup), °F (°C)	450 (232)	—	450 (232)	—	450 (232)	—	425 (218)	—	350 (176)	—
Ductility at 77 °F (25 °C), 5 cm per min., cm	100	—	100	—	100	—	100	—	—	—
Solubility, percent	99	—	99	—	99	—	99	—	99	—
Thin-film Oven Test, 1/8 in. (3.2 mm), 325 °F (163 °C), 5 hour loss on heating, percent	—	0.8	—	0.8	—	1.0	—	1.3	—	1.5
Penetration of residue, percent of original	58	—	54	—	50	—	46	—	40	—
Ductility of residue at 77 °F (25 °C), 5 cm per min., cm	—	—	50	—	75	—	100	—	100	—
Spot Test	Negative for all grades									

TABLE 702-4
SPECIFICATIONS FOR RAPID CURING LIQUID ASPHALTS

	RC-70		RC-250		RC-800		RC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140 °F (60 °C), centistokes ¹	70	140	250	500	800	1600	3000	6000
Flash Point (tag, open-cup), °F (°C)	—	—	80 (27)	—	80 (27)	—	80 (27)	—
Water, percent	—	0.2	—	0.2	—	0.2	—	0.2
Distillation Test: Distillate, percentage by volume of total distillate to 680 °F (360 °C)								
to 374 °F (190 °C)	10	—	—	—	—	—	—	—
to 437 °F (225 °C)	50	—	35	—	15	—	—	—
to 500 °F (260 °C)	70	—	60	—	45	—	25	—
to 600 °F (315 °C)	85	—	80	—	75	—	70	—
Residue from distillation to 680 °F (360 °C) volume percentage of sample by difference	55	—	65	—	75	—	80	—
Tests on residue from distillation:								
Penetration, 100 g, 5 sec. at 77 °F (25 °C), dmm	80	120	80	120	80	120	80	120
Ductility, 5 cm/min. at 77 °F (25 °C), cm	100	—	100	—	100	—	100	—
Solubility, percent	99	—	99	—	99	—	99	—

Notes:

- As an alternate, Saybolt-Furol viscosities may be specified as follows:
Grade RC-70 - Furol viscosity at 122 °F (50 °C) - 60 to 120 sec.
Grade RC-250 - Furol viscosity at 140 °F (60 °C) - 125 to 250 sec.
Grade RC-800 - Furol viscosity at 180 °F (82.2 °C) - 100 to 200 sec.
Grade RC-3000 - Furol viscosity at 180 °F (82.2 °C) - 300 to 600 sec.

TABLE 702-5
SPECIFICATION FOR MEDIUM CURING LIQUID ASPHALTS

	MC-30		MC-70		MC-250		MC-800		MC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140 °F (60 °C), centistokes ¹	30	60	70	140	250	500	800	1600	3000	6000
Flash Point (tag, open-cup), °F (°C)	100 (38)	—	100 (38)	—	150 (66)	—	150 (66)	—	150 (66)	—
Water, percent	—	0.2	—	0.2	—	0.2	—	0.2	—	0.2
Distillation Test: Distillate, percentage by volume of total distillate to 680 °F (360 °C)										
to 437 °F (225 °C)	—	25	0	20	0	10	—	—	—	—
to 500 °F (260 °C)	40	70	20	60	15	55	0	35	0	15
to 600 °F (315 °C)	75	93	65	90	60	87	45	80	15	75
Residue from distillation to 680 °F (360 °C) volume percentage of sample by difference	50	—	55	—	67	—	75	—	80	—
Tests on residue from distillation: Penetration, 100 g, 5 sec. at 77 °F (25 °C), dmm	120	250	120	250	120	250	120	250	120	250
Ductility, 5 cm/cm, cm ²	100	—	100	—	00	—	100	—	100	—
Solubility, percent	99	—	99	—	99	—	99	—	99	—
Spot Test	Negative for MC-3000 only									

Notes:

- As an alternate, Saybolt-Furol viscosities may be specified as follows:
Grade MC-70 - Furol viscosity at 122 °F (50 °C) - 60 to 120 sec.
Grade MC-30 - Furol viscosity at 77 °F (25 °C) - 75 to 150 sec.
Grade MC-250 - Furol viscosity at 140 °F (60 °C) - 125 to 250 sec.
Grade MC-800 - Furol viscosity at 180 °F (82.2 °C) - 100 to 200 sec.
Grade MC-3000 - Furol viscosity at 180 °F (82.2 °C) - 300 to 600 sec.
- If the ductility at 77 °F (25 °C) is less than 100, the material will be acceptable if its ductility at 60 °F (15.5 °C) is more than 100.

**TABLE 702-6
SPECIFICATIONS FOR SLOW CURING LIQUID ASPHALTS**

	SC-70		SC-250		SC-800		SC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140 °F (60 °C), centistokes ¹	70	140	250	500	800	1600	3000	6000
Flash Point (Cleveland, open-cup), °F (°C)	150 (66)	— —	175 (79)	— —	200 (93)	— —	225 (107)	— —
Water, percent	—	0.5	—	0.5	—	0.5	—	0.5
Asphalt residue of 100 pen., percent by wt.	50	—	60	—	70	—	80	—
Distillation Test: Total distillate to 680 °F (360 °C), percent by volume	10	30	4	20	2	12	—	5
Tests on residue from distillation:								
Kinematic Viscosity at 140 °F (60 °C), centistokes	4	70	8	100	20	160	40	350
Ductility of 100 pen., residue at 77 °F (25 °C), 5 cm per min., cm	100	—	100	—	100	—	100	—
Solubility, percent	99	—	99	—	99	—	99	—

Notes:

- As an alternate, Saybolt-Furol viscosities may be specified as follows:
Grade SC-70 - Furol viscosity at 122 °F (50 °C) - 60 to 120 sec.
Grade SC-250 - Furol viscosity at 140 °F (60 °C) - 125 to 250 sec.
Grade SC-800 - Furol viscosity at 180 °F (82.2 °C) - 100 to 200 sec.
Grade SC-3000 - Furol viscosity at 180 °C (82.2 °F) - 300 to 600 sec.

TABLE 702-7
SPECIFICATIONS FOR HIGH FLOAT EMULSIONS

GRADE	HF-100	
	Min.	Max.
Tests on emulsions:		
Viscosity Saybolt Furol at 122 °F (50 °C), sec.	50	400
Storage Stability 24 hr., %	—	1
Sieve Test, %	—	0.1
Demulsibility, 50 ml. 5.55 g/L CaCl ₂ , % by mass	30	—
Distillation:		
Residue, %	65	—
Oil Distillate, by volume of emulsion, %	—	2
Tests on residue from distillation test:		
Penetration at 77 °F (25 °C), 100 g, 5 sec., dmm	100	170
Ductility at 77 °F (25 °C), 5 cm per min., cm	40	—
Solubility, percent	95.5	—
Float Test at 140 °F (60 °C), sec.	1200	—

TABLE 702-8
LATEX OR POLYMER MODIFIED CRS-2 EMULSIFIED ASPHALT

PROPERTY	TEST METHOD	LMCRS-2	CRS-2P
Viscosity at 122 °F (50 °C), sec.	AASHTO T-59	75-400	50-400
Sieve, percent	AASHTO T-59	0.3 max.	0.3 max.
Settlement, 5 days, percent	AASHTO T-59	5 max.	5 max.
Demulsibility, percent	AASHTO T-59	40 min.	40 min.
Storage Stability Test, 1 day, percent	AASHTO T-59	1 max.	1 max.
Particle Charge	AASHTO T-59	Positive	Positive
Ash Content, percent	AASHTO T-111	0.2 max.	0.2 max.
Tests on Residue by Evaporation: Percent Residue	AASHTO T-59	65 min.	65 min.
Penetration, 100 g, 5 sec. at 77 °F (25 °C), dmm	AASHTO T-49	100-200	100-250
Ductility at 77 °F (25 °C), 5 cm per minute, cm	AASHTO T-51	40 min.	75 min.
Elastic Recovery, percent	AASHTO T-301		58 min.
Torsional Recovery, percent	MT-333	18 min.	

TABLE 702-9
PERFORMANCE GRADED ASPHALT BINDER (PGAB)

PERFORMANCE GRADE	PG 52				PG 58				PG 64				PG 70			
	-22	-28	-34	-40	-22	-28	-34	-40	-22	-28	-34	-40	-22	-28	-34	-40
Average 7-day Maximum Pavement Design Temperature, °C	<52															
Minimum Pavement Design Temperature, °C	-22	-28	-34	-40	-22	-28	-34	-40	-22	-28	-34	-40	-22	-28	-34	-40
	Original Binder															
Flash Point Temp, AASHTO T48: Minimum °C Cleveland Open Cup (COC)	230															
Viscosity, AASHTO T316 Maximum, 3 Pa·s (3000 cP), Test Temp, °C M	135															
Dynamic Shear (DSR), AASHTO T315 G'/sin Δ, Minimum, 1.00 kPa Test Temperature @ 10 rad/s, °C	52				58				64				70			
	Rolling Thin Film Oven Residue AASHTO T240															
Mass Loss, Maximum, %	1.0															
Dynamic Shear (DSR), AASHTO T315 G'/sin Δ, Minimum, 2.20 kPa Test Temperature @ 10 rad/s, °C	52				58				64				70			
	Pressure Aging Vessel Residue AASHTO R28															
Pressure Aging Vessel (PAV) Aging Temperature, °C	90															
Dynamic Shear (DSR), AASHTO T315 G'/sin Δ, Maximum 5000 kPa Test Temperature @ 10 rad/s, °C	19	16	13	10	22	19	16	13	25	22	19	16	28	25	22	19
Bending Beam Rheometer (BBR) Creep Stiffness, AASHTO T313 S, Maximum, 300 Mpa m-value, Minimum, 0.300 Test Temp, @ 60 sec, °C	-12	-18	-24	-30	-12	-18	-24	-30	-12	-18	-24	-30	-12	-18	-24	-30
Direct Tension (DT), AASHTO T314 Failure Strain, Minimum, 1.0% Test Temp @ 1.0 mm/minute C	-12	-18	-24	-30	-12	-18	-24	-30	-12	-18	-24	-30	-12	-18	-24	-30

SECTION 703

LIGHTING & SIGNAL MATERIALS

703.01 GENERAL

Furnish all electrical equipment that meets the contract and the following requirements:

- National Electrical Manufacturers Association (NEMA);
- The National Electrical Code (referred to as the Code);
- The standards of the American Society for Testing Materials (ASTM);
- The American National Standards Institute (ANSI); and
- All state and local laws or ordinances that may apply.

References to the above codes or standards are the current editions of the code, order, or standard at the time the contract is let and governs throughout the life of the contract.

Furnish galvanized parts and meeting ASTM A 153, B 454 (Class 50), or other applicable ASTM galvanizing specifications. Anchor bolts may be galvanized, or cadmium plated with Type NS coating meeting ASTM A 165. Galvanized bolts and nuts must thread together without damaging the coating.

703.02 CONDUIT

703.02.1 Plastic Conduit

Furnish rigid polyvinyl chloride meeting UL 651, schedule 80, 150 °F (66 °C) wire rated, direct bury type. Install conduit meeting the applicable requirements of Section 616.

703.02.2 Steel Conduit

Furnish galvanized rigid steel conduit and fittings of mild steel meeting UL 6 and ANSI C 80.1 requirements. Cut a 3-foot (915 mm) test sample of conduit, witnessed by an Inspector, from the end of each size of conduit to be used on the project. Conduit is tested under ASTM A 239.

Install conduit meeting the applicable requirements of Section 616.

703.03 PULL BOXES

703.03.1 Concrete Pull Boxes

Furnish concrete pull boxes, extensions, and covers made of reinforced concrete. Use Class "DD" concrete meeting Section 551 requirements. Use reinforcing steel meeting Section 555 requirements.

Meet the pull box size and details specified in the contract.

Inscribe reinforced concrete covers for signal systems, or combined signal and low-voltage lighting systems with the words "TRAFFIC SIGNALS". Furnish reinforced concrete covers for lighting systems inscribed with the words "STREET LIGHTING" ("HIGH VOLTAGE" where specified). Provide two 3/8-inch (9.5 mm) brass or stainless steel hold-down bolts, washers and nuts with the cover. Recess the nuts below the surface of the cover. Furnish a steel cover designed to withstand AASHTO H-20 loads for pull boxes subject to traffic loads.

Assure pull boxes are watertight. Seal the covers with a 1/4-inch (6 mm) bead of asphaltic mastic in the cover recess. Make conduit enter from the bottom of the box.

Furnish metal frames and covers for boxes or vaults formed in the concrete. Inscribe covers with the wording specified in the contract. Assure gasket surfaces form a true plane. Install a 1/8-inch (3 mm) one-piece neoprene gasket on the frame or cover for the seal.

703.03.2 Metal Pull Boxes

Furnish metal pull boxes made from cast iron with a checkered steel cover, both hot dip galvanized. Attach the cover to the box with brass or stainless steel screws. Provide the cover with a gasket that, with the cover in place, forms a NEMA Type 4 watertight fit. Boss, drill, tap and treat conduit entrances to the box for corrosion protection. Meet the pull box size and details shown in the contract.

703.03.3 Reserved**703.04 STANDARDS AND POSTS****703.04.1 General**

Furnish standards fabricated under Section 556 and designed meeting the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals".

Use a minimum luminaire dead load of 75 pounds (34 kg), and a minimum luminaire projected area of 3.3 square feet (0.31 square meter) for design purposes. Use a design wind velocity for all standards of 90 miles per hour (145 km/h).

All standards must be steel. Once the standards, posts, or pedestals are erected and the installation complete, grout any gap between the base and foundation using grout meeting Subsection 713.04 requirements. Form a 3/4-inch (19 mm) drain hole in the grout at the lowest point.

Meet the standard manufacturer's recommendations for the anchor bolt placement in the foundation.

Install standards or posts as specified in the contract.

Repair all damage to galvanized surfaces on poles and standards by applying one coat of cold galvanizing compound to the damaged area.

703.04.2 Type 2 and 3 Signal Standards

Furnish a single steel section shaft formed into a round, continuous taper with a single, automatic electrically welded seam, or an approved equal.

Show the type of steel used for the shafts on the shop drawings.

Provide four high-strength steel anchor bolts with each shaft. Furnish each anchor bolt with two nuts and two washers over and under the shaft base to adjust rake and plumb.

Field-drill other holes for wire entry, mounting pedestrian and vehicle signals, or pedestrian pushbuttons. Treat the holes or threads with a cold galvanizing compound following the manufacturer's directions.

All accessories welded to the shaft must be factory-welded before galvanizing.

Furnish rain tight metal covers for the top of Type 2A and 3A signal standards.

703.04.3 Type 10 Luminaire Standards

Shafts must be a single section formed into a round, continuous taper with a single, automatic electrically welded seam, or approved equal. Steel shafts must be a minimum No. 11 Manufacturer's Standard Gauge.

Show the type of steel on the manufacturer's shop drawings.

Provide a rain-tight cover for the top of each shaft.

Shafts not mounted on transformer bases must have a handhole with removable cover and an internal grounding lug, as shown on the plans. Locate the handhole in the same quadrant as the mast arm.

Shafts mounted on transformer bases do not require a handhole or grounding lug.

The shaft base (anchor or breakaway) to be used is specified in the contract.

The shaft base plate must be a one-piece plate circumferentially welded to the shaft for anchor and breakaway base types.

For anchor bases, the base plate must attach directly to the anchor bolts. Furnish each anchor bolt with two nuts and two washers for plumbing and raking the shaft.

For breakaway bases, the plate must be attached to a breakaway device that attaches to the anchor bolts.

Use breakaway bolt couplings unless they do not function with the approved luminaire standard. The bolt coupling must meet the AASHTO publication, "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals" requirements.

Use frangible transformer bases where bolt couplings cannot be used. Transformer bases must have an access door, grounding lug, and factory-made shims for plumbing. Provide each anchor bolt with one nut and one washer.

Provide four high strength steel anchor bolts with each shaft. Furnish "L" shaped anchor bolts with a minimum 6-inches (155 mm) of the bolt threaded at the top. Size the anchor bolt following the shaft manufacturers recommendations.

Anchor bolts used with breakaway bolt couplings must project out of the foundation the length recommended by the coupling manufacturer. Furnish the breakaway bolt coupling, washer, nut and bolt covering that enclose the area between the base plate and foundation.

Anchor bolts used with transformer bases must project at least 3 inches (75 mm) from the foundation.

Provide a mounting base where the mast arm connects to the shaft. Provide an opening in the base for running wire from the shaft to the mast arm.

Field drill other holes for wire entry, mounting pedestrian and vehicle signals, or pedestrian pushbuttons. Treat the holes or threads with a cold galvanizing compound following the manufacturers recommendations.

All accessories welded to the shaft must be factory-welded before galvanizing.

703.04.4 Mast Arms - Signal and Luminaire

Mast arms must be single tapered members.

The mast arm end must have a 2-inch (50 mm) slip-fitter tenon at least 6 inches (155 mm) long.

All accessories welded to the mast arm must be factory-welded before galvanizing.

Mast arm lengths and mounting heights are shown on the plans.

703.04.5 Type 1-80, 1-100, 1-120, 1-140, and 1-160 Signal Standards

Furnish standards as specified in the contract.

Furnish a cast aluminum base with an internal ground lug and handhole with removable cover. Plumb bases with factory-made shims. Provide a nut and washer with each anchor bolt for the base.

Anchor bases may be used when a single conduit enters the shaft base. The anchor base must be a one-piece steel plate circumferentially welded to the shaft before galvanizing. Furnish two nuts and two washers with each anchor bolt for plumbing and raking the standard.

Provide four high strength steel anchor bolts with each shaft. Furnish "L" shaped anchor bolts with a minimum 6 inches (155 mm) of the bolt threaded at the top.

Leave anchor bolts projecting at least 3 inches (75 mm) from the foundation.

Follow the manufacturer's recommendations for anchor bolt size and bolt circle.

Field drill holes for wire entry, mounting pedestrian and vehicle signals, or pedestrian push buttons. Treat the holes or threads with a cold galvanizing compound following the manufacturer's recommendations.

All accessories welded to the shaft must be factory-welded to the shaft before galvanizing.

703.04.6 Welding Steel

Meet the American Welding Society Specifications for Welded Highway and Railway Bridges, AWS D-1.1-75 and AWS D1.1 or current revisions, and as amended by AASHTO and the Montana Supplemental Specifications for Welding.

Furnish weld procedures with the shop drawings showing complete welded joint details including material, process, procedure, filler metal, welding technique, workmanship, dimensional tolerances for each type joint used in fabrication, pre-heat, interpass, and heat treatment temperature schedules.

703.04.7 Reserved

703.04.8 Finish

Furnish standards galvanized inside and out. A primer finish is not acceptable. Use stainless steel or zinc, cadmium, or galvanized coated fasteners. Provide galvanized nuts, washers, and shims for anchor bolts.

703.04.9 Wire Protection

Use insulated bushings or grommets to prevent wire abrasion at all wire openings and inlets.

703.04.10 Inspection

All standards will be inspected at the project before they are erected and may be inspected where fabricated.

703.05 CONCRETE FOUNDATIONS

Use Class "D" concrete for all foundations for standards.

Concrete quantity increases for foundations to accommodate the standard furnished by the manufacturer are at Contractor expense.

Construct foundations to accommodate the steel conduit and anchor bolts as specified.

Pancake grounds cannot be used.

Reinforce foundations with No.4 (#13) hoops at 1-foot (610 mm) centers and with eight No.6 (#19) bars equally spaced around the hoops. Form the top 6 inches (155 mm) of the foundation, beveling the exposed concrete edge 2 inches (50 mm). Electrically bond all conduit in each foundation to an anchor bolt using an AWG No.6 copper grounding strap. Connect a bare copper AWG No.6 solid wire between the grounding lug on the standard and the grounding strap.

703.06 CONDUCTORS AND CABLE

703.06.1 Conductors

Furnish conductors of solid or stranded copper of the gauge shown in the contract.

Insulation for conductors must be Type THW, XHHW, USE, RHH, RHW, THWN, or THHN.

All insulation must be designed for 600 volts and meet the code requirements.

Supply connectors and fuses shown in the contract and required to complete the work.

Furnish watertight connectors with midget ferrule type fuses.

703.06.2 Signal Cable

Furnish cable meeting the International Municipal Signal Association (IMSA) Specification No.19-1 or 20-1.

Individual conductors must be stranded copper.

Use spade-type connectors.

703.06.3 Detector Loop Shielded Cable

Use cable as a lead-in between the loop pull box and the loop detector as specified.

Furnish with an aluminum-polyester shield with two AWG No.14 stranded, tinned, polyethylene-insulated copper conductors, a stranded and tinned copper AWG No.18 or 16 drain wire, all encased in a black polyethylene jacket meeting IMSA Specification No.50-2.

Ground the drain wire at the controller cabinet and dead end where the cable connects to the loop wires.

Make cable to loop wire connections within the pull boxes or signal standards with soldered, waterproof splices.

No other splices are allowed.

703.06.4 Emergency Preemption Detector Cable

Run the cable from the detector head to the discriminator.

Follow the preemption manufacturers recommendations for detector cable connections at the discriminator and detector head.

No splices are allowed in the cable.

703.06.5 Communication Cable

Furnish BJFC 6 pair AWG No. 19 copper cable meeting REA specification PE 39. Do not splice this cable.

703.07 SERVICE AND CONTROL ASSEMBLY

Equip and locate service and control assemblies as shown on the plans. Meet the Code and local utility company requirements.

Furnish cabinets meeting NEMA Type 3, 3R, or 12, made of aluminum or code-grade steel having a hinged, lockable door.

Furnish the Project Manager three keys to the lock.

Include a terminal strip having the number of attaching points for the required conductors with the service and control assembly. Assure the terminal strip has the capacity equal to an AWG No. 6 conductor. Run a bare AWG No.6 solid copper ground wire from the cabinet to a 5/8-inch (16 mm) by 8 foot (2.4 m) copperweld ground rod and clamp, as shown in the plans.

Provide all steel conduit, ground wire, insulated clevis, service wire, all mounting hardware and fittings to complete the work.

Construct photoelectric controls and their associated wires meeting Subsection 703.14 requirements.

703.08 SIGNAL CONTROLLERS**703.08.1 General**

Furnish traffic signal equipment meeting the National Electrical Manufacturer's Association (NEMA) Standards Publication No. TS 1-1976 through TS 1-1989 for traffic control systems.

The equipment must also comply with the National Electric Code, ASTM, ANSI, MUTCD and state plus local requirements.

Warrant the entire cabinet and electronics to be free from defects in workmanship and material for six months from the date of installation. Replace any defective parts at Contractor expense.

Assure a signal controller and cabinet manufacturer's representative is present at the signal turn-on to provide technical assistance in setting up, checking out, and demonstrating that the signal meets functional requirements.

703.08.2 Traffic Actuated Controller

Furnish a controller that is a micro-processor based solid state traffic responsive machine that provides 4 pedestrian phases and 4 vehicle phases for the Type 4-A-SS, and 4 pedestrian phases and 8 vehicle phases for the Type 8-A-SS. The 4-A-SS must have two programmable phase overlaps and the 8-A-SS must have four programmable phase overlaps.

The basic elements for the controller must be on modules that are plug connected to the main frame assembly and interchangeable between Traconex controllers. The controller must have an RS232 port capable of upload, download, modem connection, using a DB25 system connector.

The controller must have an internal time clock to enable outputs such as coordination, flash, dial, split, and offset choices. Timing must be accomplished by digital methods and utilize the power line frequency as a base. All automatic time corrections or synchronization except from power outages must be made at 12:00 midnight.

The controller must have an internal coordinator capable of being a master or slave with the appropriate inputs/outputs for 6 dials, 3 splits, and 3 offsets. Coordination must not interfere with non-coordinated signal operation when any other NEMA controller with the same number of phases is substituted.

Assure each phase has identical control capabilities, features, and options. The options and features for each phase must be able to be exercised independently of the options and features exercised on other phases. All controller unit timing intervals and phase options must be programmable from the front panel via a keyboard pad without the use of tools or special auxiliary units. The controller must be menu driven with an LCD display having at least 4 lines, 40 characters long.

The front panel must display the following information:

1. Presence of Vehicle Calls and Actuations on each phase;
2. Presence of Pedestrian Calls on each phase;
3. Termination of phase because of Gap-out;
4. Termination of phase because of maximum Time-out or Force-off;
5. Maximum 2 in effect;
6. Phase Timing;
7. Phase Next;
8. Interval Timing;
9. Time remaining in interval;
10. Hold in effect;
11. Controller at rest; and
12. Preemption.

The front panel must permit programming the following functions and display their status:

1. Phases that are to be enabled for the specific intersection configuration;
2. Concurrent pedestrian phases that are to be enabled for the specific intersection configuration;
3. Flashing or steady walk outputs per phase;
4. Phase that is to rest in walk if there are no conflicting calls;
5. Phases that guarantee timing of the pedestrian clearance intervals when under manual control;
6. Phases assigned to non-actuated #1 and #2 inputs;
7. Start up phase and phase indication;
8. Start up flashing time; and
9. Phase Overlaps.

Overlaps must be programmable from a NEMA overlap card or from the front panel. The programming must consist of assigning the overlapped phases to the respective overlap.

It must be able to display previously programmed data stored in the controller from the front panel. The parameter called for and its current programmed value must be displayed without interruption of the controllers cyclic operation. It must be possible to change any programmed values while the controller is operating.

All display indicators must have a minimum design life of 20,000 hours at the rated voltage.

A. Cabinet. The controller and auxiliary equipment making up the rest of the controller unit with the exception of the preemption detectors and their lead-in cable must be housed in a weatherproof cabinet. Furnish a NEMA Type 3R rated and UL listed cabinet.

Fabricate the cabinets from sheet aluminum at least 0.125-inches (3.2 mm) thick, adequately reinforced, and weatherproof. The cabinet exterior must have a factory-applied prime coat and grey powder coated finish. The cabinet interior must have a white finish.

Provide the main cabinet door with a handle and a tumbler lock keyed for a Corbin #2 key. Equip the auxiliary door with a lock for a standard police key. Furnish two keys for each lock. The door must lock automatically when the door is closed and latched, with the key removed.

Furnish the cabinet with a doorstop assembly to hold the door open at approximately 90 degrees and 150 degrees.

Cabinet sizes are as follows:

1. **"H" Cabinet, Pole Mounted.** The minimum dimensions are 42 inches (1066 mm) high x 26 inches (660 mm) wide x 17 inches (430 mm) deep.
2. **"M" Cabinet, Pedestal Mounted.** The minimum dimensions are 51 inches (1295 mm) high x 30 inches (765 mm) wide x 17 inches (432 mm) deep.
3. **"P" Cabinet, Pedestal Mounted.** The minimum dimensions are 56 inches (1422 mm) high x 44 inches (1118 mm) wide x 26 inches (660 mm) deep.

Furnish two anchor bolts with "M" cabinets. Furnish four anchor bolts with "P" cabinets. Furnish two washers and one nut with each bolt. Furnish bolts meeting the manufacturer's recommendations. Furnish hardware to pole mount the "H" cabinets.

Equip cabinets with an electric fan rated at 100 cubic feet per meter (2.8 cubic meters per min.) minimum. Mount the fan in the top of the cabinet in a manner that prevents rain from entering. The fan must be thermostatically controlled and manually adjustable to turn on between 70 °F (20 °C) and 150 °F (65 °C). Fuse the cabinet fan circuit 125 percent of the capacity of the fan motor.

Furnish the cabinet with louvered filtered vents in the front door. Mount a removable air filter with a metal retainer spring inside the cabinet door behind the louvered vents.

Mount an incandescent lamp on the inside top of the cabinet, near the door. The lamp must provide illumination whenever the cabinet door is open. Florescent lamps are not acceptable.

Equip cabinets with a 150-watt strip heater with a variable adjustable thermostat on a separate circuit breaker and switch.

Supply a copy of the cabinet wiring diagram, a copy of the operating manual for each device, and a copy of the manual for controller P.C. software. Place the wiring diagram in a heavy-duty clear plastic pouch, attached to the inside of the main cabinet door. This pouch must be of a material and design that it provides storage and access to the wiring diagram.

Submit a schematic wiring diagram of the controller and auxiliary equipment before purchasing. This diagram must detail all circuits and parts. Identify the parts shown by name or number. Furnish parts that are readily available and non-proprietary.

B. Cabinet Wiring. The cabinet wiring must provide the following services:

Cabinets must have interface panels capable of terminating a 12-conductor wire 120-volt interconnect and 4-conductor telemetry. A master cabinet must have a relay driven 120-volt panel. A slave cabinet must have a solid-state 120-volt panel. This interface panel must provide the following functions:

1. Offset 1;
2. Offset 2;
3. Offset 3;
4. Dial 2;
5. Dial 3;
6. Dial 4;
7. Flash;
8. Split 2;
9. Coordination/Free;
10. Split 3;
11. AC common from Master; and
12. Spare.

Wire cabinets with a plug-in mounted (solid-state) flasher, and jack mounted relays to permit any combination of flashing red or yellow lights. Operation must cut in flasher and isolate controller from signal light circuits. The NEMA flash circuit must not be controlled by the controller.

Furnish a readily accessible mounting panel in each controller cabinet with provisions for terminating all field circuits.

Wire "H" cabinets for 6 load switches, (4 vehicle and 2 pedestrian). Wire "M" cabinets for 9 load switches, (4 vehicle, 4 pedestrian and 1 overlap). Wire "P" cabinets for 14 load switches, (8 vehicle, 4 pedestrian and 2 overlap).

Terminate the spare output circuits of pedestrian load switches on field terminals for future use.

The cabinet must include a police panel with the following switches:

<u>Switch</u>	<u>Function</u>
Auto-flash	The Flash position places the intersection in Flash and turns the conflict monitor and Opticom off and stop-times the controller. Assure the controller begins its mode of operation in the startup routine upon return from the Flash position to the Auto position.
Main Switch	The On position provides normal operation. The Off position removes power from the cabinet, with the exception of the convenience outlet.

Include an auxiliary test panel with the following switches for the cabinet:

<u>Switch</u>	<u>Function</u>
Auto-flash	The Flash position places the intersection in Flash and allows the controller and auxiliary equipment to operate.
Stop-time	The On position applies stop-timing (On - Off - Auto) to the controller. The Auto position allows the conflict monitor or other external source to apply stop-timing to the controller. The Off position removes any external stop-timing applied to the controller.

Each phase has vehicle and pedestrian push buttons to place calls on the phase; six for "H" cabinets, 8 for "M" cabinets, and 12 for "P" cabinets.

Include a 15 amp fused convenience ground fault outlet with the auxiliary test panel. Wire the outlet so it remains functional even with the main switch or main circuit breaker in the off position.

The cabinet must contain an input power panel with the following:

1. Main Circuit Breaker: 40 Amp for 4-A-SS, 50 Amp for 8-A-SS;
2. 20 Amp Auxiliary Equipment Circuit Breaker;
3. 50 Amp RIS;
4. Transient Voltage Protector;
5. Neutral Bus Bar;
6. Base-mounted MOV rated at 70 joules or greater;
7. Ground Bus Bar;
8. 50 Amp Mercury Contactor; and
9. Gas Tube Lightning Arrester.

Wire a transient voltage protector into the cabinet.

The power input for the controller, conflict monitor and other control equipment, exclusive of the flasher circuitry, must come from the transient voltage protection device that protects against abnormalities of less than one-half cycle duration. The protector must be a solid-state high energy circuit containing no spark gap, gas tube or bar component.

The devices current rating must equal or exceed 15 amps.

The protection must be a transient suppression of 200 volts peak, a transient response of less than five nanoseconds, a power dissipation of 10,000 watts, and an overvoltage response of five seconds. The protector must function with a 10 x 1000 microsecond wave form clamping no greater than 200 volt peak.

Wire cabinets to provide for a conflict monitor. Provide cabinet interlock circuitry which automatically places the intersection signals on flashing operation if the conflict monitor is disconnected while the controller is operating the signals and the cabinet door is closed.

Wire cabinets for rack mount vehicle detectors. "H" and "M" cabinets must have a 6-position rack. "P" cabinets must have a 10-position rack. Assign rack slots with slot 1 being for phase 1 detector, slot 2 for phase 2 detector with other slots following this example. Reserve slots 5 and 6 for Opticom in "H" and "M" cabinets. Reserve slots 9 and 10 for Opticom in "P" cabinets. Equip all racks with an external wall mount fused +24 volt DC regulated power supply rated at 2.4 amps.

Install a panel mounted on the lower left side of the cabinet having terminals to terminate loop lead-in cables and up to 4 pedestrian push button lead-in cables for the Type 4-A-SS and 8-A-SS controllers.

Pin assignments for the 4th connector are shown in Table 703-1:

**TABLE 703-1
PIN ASSIGNMENTS FOR THE 4TH CONNECTOR**

PIN	FUNCTION	I/O	ADDRESS BIT
1	Emergency Preempt 4 Out	O	\$62-3
2	Offset 3 Out	O	\$61-2
3	Offset 4 In (Add Bit 3)	I	\$61-3
4	ON LINE	I	\$61-5
5	Spare	O	\$62-7
6	Dial 4 In	I	\$60-3
7	Dial 6 In	I	\$60-5
8	Special Function 2 Out	O	\$61-6
9	Split 3 In	I	\$60-7
10	Offset 2 In (Add Bit 1)	I	\$61-1
11	Flash Out	O	\$62-6
12	Offset 1 In (Add Bit 0)	I	\$61-0
13	System Detector 8	I	\$63-7
14	Dial 5 In	I	\$60-4
15	Special Function 3 Out	O	\$61-7
16	Split 2 In	I	\$60-6
17	System Detector 1 (Seq. #1)	I	\$63-0
18	System Detector 4 (Seq. #4)	I	\$63-3
19	System Enable	I	\$61-6
20	Dimming On	I	\$61-7
21	Split 2 Out	O	\$60-6
22	Emergency Preempt 2 Out	O	\$62-1
23	Railroad Preempt Out	O	\$62-4
24	Spare	O	\$62-5
25	Dial 2 In (Special Function 2)	I	\$60-1
26	Coordination On (Special Function 1)	I	\$60-0
27	Coordination Out	O	\$60-0
28	Special Function 1 Out	O	\$61-5
29	Dial 4 Out	O	\$60-3
30	System Detector 5 In	I	\$63-4
31	System Detector 3 (Seq. #3)	I	\$63-2
32	Emergency Preempt 1 Out	O	\$62-0
33	Offset 1 Out	O	\$61-0
34	Emergency Preempt 3 Out	O	\$62-2
35	Dial 3 In (Special Function 3)	I	\$60-2
36	Offset 3 In (Add Bit 2)	I	\$61-2
37	Flash Status In	I	\$62-7
38	Offset 5 In (Add Bit 4)	I	\$61-4
39	System Detector 6 In	I	\$63-5
40	System Detector 7 In	I	\$63-6
41	Offset 4 Out	O	\$61-3
42	Offset 2 Out	O	\$61-1

PIN	FUNCTION	I/O	ADDRESS BIT
43	Dial 2 Out	O	\$60-1
44	Dial 3 Out	O	\$60-2
45	Offset 5 Out	O	\$61-4
46	Split 3 Out	O	\$60-7
47	System Detector 2 (Seq. #2)	I	\$63-1
48	Logic Ground		
49	Emergency Preempt 1 In	I	\$62-0
50	Emergency Preempt 2 In	I	\$62-1
51	Dial 5 Out	O	\$60-4
52	Dial 6 Out	O	\$60-5
53	Logic Ground		
54	Logic Ground		
55	Emergency Preempt 3 In	I	\$62-2
56	Emergency Preempt 4 In	I	\$62-3
57	Railroad Preempt In	I	\$62-4
58	Conflict Status In	I	\$62-5
59	Reserved		
60	Flash Command In	I	\$62-6
61	Reserved		
62	Reserved		
63	Chassis Ground		

Wire cabinets for Opticom emergency preemption equipment. Provide interface terminals for two Model 562 discriminators wired as follows:

4-A-SS

Discriminator #1 Channel A = Ø1
 Discriminator #1 Channel B = Ø3
 Discriminator #2 Channel A = Ø2
 Discriminator #2 Channel B = Ø4

8-A-SS

Discriminator #1 Channel A = Ø1 & Ø6
 Discriminator #1 Channel B = Ø3 & Ø8
 Discriminator #2 Channel A = Ø2 & Ø5
 Discriminator #2 Channel B = Ø4 & Ø7

Provide the necessary logic and wiring to allow the following operation:

1. Immediate advance of the controller to the clearance intervals of the phase timing;
2. All clearance intervals to be timed as set on the controller;
3. After proper clearances, the controller goes directly to the preempted phase bypassing any intervening phases in the normal sequences;
4. During preemption, all pedestrian indications to hold in DON'T WALK; and
5. Following preemption, places a minimum vehicle recall on all phases.

The Opticom interface panel must provide terminations for up to 4 Model 521 Opticom detectors for the Type 4-A-SS and 8-A-SS controllers. One detector must be assigned to correspond to each of the channels available on the discriminator.

Mark all wiring for easy identification. Use permanent labels.

703.08.3 Conflict Monitor

Furnish a self-contained solid-state conflict monitor able to detect the presence of conflicting signal indications and the absence of proper voltage at the field connection terminals of the red signals. It must be able to monitor for the presence of proper operating voltages in the controller and also within itself.

The conflict monitor must monitor switch fail conditions, inadequate yellow timing and have serial communications for a printer or computer.

Furnish a Type 6 or 12 conflict monitor with respect to the corresponding Type 4-A-SS or 8-A-SS controller. It must monitor the Green, Yellow, Red and Walk of each phase.

The front of the monitor unit must contain the MS connector, AC+ power fuse, power indicator, reset switch, signal conflict and Red failure indicators, +24 Volts DC #1 and #2 indicators, controller voltage failure indicator, signal status indicators for each channel, universal removable programming card, initial flash time adjustment control, a RS232 serial communications port, and an LCD display indicating which input on each channel is the conflicting display. All indicators must be LED type.

If a conflict monitor channel is used, bring out all unused inputs to a terminal for future use.

703.08.4 Flasher

Furnish a solid-state electronic flasher producing between 50 and 60 flashes per minute with equal on-and-off time intervals meeting all NEMA Type 3 requirements and conforming to part 4B-18 of the MUTCD.

703.08.5 Solid-state Load Switches

Accomplish switching of signal lights (external to the controller mechanism) by using solid-state switching assemblies. Furnish a load switch meeting all NEMA requirements as to the type. Supply 8 load switches with each Type 4-A-SS controller. Supply 12 load switches with each 8-A-SS controller.

703.08.6 Loop Detectors

Furnish two channel loop detectors of the rack mount type.

The loop detectors must be solid-state digital using external power. The front panel must contain sensitivity controls, mode selector switch, and an actuation indicator LED.

The loop detectors cannot use more than 150 MA of current at 24 volts DC. The output must be by relay and plug mounted. The relay must be normally energized providing fail-safe functioning should the power fail. Furnish loop detectors meeting all NEMA temperature requirements. Use a 44 pin edge card connector to make all electrical connections.

Supply 4 loop detectors with each Type 4-A-SS controller.

Supply 8 loop detectors with each Type 8-A-SS controller.

703.08.7 Railroad Interconnect

Where railroad interconnects to railroad circuits are specified, the railroad company must furnish a set of normally closed contacts in the railroad cabinet. Perform the traffic signal cabinet to railroad signal cabinet interconnect. Run the circuit conductors in underground, rigid electrical conduit as specified in the contract. Terminate the conduit in the railroad cabinet as directed by the railroad company engineer. Leave the wire ends projecting at least 3 feet (0.9 m) beyond the end fitting inside the railroad cabinet. The railroad must perform all work inside the railroad cabinet. Do not begin work within the railroad right of way without the Engineer's approval. The Engineer will obtain the railroad's approval and notify the Contractor. The railroad may provide any inspection necessary to oversee the Contractor's work on railroad right of way. Railroad inspection costs are at Contractor expense.

Observe the railroad special clearances found elsewhere in the contract.

Furnish solid-state railroad preemption devices meeting the following requirements:

- A. Signal Operation Preempted by Train.** Any vehicle signal displaying a green immediately receives a yellow clearance. The yellow clearance time may be controller-timed or by other timing device with a range of between 0 to 60 seconds.

Any vehicle signal displaying a yellow continues to time out the controller-set time or switch to an adjustable timer separate from the controller.

All pedestrian signals immediately receive a "DON'T WALK" call.

If vehicle signals are in emergency flashing, they remain flashing with the preemptor disconnected from the circuit.

Upon train preemption, a red signal must always be presented to approaching traffic in advance of the tracks.

The signal phasing during railroad preemption is specified in the contract.

- B. Signal Operation After Train Passage.** A signal call for "Green" and/or "Walk" must be placed on each phase for normal operation once the train has passed.

Any signal having the "Green" indication must receive a yellow clearance indication. The indication must be timed on the controller phase or other adjustable timer with limits of 0 to 30 seconds.

Once the yellow clearance interval is timed out, the controller reverts to normal operation unless a special sequence is specified.

703.09 TYPE "D" CABINET PEDESTAL

Locate the pedestal as specified or directed. Construct the pedestal, including the concrete work, as specified.

703.10 TRAFFIC AND PEDESTRIAN SIGNALS

703.10.1 Traffic Signal Heads

Furnish traffic signals meeting or exceeding the Traffic Engineers Technical Report No. 1, USAS D010.1-1966, UDC 656.057, or latest revision thereof. Use AWG No. 14 signal cable meeting Subsection 703.06.2 between the mast-arm mounted signals and the pole shaft mounted terminal block.

- A. Optical Units.** Furnish optical units consisting of a lens, reflector, lamp holder, and 120 volt, clear, 8,000-hour life, traffic signal lamp. Furnish 90, 91 or 116 watt traffic signal lamps rated at 1050 initial lumens for 8-inch (200 mm) signals and 135 watt traffic signal lamps rated at 1570 initial lumens for 12-inch lenses (300 mm).

Furnish the lens color and size specified in the contract. Use a polycarbonate traffic signal lens true to color.

Furnish an "Alzak" Type reflector.

- B. Signal Housing.** Assemble the signal head housing sections together in a watertight assembly. Each section must house an individual optical unit complete with a one-piece hinged door, a mounting for the lens and other optical system parts, watertight gaskets, and a non-corrodible door-lock.

Mount the optical system so the individual components swing open for access or removal. Assure sections are interchangeable and constructed so sections can be added or removed. Each section must have a round opening in the bottom and top to receive a 1 1/2-inch (38 mm) supporting pipe frame. The housing, including the doors and end plates must be die-cast aluminum, clean and smooth, free from flaws, cracks, blow holes, or other imperfections. Hinges, pins, lens clips, and locking devices must be non-corroding metal.

Mount a terminal block inside at the back of the housing. Wire all sockets with a white wire connected to the socket shell and a black wire to the bottom or end terminal of the socket. Connect these wires to the terminal block mounted in the housing.

The terminal block must have studs to terminate all field wires and lamp wires independently. Permanently identify the terminals.

Where terminal compartments are used, terminal blocks in the heads may be omitted.

Supply with each lens a removable tunnel visor (open bottom) of the appropriate size made from at least 0.050-inch (1.3 mm) thick aluminum.

The inside surface of all visors are to be flat black.

C. Back Plates. Furnish and install back plates on all traffic signal heads to form a 5-inch (130 mm) border around the signals. Make backplates from at least 0.058-inch (1.5 mm) sheet aluminum. Paint back plates under Subsection 617.03.12.

D. Mounting Brackets. Mount signal heads using brackets made from 1 1/2-inch (38 mm) standard steel pipe and malleable iron or brass pipe fittings. Plumb or level all elements, symmetrically arrange, and securely assemble. Conceal all conductors in the poles and assembly. At each signal location, construct a terminal compartment in the bracket system as shown on the plans. Bracket mounted signals that are post top mounted must have a terminal compartment cast with an integral slip-fitter. For post-top mounted one-way signal head, a slip-fitter without a terminal compartment may be used. Fit the slip fitter over a 4-inch (105 mm) standard pipe. Provide each slip-fitter with two rows of three set screws in each row to plumb the assembly. Use cadmium plated set screws. Signal heads mounted on luminaire standards or other tall poles must have a terminal compartment to bolt or clamp securely to the pole.

Provide each compartment with a terminal block with twelve terminals, each with two pressure type connectors. Size each connector to accommodate at least five No. 14 conductors.

Provide the terminal compartment with an access opening to the terminal block with a rain-tight cover. All slip-fitters and terminal compartments must be made of non-frangible metal.

E. Signal Head Mounting. Mount signal heads as shown on the plans. Use the standard mounting for all three-section mast arm mounted signals, unless 17.5 feet (5.3 m) of roadway clearance cannot be obtained. Use an elevator plumbizer, when necessary, to obtain the 17.5 foot (5.3 m) clearance.

Elevator plumbizer mount all four and five section signals.

Use internally wired plumbing devices for mounting signal heads to mast arms.

Provide positive lock rings and fittings for all signal heads. Use rings and fittings with serrated contacts.

F. Installing Signal Heads. Install signal heads after all other signal equipment is placed and ready for operation, or cover the signal faces with an opaque covering.

G. Directional Traffic Signals. The traffic signals must be optically-programmed and visible only to a specific area of the intersection.

Use 150-watt PAR lamps for optically-programmed signal lamps.

Furnish back plates, mounting brackets, installation, and mounting meeting Subsections 703.10.1(C), (D), (E), (F) and (G).

H. Dual Color Arrows. Furnish traffic signals equipped with a dual row of fiber-optic elements that produce a uniform display for yellow and green arrow indication. Ensure the fiber-optic elements have at least 74 light points and a 0.125-inch (3 mm) thick polycarbonate lens.

703.10.2 Pedestrian Signals

Furnish pedestrian signals rectangular in shape containing the letter messages "WALK" and "DON'T WALK" or the international symbols as specified. Letters must be at least 4 1/2 inches (115 mm) high. Furnish international symbols a minimum of 9 inch (230 mm) high. If, due to electrical or mechanical failure, the word "DON'T fails to illuminate in the "DON'T WALK" lens the signal must not illuminate the word "WALK".

Furnish one piece, watertight, cast aluminum housings with a polycarbonate lenses.

Furnish mounting hardware for pedestrian signals and mount as shown in the contract and meeting Subsection 703.10.1(D) requirements.

Furnish a terminal compartment with the frame-work for each signal mounting.

Provide AWG No.14 conductors meeting Subsection 703.06.1 from the signals to the terminal compartment as a part of this work.

Use pedestrian signals of the same type within each intersection.

Furnish lunar white "WALK" lens. Furnish portland orange "DON'T WALK" lens with both colors meeting the current requirements of the Institute for Traffic Engineers standards.

Furnish clear 90, 91 or 116-watt traffic signal lamps rated at 1050 initial lumens, and 8,000 hours of life at 120 volts.

703.11 LOOPS, LOOP DETECTORS, AND CABLE**703.11.1 Loops**

Size and install loops as specified in the contract and to meet the following.

Use one continuous length of No. 12 XHHW wire from the pull box, through the loops and returning back to the pull box. The number of loops is shown on the plans. Twist the loop wires together at three turns per foot (305 mm) between the loop and pull box.

Place the loop wire in the saw-cut slot, pour sealant into the slot encapsulating the wire, and fill the slot level to the pavement surface. Sealant must not require a primer.

Sealant must have a non-critical mix ratio allowing application and cure at ambient temperatures of 40 °F (4.4 °C) or higher.

Cured sealant must withstand heavy vehicle traffic and freeze-thaw cycles, be unaffected by water, gasoline, oils, roadway salts, and most corrosive chemicals.

Repair saw cuts through existing pavement markings as directed.

Clean the saw cut slot by high pressure air before placing the loop and sealant.

Make loop wire connections in pull boxes or signal standards using soldered, waterproof splices. Excess make-up wire or lead-in or loop wire coils is not permitted. Use rosin core solder.

Tag loop wire in the pull box, or signal standard if spliced there, with a permanent wire marker indicating the approach, loop number, and "input" or "output".

703.11.2 Loop Detector

Furnish loop detectors meeting NEMA requirements and Subsection 703.08.6.

703.11.3 Detector Loop Shielded Cable

Furnish cable meeting Subsection 703.06.3.

703.12 PEDESTRIAN PUSH BUTTONS

Furnish and install tamper-proof pedestrian push buttons having a direct push button with a single momentary contact switch in a cast-metal housing. The push button must be raised or flush with the housing and be at least 2 inches (50 mm) in the smallest dimension. The push button must activate with less than 5 pounds (22 N) of push force. The push button housing must be weatherproof, and electrically insulated to prevent shock under all weather conditions.

Furnish a housing back plate to fit the pole curvature and, when required, provide saddles to

make a near fit. Furnish and install push button signs shown on the plans. Install the push button and sign on the crosswalk side of the pole with the arrow pointing in the direction of the crosswalk.

Field drill and tap signal standards treating the holes with a rust preventative following the manufacturers directions.

703.13 LUMINAIRES

Furnish and install luminaires and lamps meeting these specifications and the contract requirements.

Wire all luminaires for 240-volt operation.

Furnish and install clear high pressure sodium vapor lamps having a 24,000 hour rated life.

Meet the following wattage and initial lumens requirements:

- 200 Watt: 22,000 initial lumens
- 250 Watt: 27,500 initial lumens
- 400 Watt: 50,000 initial lumens

Ballasts and luminaire must be integral, with the ballast providing -20 °F (-29 °C) starting capacity. Multiple ballasts must be 240 volt regulated lag type, 0.90 power factor, with an operating range of ± 10 percent. Starting and open circuit volt-amperes must not exceed operating values.

Furnish the unit with an independent, replaceable starting board.

The luminaire assemblies must be slip-fitter type, end mounted on a 2-inch (50 mm) pipe tenon.

Check luminaires on the ground to insure they provide the specified ANSI/IES light distribution pattern before mounting. Adjust the luminaires at night, as directed, to provide the best roadway light distribution.

703.14 PHOTOELECTRIC CONTROLS

Wire photoelectric controls to meet the contract requirements.

Furnish photoelectric control units of the twist-lock type.

Furnish units that turn on at 1.3 ± 0.5 foot candles, have a turn-on/off ratio in the range of 1:2 to 1:5, and are rated for a minimum of 1,000 watts at 120 volts.

Incorporate a time delay mechanism into the control preventing operation during brief light condition changes.

Provide a fail-safe that leaves the load on or becomes energized if the control fails.

Mount the control at the top of the standard with the photocell oriented toward the north sky or as directed.

Use AWG No. 14 conductor meeting Subsection 703.06.1 between the photoelectric controller and the electrical service. Supply the conductor as part of this work.

703.15 EMERGENCY PREEMPTION SYSTEM

Emergency preemption equipment must be directly interchangeable and compatible with Opticom emergency preemption equipment. Furnish Opticom model 562 discriminators.

Furnish a system using a high-intensity light source to beam a coded message from the emergency vehicles to the detectors at the intersection.

The system must hold the green light in favor of the emergency vehicle or accelerate the normal cycle of the signal change, within NEMA Standards Publication No. TS 1-1976, to provide a standard yellow light clearance, and then a red light stopping traffic across the emergency vehicle path.

When emergency preemption detector cable is included in the system use the cable recommended by the manufacturer or cable meeting Subsection 703.06.4 requirements.

Assure a preemption equipment factory representative provides technical assistance in setting up, checking out, and demonstrating that the system meets functional requirements.

703.16 CLASS 4 TREATED TIMBER POLES

Furnish the pole length and place as specified in the contract.

Furnish Class 4, machine peeled poles with 8 feet (2.4 m) of the butt treated with a five percent solution of pentachlorophenol. Seat, backfill, and compact around the poles. Compact backfill in 9-inch (230 mm) lifts. Plumb and rake the pole as directed.

703.17 OVERHEAD CONDUCTOR LIGHTING INSTALLATION

703.17.1 Luminaire

Furnish luminaires meeting Subsection 703.13 requirements.

703.17.2 Lighting Brackets

Furnish brackets as shown in the contract that meet or exceed NEMA and IES standards for vertical and horizontal deflection. Use AWG No. 10 copper wiring insulated for 600 volts between luminaire and ballast secondary.

703.17.3 Wood Poles for Overhead Conductor Highway Lighting

Furnish wood poles meeting ANSI specifications. The poles must be straight so that a line drawn from the butt center to the top center passes through the pole body. The poles must be machined-peeled and set to the ANSI recommended depth. Set poles plumb and true to line. Compact backfill in 9-inch (230 mm) lifts.

Pressure treat the bottom 8 feet (2.4 m) of the poles with a five percent by weight pentachlorophenol solution or Chromated Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWWA standards and Section 706 requirements.

Repair pole finish damage as directed.

703.17.4 Steel Poles for Overhead Conductor Highway Lighting

Furnish steel poles meeting Subsection 703.04.3 and 703.04.4 requirements.

703.17.5 Line Material

Furnish all line material that meets the contract requirements and the following.

Furnish insulators for brackets, clevises and upset bolts of the wet process type, 3-inch (75 mm) diameter x 3/16-inch (5 mm), 5/8-inch (16 mm) bolt hole having a 7/16 inch (11 mm) radius wire slot, and vertical mounting. It must be rated for wet flashover of 14KV, horizontal mounting wet flashover 17KV, dry flashover 26KV, and ultimate mechanical strength of 5,000 pounds (2,270 kg).

Furnish double upset bolts of 9/16-inch (14 mm) steel with 5/8-inch (16 mm) rolled threads, 1 1/2-inch (38 mm) upset to upset, and 4 1/2-inch (115 mm) threaded insulator end with cotter key.

Use insulated brackets that are spool clevises of the cross arm mounting type constructed of 1 3/4 inch x 1/8-inch (45 x 3 mm) steel providing a 3/4-inch (19 mm) mounting hole and a 5/8-inch (16 mm) cotter pin for mounting the insulator. The clevis must provide a 5-inch (130 mm) distance from the center of the insulator to the mounting face.

Furnish insulated swinging clevises of 1 1/2 x 3/16-inch steel (38 x 5 mm), 5 inches (130 mm) from 5/8-inch (16 mm) cotter pin to eye attachment for 3-inch (75 mm) insulator and 5/8-inch (16 mm) eyebolt or eye-nut.

Furnish copper to copper connectors of high strength silicon bronze threaded with spacer and nut. Use aluminum to copper connectors of an aluminum-alloy bolt and nut with a plated

copper spacer and plated copper contact. Remove the plating from the contact surfaces to identify the copper conductor location.

Insulated tension splices must have a 4-inch (100 mm) insulated length. Size the tap wire attaching clips for the appropriate wire size being installed. Obtain the Project Manager's approval before installation. Use insulated tension splices where required, in series installations, as follows:

1. Do not locate splices closer than 18 inches (460 mm) from a support point.
2. Do not locate splices in spans crossing a highway, street, or railroad.

Do not use conductor with cuts, kinks, or other injuries.

On angle assemblies, place the conductors on the insulator side away from the strain and tie it in place as shown on the plans. Sag all wire with the Project Manager present. The Project Manager will provide the sag tables. Provide an approved thermometer for the temperature reading. Gradually pull the wire to the required sag, keeping the wire free to move at intermediate support points. Do not pull wire beyond the required sag.

703.17.6 Guys and Anchors

Install guys and anchors as specified. Use two strain insulators in all guy spans. Use eye-bolts, eye-nuts, and anchor rods with thimble eyes when used on guys. Furnish eye-bolts and eye-nuts used on down guys of the 45° angle type.

Use 3/8-inch (9.5 mm) Siemens-Martin seven strand, galvanized guy wire meeting ASTM A 363.

Use three medium duty bolt clamps where necessary. Draw all three bolts up tight. Clamps using a stainless steel bail for straight through dead ending of the guy wire are an acceptable alternate to guy clamps.

Furnish 8-feet (2.4 m) long, full round gauge 14 galvanized steel guy protectors.

Use strain insulators meeting the following:

- Rated Voltage, KV: 4.4
- Flashover Voltage, 60 CY, Dry KV: 30
- 60 CY, Wet KV: 15
- Mechanical Strength, Pounds (kN): 12,000 (53.3)
- Max. Cable Size, Inches (mm): 1/2 (13)
- Length, Inches (mm): 4-1/8 (105)
- Width, Inches (mm): 2-7/8 (73)

Provide anchors and rods as specified. Install in line with the strain and installed with approximately 6 inches (155 mm) of the rod projecting out of the ground. Backfill the hole with course crushed rock 2 feet (610 mm) above the anchor, compacting in 6-inch (155 mm) lifts for the full depth.

703.17.7 Overheight Detector

An overheight detector consists of a transmitter and receiver each mounted on an adjustable metal pole. Furnish detectors meeting the following requirements:

- Operating Voltage: 115 AC \pm 10%
- Operating Temperature Range: -40 °F (-40 °C) to 130 °F (54 °C)
- Detector Beam: infrared or visible-red light-emitting-diodes (LED)
- Alarm Output Adjustment: 5 to 30 second duration

Ensure the detector can discern the vehicles direction of travel and is able to detect vehicles traveling between 2 mph (3.2 km/h) and 90 mph (145 km/h).

Mount the transmitter and receiver on metal poles that permit adjusting the detector height from 10 to 16 feet (3.1 m to 4.9 m). Install and adjust the detectors on the poles following the manufacturer's recommendations.

Furnish the transmitter, receiver, two poles, anchor bolts, nuts, washers, all necessary wiring and connectors for this item. The concrete foundations are a separate item.

This work is measured under Subsection 617.04.2(4) and paid for under Subsection 617.05.2.

**SECTION 704
SIGNING MATERIALS**

704.01 MATERIAL FOR SIGNS

704.01.1 Sheet Aluminum

Use aluminum alloy meeting the Aluminum Association alloy AA5052-H38 or AA6061-T6 requirements. Meet the sheet thickness requirements in Table 704-1.

**TABLE 704-1
SINGLE POST CENTERLINE MOUNTING**

SIGN SIZE inches (mm)	THICKNESS inches (mm)
REGULATORY SERIES WITHOUT BACK BRACING	
0 to 33 (0 to 838) inclusive	0.080 (2)
34 to 41 (864 to 1,041) inclusive	0.100 (2.54)
42 to 51 (1,067 to 1,295) inclusive	0.125 (3.17)
WARNING SERIES WITHOUT BACK BRACING	
30 x 30 (762 x 762) or smaller	0.080 (2)
36 x 36 (914 x 914)	0.080 (2)
48 x 48 (1,219 x 1,219)	0.100 (2.54)
60 x 60 (1,524 x 1,524)	0.125 (3.17)
ALL SIGNS WITH BACK BRACING	
< or = 32 (813)	0.080 (2)
< or = 40 (1,016)	0.100 (2.54)
< or = 50 (1,270)	0.125 (3.17)
DELINEATOR REFLECTORS	
All sizes	0.063 (1.6)

Use the sheet thickness shown in the regulatory series for the route marker series, using the widest point on the cut-out shield for the width dimension.

704.01.2 Aluminum Sheet Increment

Construct Aluminum sheet increment signs using AA5052-H38 or AA 6061-T6 sheet aluminum (thickness in Table 704-1) fastened to an extruded T-section (AA6063-T6) back brace with 3/16-inch (5 mm) blind rivets. Use the back brace and rivet spacing shown in the Detailed Drawings. Use extruded T-sections weighing a minimum 0.88 pounds per linear foot (1.3 kg /m) with a minimum moment of inertia about the neutral axis of 0.40 inches⁴ (166.5 mm⁴).

704.01.3 Plywood

Use Douglas fir meeting the "Commercial Standard 45 for Douglas Fir plywood", B-B high density overlay, 60/60 with plastic overlay, both sides, 3/4-inch (20 mm) thick. Do not use plywood on multiple post installations.

704.01.4 Aluminum and Steel Posts

- A. General.** Furnish posts meeting the contract requirements. Treat steel post field cuts and holes with one coat of metal primer and two coats of aluminum paint. Coat galvanized posts meeting AASHTO M 111 specifications.

B. Steel Posts.

1. **Structural Steel.** Furnish structural steel posts having a nominal weight exceeding 3 pounds per foot (4.5 kg/m) meeting ASTM A 36 requirements. Bid these posts as "steel structural sign posts". Paint the posts meeting the Detailed Drawing requirements.
2. **Steel U Sign Posts.** Furnish steel posts formed into a "flying U " shape having a nominal weight exceeding 3 pounds per foot (4.5 kg/m) meeting AASHTO M 281. Bid these posts as "steel U sign posts."
3. **Tubular Steel Posts.** Furnish round tubular steel posts meeting ASTM A 53 Type E or S, Grade B requirements. Furnish square or rectangular tube posts meeting ASTM A 500 or 501 requirements. Painted or galvanized posts are acceptable. Meet ASTM A 123 requirements for galvanizing. Paint the posts meeting the Detailed Drawing requirements.
4. **Square Tubular Steel Posts.** Furnish square tubular steel sign posts, anchor posts, anchor sleeves, and splice sleeves meeting one of the following requirements as specified in the contract:
 - a. ASTM A-446 Grade A steel in 10 or 12 gauge having a 33,000-psi (22.7 MPa) minimum yield strength and a 45,000-psi (31 MPa) minimum tensile strength.
 - b. ASTM A-570, steel in 12 or 14 gauge having a 60,000-psi (41.4 MPa) minimum yield strength and a 75,000 (51.7 MPa) minimum tensile strength. Use ASTM A-307 Grade 2 bolts and nuts. Ensure the sign posts, sleeves, anchor posts, auxiliary fittings and anchor sleeves have 7/16-inch (11 mm) diameter holes or knockouts on 1-inch (25 mm) centers on all four sides. The permissible pole straightness variation is 1/16-inch in 3 feet (1 mm per m) with the corner radius being 5/32-inch (4 mm) plus or minus 1/64-inch (0.4 mm).
 - c. Coat the post with Type 2 aluminum paint at a minimum 0.75 ounces per square foot (228 kg per square meter) of surface area, measured by triple spot testing under AASHTO T-213. Follow with a chromate conversion coating, and a thin acrylic or polymer resin film; or a triple coating of hot dipped zinc weighing 0.60 ± 0.15 ounces per square foot ($183 \text{ kg} \pm 4.3 \text{ kg}$ per square meter) meeting AASHTO M-120, followed by a chromate conversion coating 15 ± 5 micrograms per square inch (645 square mm), and a clear organic coating 0.2 ± 0.1 mils ($0.005 \text{ mm} \pm 0.0025 \text{ mm}$) thick on the outside surface. Provide double in-line application of a full zinc-based organic coating 1.2 ± 0.6 mils ($0.003 \text{ mm} \pm 0.0015 \text{ mm}$) thick tested under ASTM B-117 on the inside surface.

- C. Aluminum U Posts.** Furnish aluminum posts made of AA6061-T6 alloy extruded to a U channel meeting ASTM B 209.

704.01.5 Treated Timber Posts

Furnish treated timber posts of construction grade, S4S, full length pressure treated with a five percent by weight pentachlorophenol solution or Chromate Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA standards and Subsection 706.04.1. Perform all cutting, trimming and boring, excluding the breakaway hole, before treatment. Assure individual posts are uniform in color for each project. The posts will be inspected where treated.

Treat injuries, cuts, and holes in posts after treatment with three applications of copper naphthenate solution containing a minimum two percent copper metal or with Chromate Copper Arsenate (CCA) meeting AWPA M4 requirements.

704.01.6 Treated Timber Poles

Furnish treated timber poles meeting ANSI Specification 05.1 and of the species listed in Table 4, 5, or 6. All poles on each project must be the same species and uniform in color after treatment. Machine-peel and full-length pressure treat all posts with a five percent by weight pentachlorophenol solution or CCA (Type B or C), or ACA as specified in Subsection 706.04.1. Gain each pole on the sign face as specified. Poles may be gained full-length, or half gained from the top.

Use pressure treated, construction grade 2-inch x 4-inch (50 mm x 105 mm) in S4S for back bracing.

Treat poles, damaged, cut, or bored after treatment meeting Subsection 704.01.5 requirements.

704.01.7 Barn Poles

Barn poles are specified by the top diameter. Meet the following table 704-2 top diameter limits:

**TABLE 704-2
BARN POLE - TOP DIAMETER LIMITS**

SPECIFIED TOP DIAMETER inch (mm)	DIAMETER LIMITS inch (mm)	
	Min.	Max.
3 (75)	3 (75)	4 (100)
4 (100)	4 (100)	5 (130)
5 (130)	5 (130)	6 (150)
6 (150)	6 (150)	7 (180)

Furnish poles that are straight so that a line from center of tip to center of butt passes through the pole body from tip to butt. The poles must be free of crooks and sweeps. Full length pressure treat all barn poles with a 5 percent by weight pentachlorophenol solution or Chromate Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWWA standards and Subsection 706.04.1 requirements.

Treat damaged, cut, or bored holes in treated posts meeting Subsection 704.01.5 requirements. Gain each pole on the sign face at least 2 inches (50 mm) in width as specified. The post may be gained full length or half-gained from the top.

Use pressure treated, construction grade 2-inch x 4-inch (50 x 105 mm) in S4S for back bracing.

704.01.8 Overhead Structures

Furnish overhead sign structures meeting the current AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, and the contract requirements.

704.01.9 Concrete

Use Class "A" or "D" concrete meeting Section 551 requirements for steel sign post foundations. Hand mixing is not allowed. Add an air entraining agent to all foundation concrete.

704.01.10 Retro-reflective Sheeting

- A. General.** Furnish the type of retro-reflective sheeting and color specified in the contract. Meet AASHTO M 268 requirements for the type specified.

- B. Acceptance.** Submit a notarized manufacturer's certification that the retro-reflective sheeting used for each project meets or exceeds contract requirements.

The Department may take sheeting samples for analysis and testing. The Project Manager may visually compare the sheeting's diffuse day color in the field using standard color charts and test the signs reflectivity using a reflectometer.

Replace rejected material at Contractor expense.

704.01.11 Letters, Symbols, and Accessories

- A. General.** Furnish the material type(s) specified in the contract. Use Type A, Type B, or Type C, described as follows.

B. Type A Letters Using Acrylic Plastic Reflectors.

- 1. Description.** Furnish Cutout letters, numerals, alphabet accessories, and border strips of embossed aluminum frames with prismatic reflectors installed or affixed as an integral part of the character. Do not use tape or adhesives to affix the reflectors.
- 2. Design and Fabrication.** Use the Federal Standard Alphabet Series "D" or "E modified" for character sizes, series, and spacing. Fabricate characters, borders, and accessory frames from minimum 0.040-inch (1.01 mm) thick sheet aluminum. Drill mounting holes in the frames for attaching to the sign panel. Size and space reflectors to provide maximum night legibility and visibility to the finished figure. The Project Manager will conduct a night inspection for legibility and visibility.
- 3. Frame Finishing.** Once metal fabrication is complete, de-grease, etch, neutralize, and treat the frame for painting following the paint manufacturer's recommendation. Paint the frames the specified color with a quality metal enamel following the paint manufacturer's recommendations. White reflective sheeting meeting Subsection 704.01.10 may be used in place of painting.
- 4. Acrylic Plastic Reflector.** Use acrylic plastic reflectors meeting AASHTO M 290 requirements.

C. Type B Letters - Removable.

- 1. General.** Provide letters, numerals, symbols, and borders that are adhesive-coated reflective sheeting permanently adhered to die cut aluminum backing. De-grease, etch, and treat the aluminum with a light, tight amorphous chromate type coating. Use Type III white reflective sheeting. Letter and number design is Federal Standard Alphabet Series "E modified".
- 2. Fabrication.** Fabricate letters, numerals, and symbols from minimum 0.040-inch (1.01 mm) thick 3003 H 14 alloy aluminum sheeting. Fabricate borders from 0.032-inch (0.81 mm) thick AA6062 T 6 alloy aluminum sheeting. Prepare the aluminum sheeting and apply the reflective sheeting following the reflective sheeting manufacturer's recommendations. All pieces must have an embossed height of approximately 1/8-inch (3 mm).

Space mounting holes for screws, bolts, or rivets no more than 8 inches (205 mm) on center; determined by the character size and shape. Edge-seal completed pieces following the reflective sheeting manufacturer's recommendations.

D. Type C Letters - Direct Applied.

- 1. Sheeting.** Furnish letters, numerals, symbols, and borders from Type III sheeting, permanently adhered to the sign face reflective sheeting.
- 2. Fabrication.** Apply the letters, numerals, symbols, and borders following the sheeting manufacturer's recommendations. Follow the size, series, and spacing in the Federal Highway Administration's Standard Alphabets proportion and spacing requirements.

Use finished pieces that are clean cut, free of ragged borders.

704.01.12 Paint

Use paints meeting Section 710 requirements.

704.01.13 Hardware

Use bolts, washers, nuts, lock washers, incidental hardware, and angles for erecting aluminum sheet and plywood signs that are:

- A. Galvanized meeting ASTM A 153 or ASTM A 164 specifications; or
- B. Cadmium-plated steel meeting ASTM A 165; or
- C. Aluminum alloy meeting ASTM B 211 for alloy 2024-T4.

704.02 FABRICATION OF SIGNS**704.02.1 Aluminum Signs**

Provide a reflectorized sheet background. Clean rust, white rust, oil, and dirt from the aluminum sheeting. De-grease the sheeting using vapor or alkaline de-greasing agent following the de-greasing agent manufacturer's recommendations. De-grease, acid or alkaline etch, rinse, and dry the sheeting as recommended by the etching solution manufacturer.

Treat the etched sheeting with a light, tight adherent chromate conversion coating before applying the reflective sheeting. This coating must not leave a powdery residue and may leave a silvery iridescence to pale yellow appearance. Coat meeting ASTM B-499, Class 2, 10 to 35 milligrams thick per square foot (0.093 square meter). Hot air dry the sheeting once coated. Apply and seal the reflectorized sheeting on the prepared aluminum sheeting following the reflective sheeting manufacturers recommendations. Meet the applicable requirements of Subsection 704.01.11 for legend and borders.

Color the blind rivet heads to match the sign face. Apply background material to the sheet aluminum before fabricating the sign. Butt the sheet increments together to produce a joint that meets the specified tolerances limits.

Do not use water to float the reflective sheeting or legends into place during fabrication.

704.02.2 Plywood Signs

Provide a reflective background. Seal all wood edges, including interior joints, before fabrication using one coat of exterior aluminum paint followed by one coat of enamel, colored to match the reflective background sheeting. Apply the reflective sheeting and seal the edges following the sheeting manufacturer's recommendations.

A. Screen-processed Legend and Borders. Screen process or reverse-screen process the legend and borders on reflectorized backgrounds meeting the contract requirements. Use the process and paints recommended by the sheet manufacturer.

B. Reflective Sheeting Legend and Borders. Cut the legend and borders from Type III sheeting.

Do not splice legend characters. Apply legends following the sheeting manufacturer's recommendations. Do not use water to float the reflective sheeting or legend into place during fabrication.

C. Demountable Reflective Legend and Borders. Fabricate demountable legend meeting Subsection 704.01.11 requirements. Furnish the letter type specified in the contract. Letters cannot be spliced. Make borders and median sections in the longest pieces possible. Butt all joints with no overlap.

704.02.3 Inspection and Acceptance

Completed signs will be inspected where fabricated for acceptance. Signs will be rejected for defects including, but not limited to cracks, tears, splits, crazing, gouges and curled edges of background sheeting or legends.

SECTION 705

GUARDRAIL AND GUIDE POSTS

705.01 GUARDRAIL

Furnish metal beam and cable guardrail materials meeting the contract requirements.

705.01.1 Steel Beams and Fittings

Furnish steel beam guardrail meeting AASHTO M 180, Class A, Type 1 requirements. Supply rail in lengths that place the splices on posts. Shape rail to be erected on curve radii less than 150 feet (45.75 m) before erecting.

Use ASTM A 307 bolts with ASTM A 563, Grade A or better nuts. Use ANSI B27.2, Type A plain steel washers.

Galvanize all bolts, nuts, washers, and fittings meeting ASTM A 153 or B 695 (Class 50) requirements.

Furnish rounded end sections, buffer sections, and terminal connectors meeting AASHTO M 180, Class B, Type 1 requirements.

705.01.2 Wood Posts and Blockouts

Furnish wood posts and blockouts made from Douglas fir, Hemlock, Ponderosa Pine, Spruce, Larch, or Lodgepole pine. Furnish posts that are straight, sound, free from defects and meet the dimensions specified in the contract.

Meet the Western Wood Products Association requirements, or equivalent grading rules, all of which must meet ASTM D 245.

Ensure the posts surfaces do not vary more than 1 inch (25 mm) from a straight line connecting the ends. Saw the wood posts before treating. Ensure the wood posts are seasoned to accept the specified treatment. Furnish wood posts and blocks treated with a minimum 5 percent by weight pentachlorophenol solution or Chromated Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA standards. The minimum penetration depth is 1/2-inch (13 mm). Do not paint posts unless specified.

Other acceptable blockouts may be manufactured from steel, recycled plastic, and recycled plastic with wood fibers provided information is furnished that they meet NCHRP 350 requirements for the application, i.e., for use with wood, concrete or steel guard rail posts.

Use only one type of blockout in each run of guardrail.

705.01.3 Concrete Posts

Furnish precast concrete posts meeting the contract requirements. Use Class "DD" concrete or concrete of equal strength meeting Section 551 requirements. Manufacture, transport, and handle guardrail posts meeting Section 554 requirements. Use reinforcing steel meeting Section 711 requirements.

705.01.4 Lightweight Concrete Guardrail Posts

Lightweight aggregates may be used in manufacturing guardrail posts.

Produce both fine and course aggregates for lightweight concrete by expanding, calcining, or sintering blast furnace slag, clay, diatomite, shale, or slate.

Meet AASHTO M 195 aggregate requirements. Use separate fine and course aggregate. Use fine aggregate in the No.4 (4.75 mm) to 0 size. Use course aggregate of either 3/4-inch (19.0 mm) to No.4 (4.75 mm) or 1/2-inch (12.5 mm) to No. 4 (4.75 mm).

Meet a minimum compressive strength of 3,000 psi (20.7 MPa) (equal to Class "DD" concrete) with a maximum absorption of 15 percent by volume and a maximum unit weight of 115 pounds per cubic foot (1,864 kg per cubic meter). Aggregate pre-wetting may be required.

Use reinforcing steel meeting Section 711 requirements. Steel size and shape is specified in the contract.

The AASHTO M 195 Freeze-Thaw test is not required.

705.01.5 Steel Posts

Furnish steel posts for cable guardrail meeting the contract requirements.

Furnish minimum 6-foot (1830 mm) long steel guardrail posts for steel beam guardrail.

Ensure that steel guardrail posts and associated hardware meets the AASHTO *Guide to Standardized Highway Barrier Hardware* (Task Force 13 Report) and the National Cooperative Highway Research Council (NCHRP) 350 crashworthy requirements.

705.02 WIRE ROPE AND CONNECTING HARDWARE

Furnish wire rope and hardware for cable guardrail meeting the contract requirements.

705.03 WOOD TREATMENT AND PAINTING

705.03.1 Wood Treatment

Furnish wood posts and blocks pressure treated meeting Subsection 706.04.1, with a five percent by weight pentachlorophenol solution Chromated Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA standards. Chamfer and perform other required framing and boring of bolt holes before post treating. Plug drill holes used for determining preservative penetration depth with tight fitting treated wood plugs. The requirements of Subsection 706.04.2 for incising, do not apply to Ponderosa pine sawn wood posts.

705.03.2 Painting

Use paint and perform painting meeting Subsection 612.03.5(C)(2) requirements when specified.

705.04 GUIDE POSTS

705.04.1 Wood Posts

Furnish wood posts meeting Subsection 705.01.2 and 705.03 requirements. Size and shape are specified in the contract.

705.04.2 Flexible Guideposts

Furnish flexible guideposts meeting the contract requirements and the following:

- The posts must be a white seamless polyethylene extrusion with a minimum 5/32-inch (4 mm) wall thickness having a minimum weight of one pound per foot (1.49 kg/m). The post cross section may be round, triangular, or other shape providing at least 4 inches (100 mm) viewable width.

Erect permanent installations meeting the contract requirements.

Epoxy-cement or nail temporary installations to the pavement surface.

705.04.3 Hardware

Furnish backplates or faceplates for posts meeting the contract requirements.

Furnish bolts, nuts, or studs for fastening the backplate to the post, galvanized meeting ASTM A 153 or B 454 (Class 50) requirements or use cadmium plated. Furnish nuts and studs that are "vandal-resistant".

Furnish other miscellaneous hardware galvanized meeting ASTM A 153 or B 454 (Class 50) requirements.

**SECTION 706
TREATED AND UNTREATED
TIMBER AND TIMBER PILES**

706.01 STRUCTURAL TIMBER AND LUMBER

Furnish timbers and lumber being:

- A.** Standard sawn Douglas fir or Larch.
- B.** Graded under the current West Coast Lumber Standard Grading Rules or the Western Lumber Grading Rules.
- C.** Grade stamped by an American Lumber Standards certified inspection agency.

The recommended design values under the rules for grading timbers and lumber grades cannot be less than those shown on the plans for the required minimum timber stress.

Note the grade, the grading rule, and the recommended design stress value for that rule on the shop drawings for each size.

Use only pieces of sound wood free from all decay.

When untreated timber is specified, it must show at least 85 percent heartwood on the girth, measured where the least amount of heartwood occurs on any girth. When treated timber is specified, there are no heartwood requirements and the sapwood amount is not limited.

706.02 RESERVED

706.03 POLES AND POSTS

Furnish the poles and posts as specified.

706.04 TREATED TIMBER AND LUMBER

Furnish structural timber and lumber, treated with a timber preservative specified as follows.

706.04.1 Treating

Furnish timber and lumber that is pressure treated retaining at least the minimum preservative treatment quantity per cubic foot (cubic meter) specified in AWPA C-14.

Use one of the following preservatives:

- Creosote oil, creosote coal tar solution, five percent by weight pentachlorophenol solution; or
- Chromated Copper Arsenate (CCA), Type B or C; or
- Ammoniacal Copper Arsenate (ACA).

Use preservative meeting AWPA standards.

Treated timber or lumber to receive paint must permit the paint to adhere to the treated surface without discoloration.

Meet AASHTO M 133 requirements for all preservatives and their sampling and testing methods.

706.04.2 Incising

Mechanically incise timber and lumber of the following listed species having a nominal thickness of 2 inches (actual 38 mm thickness) or greater before treating:

Intermountain Douglas Fir	Northern White Pine	Jack Pine
Pacific Coast Douglas Fir	Red Pine	Red Wood
Western Hemlock	Sugar Pine	Lodgepole Pine
Western Larch	Western White Pine	

Incise timber and lumber 3 inches (63 mm actual thickness) thick or greater on all four sides. Incise timber and lumber 3 inches (63 mm actual thickness) thick and less on the wide faces only, unless otherwise specified. The spacing and shape of the cutting teeth and the incising method must produce a uniform penetration. 1 1/2-inch (38 mm actual dimension) center-matched material used for flumes, boxes, etc., does not need to be incised.

Follow the requirements for minimum incision depths in Table 706-1:

TABLE 706-1
MINIMUM INCISION DEPTHS

SIZE IN INCHES (mm)	MINIMUM DEPTH OF INCISION inch (mm)
1 1/2 x 12 (38 x 286)	3/8 (9)
3 x 12 (63 x 290)	7/16 (11)
4 x 12 (89 x 290)	1/2 (13)
8 x 10 (190 x 240)	9/16 (14)
10 x 12 (240 x 290)	5/8 (16)
12 x 12 (290 x 290)	3/4 (19)

Notes:

- Proportion intermediate sizes.

706.04.3 Inspection

Each shipment of treated timber or lumber must be inspected before and after treating at the plant by a Department Inspector. The Inspector must stamp the ends of each accepted piece with the Inspector's copyrighted stamp. File a true impression of the copy-righted stamp with the Department before transporting timber or lumber to the project. Provide the Project Manager the Inspector's itemized report of all timber and lumber inspected, giving temperatures, quantity of preservative, time of treatment, length and sizes of timbers, total footage, and other pertinent information. Treated timber and lumber not bearing the Inspector's stamp in legible form cannot be transported to the project.

Each shipment of untreated timber and lumber must be inspected at its source by a Department Inspector. If inspection at the source is, in the Project Manger's opinion impractical the material may be accepted by a "Certificate of Inspection" from a recognized competent grading or inspection bureau or agency.

The acceptance of any material or finished members by the Inspector does not prevent their rejection if found defective. Replace rejected material and work at Contractor expense.

706.05 TIMBER PILES

Meet the following straightness requirements for both treated and untreated timber piles:

- A straight line from the center of the butt to the center of the tip must lie entirely within the body of the pile. Piles must be free from short crooks that deviate more than 2 1/2 inches (64 mm) from straightness in any 5-foot (1525 mm) length.

A. Treated Timber Piles. Furnish treated timber piling of Douglas Fir, Southern Pine, or Western Larch meeting ASTM D 25 requirements, excluding Tables 1 and 2.

Season, condition, and treat piles meeting ASTM D 1760 and AWPA Standard Specifications for preservative treatment by pressure process. Use creosote oil, creosote coal tar solution, or a 5 percent by weight pentachlorophenol solution for the preservative.

B. Untreated Timber Piles. Furnish untreated timber piles meeting ASTM D 25 requirements, except for Tables 1 and 2.

SECTION 707 JOINT MATERIALS

707.01 CONCRETE JOINT FILLERS

707.01.1 Concrete Pavement

- A. Expansion Joint Filler.** Furnish expansion joint filler Type II cork meeting AASHTO M 153 requirements.
- B. Joint Sealing Material.** Furnish sealing material for all types of pavement joints that is a hot-poured thermoplastic rubber or rubber asphalt compound meeting AASHTO M 324, furnished in one grade only. Use ready-mixed, cold applied joint fillers for sealing concrete pavement joints only with the Project Manager's prior written approval.

707.01.2 Concrete Structures Other than Pavement

Furnish Type II cork pre-formed expansion joint filler meeting AASHTO M 153 requirements.

707.01.3 Concrete Curbs, Gutters, and Sidewalks

Use joint material for concrete curbs, gutters, and sidewalks meeting AASHTO M 213 requirements.

707.02 CULVERT SEALERS

707.02.1 Rubber Gaskets

Furnish ring gaskets meeting AASHTO M 198 requirements.

707.02.2 Flexible Plastic Gaskets

Furnish flexible plastic joint compounds produced from refined hydrocarbon resins and plasticizing materials reinforced with inert mineral filler and not containing solvents. Cohesive and adhesive strength must not be developed by oxidation, evaporation, or chemical action. Supply the gasket in extruded rope form, sized to fill spaces between the pipe sections. Furnish with a two-piece removable wrapper that permits removing one half without disturbing the other half.

Meet Table 707-1 requirements.

**TABLE 707-1
COMPOSITION AND PROPERTIES - FLEXIBLE PLASTIC GASKETS**

PROPERTY	TEST METHOD	REQUIREMENT	
		Min.	Max.
Bitumen (petroleum plastic content), percent	ASTM D 4	50	70
Mineral Matter (Ash Inert), percent	AASHTO T 111	30	50
Penetration, dmm 0 °C, 300 g, 60 sec. 25 °C, 150g, 5 sec. 46.1 °C, 150 g, 5 sec.	ASTM D 217 Cone	75 50	120 150
Softening Point at 25 °C, °C	ASTM D 36	160	
Specific Gravity at 25 °C	ASTM D 71	1.20	1.35
Weight, pounds per gallon		10.4	11.25
Ductility at 77 °F (25 °C), cm	ASTM D 113	5.0	
Flash Point (Cleveland, open-cup), °C	ASTM D 92	315.5	
Fire Point (Cleveland, open-cup), °C	ASTM D 92	329	
Volatile Matter, percent	ASTM D 6		2.0

707.03 SHEET COPPER, RUBBER, AND PLASTIC WATERSTOPS

707.03.1 Sheet Copper

Furnish sheet copper for waterstops meeting ASTM B 152 requirements for copper sheet, strip, plate, and rolled bar, Type ETP with a nominal weight of 16 ounces per square foot (5 kg per square meter) plus or minus eight percent.

707.03.2 Rubber

Furnish molded or extruded rubber waterstops having a uniform cross section, free from porosity or other defects, and meeting the nominal dimensions specified in the contract. An equivalent standard shape may be furnished if approved. The waterstop may be compounded from natural rubber, synthetic rubber, or a blend of the two, together with other materials that produce a finished waterstop meeting contract requirements. Reclaimed material cannot be used. Furnish a manufacturer's certificate showing the material composition and the values for the designated properties in Table 707-2. Furnish samples when requested.

**TABLE 707-2
PROPERTIES AND TEST METHODS - FINISHED RUBBER WATERSTOP**

PROPERTY	FEDERAL TEST METHOD STANDARD NO. 601	REQUIREMENT
Hardness (shoredurometer)	3021	60 to 70
Compression Set	3311	30% max.
Tensile Strength	4111	2,500 psi (17 Mpa) min.
Elongation at breaking	4121	450% min.
Tensile Stress at 300% elongation	4131	900 psi (6 Mpa) min.
Water Absorption by weight	6631	5% max.
Tensile Strength	7111	80% min. after aging original

707.03.3 Plastic

Furnish plastic waterstops manufactured from virgin polyvinyl chloride plastic or other material meeting Table 707-3 requirements.

**TABLE 707-3
PROPERTIES AND TEST METHODS - FINISHED PLASTIC WATERSTOP**

ASTM STANDARD	PROPERTY	REQUIREMENT
D 2240	Hardness	75 ± 5
D 412	Tensile Strength, min.	2000 psi (14 MPa)
D 412	Ultimate Elongation, min.	350%
D 746	Low Temperature	
Procedure B	Brittleness at -37 °C	No Failure

Furnish for approval, a drawing or catalog cut of the waterstop intended for use, and a written certificate from the manufacturer that the waterstop meets the specifications.

SECTION 708 CONCRETE, PLASTIC, AND FIBER PIPE

708.01 REINFORCED CONCRETE PIPE

708.01.1 General

Use cement in reinforced concrete pipe meeting AASHTO M 85 requirements for Portland cement.

Furnish reinforced concrete pipe produced by a manufacturing plant that has been approved by the Engineer before the contract award date.

The bid tabulations specify only the span dimension to the nearest inch (25 mm), of pipe arch culverts as shown in the Detailed Drawings for the culverts. The plans show both span and rise dimensions.

The Department will inspect and approve the equipment and methods for manufacturing, protecting, curing and storing pipe before fabrication.

Meet AASHTO M 55 requirements for reinforcement in circular or elliptical pipe.

Use Type V cement unless otherwise specified.

708.01.2 Circular Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

Furnish pipe meeting AASHTO M 170 requirements, except that par. 12.4 does not apply. Use a minimum wall B pipe.

708.01.3 Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe

Furnish pipe meeting AASHTO M 206 requirements with Class A-III pipe strength requirements.

708.01.4 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

Furnish pipe meeting AASHTO M 207 requirements.

708.01.5 Flared End Terminal Sections and Tee Risers

Furnish flared end terminal sections and the riser of tee sections meeting AASHTO M 170 Class III pipe requirements.

708.02 CONCRETE PRESSURE PIPE

Furnish reinforced concrete low head pressure pipe meeting ASTM C 361 requirements.

708.03 PERFORATED CONCRETE PIPE

Furnish perforated concrete pipe meeting AASHTO M 175 requirements.

708.04 POROUS CONCRETE PIPE

Furnish porous concrete pipe meeting AASHTO M 176 requirements.

708.05 PVC GRAVITY SEWER AND DRAIN PIPE

708.05.1 Pipe

Furnish gravity pipe 4-inch through 12-inch (105 through 305 mm) nominal diameter produced by continuous extrusion and having self-extinguishing characteristics. The PVC plastic must have a cell classification of 12454-B, 12454-C, or 13364-B (minimum tensile modulus of 500,000 psi (34.5 MPa) as specified in ASTM D 1784. Meet ASTM D 3034 requirements for pipe and fittings. Meet a minimum Standard Dimension Ratio (SDR) of 35.

Furnish perforated pipe meeting ASTM D 2729 requirements.

Furnish pipe with nominal laying lengths of 12.5 feet (3.8 m), except for connections to manholes, inlets, and other appurtenances.

Assure each pipe length is marked with nominal size, PVC cell classification, SDR, and ASTM designation.

708.05.2 Pipe Joints

Each pipe length must have a bell end. The bell must have an elastomeric rubber gasket in a retaining groove to provide a watertight joint when the pipe is joined. The rubber gasket must maintain a watertight joint under all service conditions including expansion, contraction, settlement, and pipe deformation movements. Make the joint connections following the pipe manufacturer's recommendations.

708.05.3 Appurtenance Joints

Make all connections to manholes, inlets, or other appurtenances watertight using rubber gaskets, waterstops, or non-shrink Portland cement grout for grouted joints.

708.06 PVC PRESSURE WATER PIPE

708.06.1 Pipe

Furnish pressure PVC water pipe 4-inch through 12-inch (105 mm through 305 mm) nominal diameter in either Class 150 with a dimension ratio (DR) of 18 or Class 200 with a dimension ratio (DR) of 14 meeting AWWA Specification C-900. Pipe sections must be marked with diameter, code designation, DR, pressure class, and AWWA specification.

708.06.2 Pipe Joints

Each manufactured length of pipe must have an integral bell with an elastomeric gasket in a retaining groove that provides a watertight joint when joined.

708.07 POLYETHYLENE CORRUGATED DRAINAGE PIPE OR TUBING

Furnish heavy duty corrugated polyethylene drainage pipe or tubing and fittings meeting AASHTO M 252 requirements for nominal diameters 3 through 10 inches (76 through 254 mm) and AASHTO M 294 for nominal diameters 12 through 36 inches (305 through 915 mm).

SECTION 709 METAL PIPE

709.01 DUCTILE IRON AND STEEL WATER PIPE

709.01.1 Ductile Iron Water Pipe

Furnish ductile iron pipe meeting AWWA C 151 requirements for the pipe class specified in the contract.

Use mechanical or slip-on joints meeting AWWA C 111 (ANSI A 21.11) requirements. Construct the joints to provide electrical conductivity using bronze shims, or gaskets with metallic shims molded into the gasket.

709.01.2 Steel Water Pipe

Furnish steel pipe meeting AWWA C 200 Standard for Water Pipe, 6 inches (155 mm) and larger.

Field weld joints and bends meeting AWWA C 206 requirements. Meet AWWA C 203 requirements for shop and field coatings.

709.02 CORRUGATED STEEL PIPE AND PIPE ARCHES

Furnish corrugated steel pipe that is lock seam helically corrugated pipe or continuously welded seam corrugated pipe.

Furnish corrugated steel pipe and pipe arches and coupling bands meeting AASHTO M 36 requirements (excluding projection bands under 9.1.3) and the following:

- A.** When pipe is cut and to be rejoined, matchmark cut pipe ends and rejoin the matching ends during installation.
- B.** When using corrugated locking bands, re-roll the pipe ends forming at least two annular corrugations. Unraveling of lock seams due to re-rolling pipe ends is a defect and the pipe will be rejected.

Repair zinc or aluminized pipe coating damaged by re-rolling using a zinc rich paint. Apply the paint to provide a minimum 0.005-inch (0.13 mm) thickness.

If flanges are provided on the pipe ends, the coupling may be made by interlocking the flanges with a preformed channel band or other band incorporating a locking channel that meets AASHTO M 36 requirements. These bands may be used only on pipes with diameters up to and including 36 inches (915 mm).

The coupling bands or devices other than those specified in AASHTO M 36 require the Project Manager's approval before use.

Meet the following additional requirements for syphon and irrigation pipe installations:

1. Use lock seam helically corrugated pipe, or welded seam helically corrugated pipe;
2. Continuously weld lock seams from end to end of each lock seam helically corrugated pipe section for syphon installations. Perform the welding after re-rolling the ends;
3. For irrigation installations using lock seam helically corrugated pipe, weld the lock seams as specified above or fabricate by inserting a 3/16-inch (5 mm) diameter continuous rubber chord meeting pipe industry standards into the lock seam during fabrication, all meeting AASHTO M 36; and
4. Construct watertight field joints. Make the connection using a 10 1/2-inch (267 mm) wide "hugger" type band. Hugger bands must have O-ring gaskets. Lubricate and install gaskets and coupling bands following the manufacturer's recommendations.

The Project Manager may direct the fabricator to conduct a water-tightness test, witnessed by an Inspector, on the type or types of pipe and coupling devices to be

furnished. Submit the test method to the Project Manager for approval before testing. Alternate test methods may be required.

709.03 STEEL STRUCTURAL PLATE PIPE AND PIPE ARCHES

Use galvanized corrugated steel structural plates and fasteners for constructing pipe meeting AASHTO M 167 requirements.

Bevel the end plates of structural steel pipe plate arches as specified.

Meet AASHTO M 245 requirements for allowable tolerance in span and rise for pipe arches.

Submit a supplier's itemized statement of the plate sizes for each shipment for field inspection of the plates. Department inspection will include examining pipe for deficiencies in the lengths of sheets used and evidence of poor workmanship. Samples may be taken for chemical analysis and weight of spelter coating.

709.04 BITUMINOUS COATED CORRUGATED STEEL PIPE AND PIPE ARCHES, AND STEEL STRUCTURAL PLATE PIPE AND PIPE ARCHES

Meet AASHTO M 243 pipe coating requirements except as modified below:

- Clean and dry the surface to be coated before applying the bituminous coating. Apply coating with the ambient air temperature at least 50 °F (10 °C) and rising. Coat the full circumference of the pipes outside and the bottom up to one third of the vertical height of the pipes inside circumference. Provide a coat thickness of at least 0.05 inch (1.3 mm).

709.05 PRE-COATED, GALVANIZED STEEL CULVERTS AND UNDERDRAINS

Meet AASHTO M 245 and 246 requirements and the requirements of Subsection 709.02 for irrigation and syphon pipe installations.

Provide a minimum 0.010 in (0.25 mm) coating for both inside and outside surfaces meeting AASHTO M 246, Section 7 requirements.

709.06 CORRUGATED STEEL PIPE FOR UNDERDRAINS

Furnish pipe and coupling bands meeting AASHTO M 36 requirements. The class of underdrain in AASHTO M 36 is the Contractor's option.

Furnish semi-circular underdrain and coupling bands meeting AASHTO M 36 requirements and the Detailed Drawings. Furnish nuts, caps, screws and other parts galvanized meeting ASTM A 153 or B 695 (Class 50). Furnish screens and caps for semicircular underdrains meeting the Detailed Drawings.

Furnish bituminous coated underdrains meeting AASHTO M 190 requirements. Nuts, bolts and screens must not be coated.

709.07 CORRUGATED ALUMINUM PIPE AND PIPE ARCH CULVERTS

Furnish corrugated aluminum pipe and pipe arch culverts meeting AASHTO M 196 requirements, and the modifications to AASHTO M 36 specified in Subsection 709.02.

709.08 CORRUGATED ALUMINUM PIPE FOR UNDERDRAINS

Furnish corrugated aluminum pipe for underdrains meeting AASHTO M 196 requirements.

709.09 SEAMLESS STEEL PIPE

Furnish seamless steel pipe meeting ASTM A 53 requirements.

709.10 COPPER PIPE

Furnish copper pipe and tube meeting ASTM B 88, Type K requirements.

709.11 SLOTTED CORRUGATED STEEL PIPE

Furnish slotted corrugated steel pipe that is commercially fabricated with the grate and steel pipe an integral unit. Pressure or fusion weld the grate spacer bars to the bearing bar. Meet ASTM A 36 requirements for grating materials galvanized after fabrication.

709.12 TYPE II ALUMINIZED CORRUGATED STEEL PIPE

Furnish pipe and coupling bands fabricated from material meeting AASHTO M274 requirements. Assure the prefabricated pipe and coupling bands meet the applicable Subsection 709.02 requirements.

**SECTION 710
PAINTS**

710.01 PIGMENTS, VEHICLES, AND THINNERS

Assure all materials from which paints are made and formulated meet the following specifications:

Zinc Oxide Pigments.....	ASTM D 79
Pure Chrome Green Pigments.....	ASTM D 212
Iron Blue Pigments	ASTM D 261
Calcium Carbonate Pigments	ASTM D 1199
Titanium Dioxide Pigments	ASTM D 476
Bone Black Pigment	ASTM D 210
Carbon Black Pigment	ASTM D 561
Black Synthetic Iron Oxide Pigment.....	ASTM D 769
Red and Brown Iron Oxide Pigments.....	ASTM D 3722
Ochre (Ferrous Earthy Pigments)	ASTM D 85
Raw and Burnt Umber Pigments	ASTM D 763
Raw and Burnt Sienna Pigments	ASTM D 765
Copper Phtalocyanine Blue Pigment	ASTM D 963
Iron Blue Pigment	ASTM D 261
Ultramarine Blue Pigments	ASTM D 262
Chrome Oxide Green Pigment.....	ASTM D 263
Chrome Yellow and Chrome Orange Pigments.....	ASTM D 211
Yellow Iron Oxide Pigment-hydrated	ASTM D 768
Aluminum Pigments	ASTM D 962
Zinc Dust (Pigment)	ASTM D 520
Magnesium Silicate Pigments.....	ASTM D 605
Diatomaceous Silica Pigments	ASTM D 604
Mica Pigment	ASTM D 607
Raw Linseed Oil.....	ASTM D 234
Boiled Linseed Oil.....	ASTM D 260
Spirits of Turpentine.....	ASTM D 13
Petroleum Spirits (Mineral Spirits)	ASTM D 235
Lampblack Pigments.....	ASTM D 209
Liquid Paint Driers	ASTM D 600
Raw Tung Oil	ASTM D 12

710.02 PAINTS AND ENAMELS

A. General. Follow the paint manufacturers recommendations including but not limited to storage, application, thinning, safety precautions, and film thickness unless otherwise specified.

Furnish all paints under this Section free of lead, or zinc chromate unless specified.

Provide the manufacturer's Product Safety Data Sheets. Supply the paint in the original container labeled with the manufacturer's name, address, paint type, formula identification, date of manufacture, and lot or batch number.

Paints for structural steel where multiple coats are applied must be produced by the same manufacturer. Provide the Project Manager certified test results from an

independent testing facility showing the following paints supplied meet the applicable requirements.

B. Paints for Miscellaneous Metals. Use the following paints on metal unless otherwise specified.

1. **Aluminum Paint, Ready-mixed.** Furnish aluminum paint meeting AASHTO M 260 (Type II, Leafing Finish).
2. **Aluminum Epoxy Paint.** Furnish aluminum epoxy paint that is a self-priming, two-component, high build, aluminum filled epoxy mastic. The paint must adhere to metal surfaces and existing painted surfaces when the surface is prepared following the paint manufacturer's recommendations.

Apply the coating following all the manufacturer's recommendations to produce a minimum 5 mil (125 μ m) dry film thickness.

Meet Table 710-1 minimum paint composition requirements.

**TABLE 710-1
ALUMINUM EPOXY PAINT COMPOSITION**

	COMPOSITION
Solids	90% \pm 2% by volume (ASTM D 2697)
Pigment	19% by volume
Vehicle	66% by volume
Percent non-volatile vehicle	74%
Nominal VOC	0.74 pounds/gal. (89.1 grams/liter)

The mixed paint must weigh between 11 to 12 pounds per gallon (1.3 to 1.4 kg per liter) when measured under ASTM D 1475 at 75 plus or minus 2 °F (24 \pm 1 °C).

The mix ratio of the two components must be 1:1 by volume and have a minimum pot life of 4 hours at 75 °F (24 °C) when thinned following the manufacturer's recommendations.

3. **Epoxy Paint for Pipe Pile.** Furnish epoxy paint that is a two-component, self-priming epoxy coating meeting Table 710-2 requirements.

**TABLE 710-2
EPOXY PAINT FOR PIPE PILE REQUIREMENTS**

	REQUIREMENT
Drying Time at 75 °F (24 °C) To Touch To Cure	2 hours max. 10 days max.
Pot Life at 70 °F (21 °C)	12 hours min.
Abrasion Resistance (ASTM D 4060; CS-17 wheel, 1,000 Gram load, 1,000 cycles)	170 mg loss, max.
Direct Impact Resistance (ASTM D 2794)	60 in. pounds min. (6.8 Nxm/min)

Additional requirements:

- a. **Salt Fog.** No blistering, cracking, or film delamination when tested under ASTM B 117 for 1,500 hours; and
- b. **Moisture Condensation Resistance.** No blistering, cracking, or film delamination when tested under ASTM D 2247 for 1,000 hours at 100 °F (37 °C).

- 4. Equipment Enamel.** Furnish equipment enamel that is formulated using Federal Specification TT-E-489b, Class A, spray or brush consistency as specified in the contract. Match the appropriate color chip, available from the Materials Bureau. Meet the thinner requirements of Federal Specification TT-T306. Use at a maximum rate of 1 pint per gallon (0.12 L per L) when required.
- 5. White, Yellow, and Black Enamel.** Furnish water resistant enamels made from synthetic gums capable of brush application to vertical metal surfaces without running, streaking, or sagging.
Meet Table 710-3 requirements.

**TABLE 710-3
ENAMEL PAINT REQUIREMENTS**

	WHITE	YELLOW	BLACK
Coarse particles and skins retained on No. 325 sieve, max. (45 µm)	0.50%	0.50%	0.50%
Nonvolatile matter, min.	85%	85%	85%
Dry to touch at 70 °F (21 °C) time in hours, max.	5	5	5
Dry hard at 70 °F (21 °C) time in hours, max.	24	24	24
Toughness, Kauri reduction test at 75 °F (24 °C), min.	150%	150%	150%
Hiding power, square feet per gallon (m ² per L) by Pfund cryptometer Model E,	300	450	
Black plates, min.	(7.3)	(11)	

Meet Federal Test Method Standard No. 141C for whitening, dulling, or change in color, brushing, flowing, covering, and leveling properties.

The white enamel must be equal in brightness to Rutile (Type IV) Titanium Dioxide Pigment.

Yellow enamel must match standard color sample for D-2 yellow guardrail paint. Black enamel must be jet black and cover completely in one coat.

- 6. Zinc Phosphate Paint.** Zinc Phosphate Paint may be used as a primer or finish coat unless otherwise specified. Provide the finish paint color specified in the contract and match the appropriate color chip, available upon request. The paint must:
- a. Be well ground;
 - b. Show no skinning in a freshly opened, full can;
 - c. Not cake or settle in the container;
 - d. Readily break up with a paddle to a smooth, uniform consistency;
 - e. Brush easily, possess good leveling qualities; and
 - f. Dry to a hard uniform finish.

Meet Table 710-4 requirements.

**TABLE 710-4
ZINC PHOSPHATE PAINT REQUIREMENTS**

	REQUIREMENT	
	Min.	Max.
Pigment⁴	56.5%	58.5%
Vehicle⁵	41.5%	43.5%
Pigment Composition:		
Zinc Phosphate	60.0%	—
Titanium Dioxide (Rutile) ⁶	13.0%	—
Calcium Carbonate	21.4%	—
Vehicle Composition:		
Alkyd Phthalic Resin (50% Solids)	52.4%	—
Raw Linseed Oil	26.2%	—
Mineral Spirits	17.2%	—
Driers and Additives	4.2%	—
Finished Paint:		
Consistency (Krebs-Stormer) ¹	70 KU	83 KU
Weight Per Gallon, pounds ²	12.6 (5.7 kg)	—
Dry To Touch ³		8 hours
Dry To Handle ³		16 hours
Dry Film Thickness mil	1.0	—

Notes:

1. By ASTM D-562
2. By ASTM D-1475
3. Federal Test Method Standards 141C Method 4061.2
4. Federal Test Method No. 141-Method 4021
5. Federal Test Method No. 141-Method 4051
6. ASTM D 1394

710.02.1 Reserved**710.02.2 Reserved****710.02.3 Paint Coating Systems for Structures**

- A. Epoxy Zinc Rich Primer.** Meet AASHTO M 300 Type I or II requirements, excluding those in Section 4.7.
- B. Intermediate Coat.** Use a two-component polyamide epoxy meeting Table 710-5 requirements.

**TABLE 710-5
STRUCTURES - INTERMEDIATE COAT REQUIREMENTS**

	REQUIREMENT
Drying Time @ 50 °F (10 °C) To Touch Tack Free Cure	4 hours max. 24 hours max. 14 days max.
Pot Life @ 50 °F (10 °C)	10 hours min.
Abrasion Resistance (ASTM D 4060, CS-17 wheel, 1,000 cycles)	224 mg max. loss
Direct Impact Resistance	120 in. pounds. (13.6 Nxm min.)

Additional requirements:

1. **Salt Fog.** No blistering, softening, cracking or film delamination when tested under ASTM B 117 for 1,000 hours; and
 2. **Moisture Condensation Resistance.** No blistering, rusting or delamination when tested under ASTM D 2247 for 1,000 hrs. at 100 °F (37 °C).
- C. Finish Coat.** Provide a two-component finish epoxy meeting Table 710-6 requirements.

**TABLE 710-6
STRUCTURES - FINISH COAT REQUIREMENTS**

	REQUIREMENT
Drying Time @ 50 °F (10 °C) To Touch Tack Free Cure	10 hours max. 24 hours max. 14 days max.
Pot Life @ 50 °F (10 °C)	10 hours min.
Abrasion Resistance (ASTM D 4060, CS-17 wheel, 1,000 cycles)	224 mg. max. loss
Impact Resistance	120 in. pounds. (6714 mm kg min.)

Additional requirements:

1. **Salt Fog.** No blistering, softening, cracking or film delamination when tested under ASTM B 117 for 1,000 hours; and
2. **Moisture Condensation Resistance.** No blistering, rusting or delamination when tested under ASTM D 2247 for 1,000 hours at 100 °F (37 °C).

SECTION 711
REINFORCING STEEL, STRUCTURAL
STEEL HARDWARE, AND
MISCELLANEOUS STRUCTURE ITEMS

711.01 REINFORCING STEEL

711.01.1 Bar Reinforcing

Furnish the specified reinforcing steel meeting AASHTO M 31 requirements.

The Project Manager may accept small lots of reinforcing steel subject to it passing the bending test specified in AASHTO M 31.

711.01.2 Epoxy-coated Reinforcing Bars

Furnish epoxy-coated reinforcing bars meeting AASHTO M 284 and the contract requirements.

Assure the bars are coated by an applicator plant certified under the Concrete Steel Institute's certification program for Fusion-bonded Epoxy Applicator Plants, or equivalent certification program.

711.01.3 Wire and Wire Mesh

Furnish concrete reinforcing wire meeting AASHTO M 32 requirements.

Furnish wire mesh reinforcing for concrete meeting AASHTO M 55 requirements and the contract.

Furnish bar mats meeting AASHTO M 54 requirements.

711.02 STRUCTURAL STEEL

Furnish structural steel for:

- A.** Bridge superstructure applications meeting AASHTO M 270/M 270M.

Use material meeting Charpy V-notch impact test requirements for zone 3 to fabricate webs, flanges in tension or stress reversal zones, splice plates, w-shaped rolled beams.

This requirement applies to diaphragms and diaphragm connection plates for horizontally curved girders.

- B.** Other applications meeting AASHTO M 183/ M 183M.

711.03 STRUCTURAL STEEL TUBING

Furnish structural steel tubing for bridges meeting ASTM A 500, Grade B, requirements for cold-formed welded seamless carbon steel structural tubing in rounds and shapes.

711.04 PINS AND ROLLERS

Furnish pins and rollers of annealed carbon steel forging's meeting AASHTO M 102, Class C requirements, or cold-finished carbon steel shaft meeting AASHTO M 169 requirements, Grades 1018 to 1030 inclusive. Fabricate pins and recessed pin nuts as detailed in the AISC Manual of Steel Construction, current edition.

711.05 WELDING ELECTRODES

Use welding electrodes meeting AWS, AASHTO, and the contract requirements.

711.06 HIGH TENSILE STRENGTH BOLTS

Furnish heat-treated carbon steel bolt, nut, and washer material meeting AASHTO M 164 requirements.

Specify in the purchase order for galvanized high tensile strength bolts that copies of the manufacturer's inspection test reports for the materials are to be forwarded with the order. Make the reports available to the Project Manager upon request.

Rockwell C hardness cannot exceed 32 before galvanizing.

711.07 BOLTS AND NUTS

Furnish bolts, threaded rod, and nuts meeting ASTM A 307 Grade A requirements. Use hexagonal headed nuts for steel machine bolts and tap bolts.

711.08 GALVANIZED METAL

Furnish galvanized ferrous metal products meeting AASHTO M 111 requirements, or when applicable, meeting ASTM B 695 (Class 50) requirements.

711.09 WELDED STUD SHEAR CONNECTORS

Furnish shear connector studs meeting the AWS specification for "Stud Welding" and the contract requirements.

711.10 STEEL PILING

711.10.1 Structural Steel Piles

Furnish new steel H piles, smelted and manufactured in the USA, meeting AASHTO M270 Grade 345 MPa (50 ksi) and contract requirements.

711.10.2 Steel Pipe Piles

Furnish new steel pipe piles, smelted and manufactured in the USA, meeting ASTM A 252, Grade 2 requirements with a minimum yield strength of 310 Mpa (45 ksi). Steel pipe diameter and wall thickness is specified in the contract.

711.11 PRESTRESSING STEEL

Furnish prestressing steel meeting ASTM A 416 requirements.

711.12 CASTINGS

711.12.1 Steel Castings for Highway Bridges

Furnish castings meeting AASHTO M 192, Class 485 requirements.

711.12.2 Chromium Alloy Steel Castings

Furnish castings made from Grade CA-15 meeting AASHTO M 163 requirements.

711.12.3 Drainage Structure Castings

Furnish structural drainage castings meeting the Detailed Drawing requirements and AASHTO M 306 requirements modified as follows:

1. References to Federal Specification RR-F-621C are changed to read RR-F-621 and current amendments thereto;
2. The Grey iron casting requirements of Subsection 3.1 are changed to AASHTO M 105 (ASTM A 48) Class 207;
3. The weight requirement of Subsection 4.2.4 is (plus or minus 5 percent Drawing/Specification Weight);
4. The proof load testing of Subsections 7.1 and 9.1.1 is 25,000 pounds. (110 kN);
5. Delete Subsections 11.1.2 and 11.1.3; and
6. Subsection 11.1.4 is changed to read Heat number or date.

711.13 BEARING ASSEMBLY ANCHOR BOLTS FOR BRIDGES

Furnish anchor bolts sized as specified and meeting ASTM A 36 requirements.

711.14 ELASTOMERIC BEARING DEVICES

Furnish elastomeric bearings meeting AASHTO M 251 and the contract requirements.

711.15 COMPRESSION JOINT SEALS

Furnish preformed elastic joint seals meeting the open cell compression seal requirements of ASTM D 3542 and the contract.

Furnish joint seals that accommodate the design movement specified in the contract and follow the manufacturers recommended installation width.

Use the seal manufacturer's recommended adhesive lubricant for seal installation. Use Lubricant meeting ASTM D 4070 requirements.

Furnish a minimum 3-foot (915 mm) long seal sample taken from each size and type furnished on the project. Order the seals 3 feet (915 mm) longer than required for the installation. Submit a copy of the manufacturers certificate of compliance meeting Subsection 106.03, attesting that the material meets specifications.

Obtain the Project Manager's approval of all joint seals before installation.

Install the seals following the manufacturer's recommendations. Do not field splice seals.

Furnish and install the seals, including these costs in the bid price for structural steel.

711.16 FIBER REINFORCED PADS

Furnish vulcanized rubber-fiber pads made from new unvulcanized rubber and synthetic fibers. Each component must make up 50 percent of the pads weight.

The pad surface must have:

1. A standard rubber hardness of 80 plus or minus 5 Shore A durometer;
2. An ultimate compressive breakdown strength of at least 7,000 psi (48.3 MPa); and
3. A minimum and maximum pad thickness of 1/16-inch (2 mm) and 1/8-inch (3 mm), respectively.

Submit the manufacturer's certification that the pads meet these specifications. A copy of the certification must accompany the shipment to the project. Pads not meeting these requirements will be rejected.

Fiber reinforced pads are incidental to and included in payment for other structural steel work.

711.17 METAL BIN-TYPE RETAINING WALLS

Furnish metal bin-type retaining walls meeting the contract requirements.

Furnish the necessary bolts and appurtenances for complete assembly of the members into a continuous closed-face wall of connected bins.

Assure the base metal and spelter coating meet AASHTO M 218 requirements. Use galvanized bolts, nuts, washers, and other hardware meeting ASTM A 153 or B 695 (Class 50, Type I) requirements.

Assure all members are fabricated so units of the same nominal size are fully interchangeable. Do not drill, punch, or drift holes to correct defects in manufacture. Replace members having improperly punched holes at Contractor expense.

Remove and replace damaged members or members with damaged or broken spelter at Contractor expense.

STEEL HARDWARE, AND
MISCELLANEOUS STRUCTURE ITEMS

Meet the applicable treatment and handling requirements for bituminous-coated steel structural plate pipe and pipe arches under Section 709 when handling bituminous-treated walls. Repair broken or damaged bituminous coating at Contractor expense.

SECTION 712 FENCING MATERIALS

712.01 CHAIN LINK FENCE

712.01.1 General

Meet AASHTO M 181 requirements, as modified herein. Use one of the following fence fabrics, as specified in the contract:

- Type 1 Class C Zinc-coated Steel
- Type 2 Aluminum-coated Steel
- Type 3 Aluminum Alloy
- Type 4 Vinyl-coated Fabric

Use zinc-coated steel for all Type 1 or Type 2 fabric, fence posts, rails, gate frames, expansion sleeves, wire ties, fabric ties, hog rings, tension wire, miscellaneous fittings, and hardware. Use aluminum alloy for these same Type 3 fabric fence parts. Use either zinc-coated steel or aluminum alloy for these Type 4 fabric fence parts.

712.01.2 Fence Fabric

Furnish fence fabric having 2-inch (50 mm) openings and meeting AASHTO M 181 requirements. Use 11-gauge wire for fabric 48 inches (1,220 mm) high and under. Use 9-gauge wire for fabric 60 inches (1,525 mm) high and over. The fabric height is specified in the contract.

712.01.3 Posts, Rails, and Braces

Meet Table 712-1 and the contract length requirements. Furnish all posts with a watertight cap that fits securely over the outside post top and supports the top rail.

712.01.4 Truss Rods

Furnish 3/8-inch (9.5 mm) truss rods as follows:

- Steel - galvanized with dropforged turnbuckles or other approved type of adjustment.
- Aluminum - with cast aluminum turnbuckles or other approved type of adjustment.

712.01.5 Fabric Bands and Stretcher Bars

Furnish bands as follows:

- Steel - a minimum 1/8-inch (3 mm) thick by 3/4-inch (19 mm) wide.
- Aluminum - a minimum 1/8-inch (3 mm) thick by 7/8-inch (22 mm) wide.

Furnish aluminum or steel stretcher bars as follows:

- A minimum 1/4-inch (6 mm) thick by 3/4-inch (19 mm) wide.
- At least 2 inches (50 mm) shorter than the fabric width used.

712.01.6 Tie Wire

Furnish 9-gauge galvanized steel tie wire meeting ASTM A 116 requirements. Furnish 11-gauge, Class 1 galvanized steel hog ring fasteners meeting ASTM A 116 requirements.

Furnish 9-gauge aluminum tie wire meeting ASTM B 211 Alloy 1100, Temper H14 requirements. Furnish minimum 11-gauge aluminum hog ring fasteners meeting ASTM B 211, Alloy 6061 requirements.

712.01.7 Tension Wire

Furnish 7-gauge galvanized coiled spring steel tension wire. Meet ASTM A 116, Class 1 galvanizing requirements.

Furnish 6-gauge aluminum tension wire meeting ASTM B 211, Alloy 6061, Temper T 94 requirements.

712.01.8 Gates

Furnish gates complete with all necessary hinges, latch, and drop-bar locking device for the type of gate and gateposts specified. Meet AASHTO, AWS specifications, and the contract requirements for all welding.

A. Steel Gates. Construct gate frames from steel sections meeting Table 712-1 requirements. The gate frame corners may be welded or fastened and reinforced with galvanized malleable-iron fittings designed for this use.

Use chain link fabric for gate frames meeting Subsection 712.01.2 and match the fabric used in the fence.

B. Aluminum Gates. Construct gate frames from aluminum sections meeting Table 712-1 requirements. Assemble the gates frames by welding.

Use aluminum alloy cast hinges meeting ASTM B 108 or B 26 requirements or made of malleable iron or steel and hot-dip galvanized or mechanically galvanized meeting ASTM B 695 (Class 50). Make all latches, stops, and keepers of the aluminum alloy specified for hinges or use galvanized malleable iron or pressed steel.

Use chain link fabric for the gate frame meeting Subsection 712.01.2 requirements and matching the fabric used in the fence.

TABLE 712-1
TABLE OF FENCE SUPPORTS AND FRAMING FOR CHAIN LINK FENCE

USE	GRADE	STEEL SHAPE, SIZE, WT	ALUMINUM SHAPE, SIZE, WT
Line Posts	1	1.90" O.D. pipe at 2.70 lb/ft (48 mm O.D. pipe at 4 kg/meter), 1.875' x 1.625' x 0.113' H-section at 2.70 lb/ft (571 mm x 495 mm x 35 mm at 4 kg/meter)	2.375" O.D. pipe at 1.25 lb/ft (61 mm O.D. pipe at 1.85 kg/meter), 2.25" x 1.95" H-section at 1.25 lb/ft (58 mm x 50 mm H-section at 1.90 kg/meter)
	2	1.90" O.D. pipe at 2.28 lb/ft (48 mm O.D. pipe at 3.40 kg/meter)	
End, Corner and Pull Posts	1	2.375" O.D. pipe at 3.65 lb/ft (61 mm O.D. pipe at 5.40 kg/meter), 2.0" x 2.0" sq. tubing at 3.61 lb/ft (51 mm x 51 mm sq. tubing at 5.40 kg/meter)	2.875" O.D. pipe at 2.0 lb/ft (75 mm O.D. pipe at 3 kg/meter), 3.0" x 3.0" sq. tubing at 2.0 lb/ft (76 x 76 mm sq. tubing at 3 kg/m)
	2	2.375" O.D. pipe at 3.12 lb/ft (61 mm O.D. pipe at 4.6 kg/meter)	
Gate Posts Leaf Width: 6 ft (1.8 m) and less	1	2.875" O.D. pipe at 5.79 lb/ft (73 mm O.D. pipe at 8.60 kg/meter), 2.5" x 2.5" sq. tubing at 5.7 lb/ft (64 mm x 64 mm tubing at 8.50 kg/meter)	2.875" O.D. pipe at 2.0 lb/ft (73 mm O.D. pipe at 3 kg/meter)
	2	2.875" O.D. pipe at 4.64 lb/ft (73 mm O.D. pipe at 6.9 kg/meter)	3.0" x 3.0" sq. tubing at 2.0 lb/ft (76 x 76 mm sq. tubing at 3 kg/meter)
Over 6 ft thru 13 ft (1.8 thru 4 m)	1	4.0" O.D. pipe at 9.10 lb/ft (105 mm O.D. pipe at 13.5 kg/meter), 3.0" x 3.0" sq. tubing at 9.10 lb/ft (76 mm x 76 mm tubing 13.5 kg/meter)	4.0" O.D. pipe at 3.0 lb/ft (102 mm O.D. Pipe at 4.50 kg/meter)
Over 13 ft thru 18 ft (4 thru 5.5m)	1	6.625" O.D. pipe at 18.97 lb/ft (168 mm O.D. pipe at 28.20 kg/meter)	6.625" O.D. pipe at 7.0 lb/ft (168 mm O.D. pipe at 10.50 kg/meter)
Rails and Braces	1	1.660" O.D. pipe at 2.27 lb/ft (42 mm O.D. pipe at 3.40 kg/meter)	1.660" O.D. pipe at 0.786 lb/ft (42 mm O.D. pipe at 1.2 kg/meter)
	2	1.660" O.D. pipe at 1.84 lb/ft (42 mm O.D. pipe at 2.70 kg/meter)	
Gate Frames Leaf Width: 8 ft. (2.4 m) and less	1	1.660" O.D. pipe at 2.27 lb/ft (42 mm O.D. pipe at 3.40 kg/meter), 1.5" x 1.5" sq. tubing at 1.90 lb/ft (38 mm x 38 mm tubing at 2.90 kg/meter)	1.900" O.D. pipe at 0.94 lb/ft (48 mm O.D. pipe at 1.40 kg/meter), 2.0" x 2.0" sq. tubing at 0.94 lb/ft (51 x 51 mm sq. tubing at 1.40 kg/meter)
	2	1.660" O.D. pipe at 1.84 lb/ft (42 mm O.D. pipe at 2.70 kg/meter)	
Over 8 ft (2.4 m)	1	1.90" O.D. pipe at 2.72 lb/ft (48 mm O.D. pipe at 4 kg/meter), 2.0" x 2.0" sq. tubing at 2.10 lb/ft (51 mm x 51 mm sq. tubing at 3.10 kg/meter)	1.90" O.D. pipe at 0.94 lb/ft (48 mm O.D. pipe at 1.40 kg/meter), 2.0" x 2.0" sq. tubing at 0.94 lb/ft (51 x 51 mm sq. tubing at 1.40 kg/meter)
	2	1.90" O.D. pipe at 2.28 lb/ft (48 mm O.D. pipe at 3.40 kg/meter)	

712.02.1 Woven Wire

Furnish woven wire meeting ASTM A 116 requirements and either of the Table 712-2 designations.

**TABLE 712-2
WOVEN WIRE REQUIREMENTS**

INTERSTATE FENCE			
Specification	Grade	Design Number	Metallic Coating
ASTM A 116	No. 12 1/2 Grade 60	832-6-12 1/2	Type Z, Class 1
ASTM A 116	No. 14 Grade125	832-6-14	Type Z, Class 3

FARM FENCE			
Specification	Grade	Design Number	Metallic Coating
ASTM A 116	No. 12 1/2 Grade 60		Type Z, Class 1
ASTM A 116	No. 14 Grade125		Type Z, Class 3

Provide a 6-inch (155 mm) stay spacing. Match the fence height and mesh dimensions of the fence being replaced if not specified.

712.02.2 Barbed Wire

Use 2-point 12 1/2 or 13 1/2-gauge barbed wire meeting ASTM A 121 requirements. Space barbs a nominal 4-inches (105 mm) or a nominal 5-inches (130 mm). Zinc coating must be Class 1 for 12 1/2 and 13 1/2 gauge wire. Provide the Project Manager Certification that the wire meets ASTM A 121 requirements.

712.02.3 Brace Wire

Use 9 or 12 1/2 gauge soft, smooth wire.

712.02.4 Staples and Nails

Use minimum 9-gauge U-shaped, 1 3/4-inch (45 mm) long staples unless otherwise specified.

712.02.5 Tie Wires

Use minimum 12 1/2 gauge galvanized tie wire. Commercial galvanized fasteners supplied with the wire may be used if approved by the Project Manager.

712.02.6 Metal Fence Stays

Use commercially made and fabricated metal fence stays from 9 1/2-gauge wire twisted to form a two-wire unit.

712.02.7 Metal Posts and Assemblies

Provide metal fence posts and assemblies meeting ASTM A 702 requirements, modified as follows:

- Tables 3, 4, and 6.1 through 6.2.2 of ASTM A 702 apply to finished posts and assemblies after fabrication, punching, drilling, and finish coating.

Galvanize or paint posts, braces, and anchor plates. Meet AASHTO M 111 galvanizing requirements. Furnish nuts, bolts, fittings, and other hardware meeting ASTM A 153 or B 695 (Class 50) galvanizing requirements. Paint following the paint manufacturer's recommendations.

Furnish fence posts and braces of the lengths in Table 712-3.

**TABLE 712-3
POST LENGTHS**

FENCE	POST TYPE	CORNER, END, GATE, PULL & PANEL POSTS	LINE POSTS	BRACES AND BRACE RAILS
Interstate	Metal	7 feet 8 inch (2.3 m)	6 1/2 feet (2.0 m)	7 feet 8 inch (2.3 m)
Interstate	Wood	8 feet (2.4 m)	7 feet (2.1 m)	8 feet (2.4 m)
Farm	Metal	7 feet (2.1 m)	6 feet (2.0 m)	7 feet (2.3 m)
Farm	Wood	8 feet (2.4 m)	7 feet (2.1 m)	8 feet (2.4 m)

Use 2 1/2 inch x 2 1/2 inch x 1/4 inch (64 mm x 64 mm x 6 mm) or heavier metal fence posts for Interstate and Farm fence for corner, end, gate and pull posts. Use 2 inch x 2 inch x 1/4 inch (51 mm x 51 mm x 6 mm) or heavier metal pipe brace posts. Line posts must have a nominal weight of 1.33 pounds per foot (2 kg per meter) exclusive of anchor plates.

The metal must be good commercial-quality steel having a maximum 0.82 percent carbon content.

Use Tee, Channel, U, or Y bar section line posts with corrugations, knobs, notches, holes, or studs placed to engage the fence line wires.

Weld a steel anchor plate to each line post so that the anchor top is 2 inches to 3 inches (50 mm to 75 mm) below groundline when the post is set to the specified depth.

712.02.8 Wood Fence Posts and Brace Rails

- A. General.** Make fence posts and brace rails from well seasoned, sound, and straight-grained Western Larch, Lodgepole Pine, Ponderosa Pine, or Douglas Fir. Remove all bark from the posts.

Taper round posts to be driven from 8 inches to 12 inches (205 to 305 mm) up from the bottom to a 1-inch (25 mm) point. Taper the post tops to a round top with a minimum 3-inch (75 mm) diameter for line posts and 4-inch (105 mm) diameter for corner, brace, pull, end, and gate posts. These taper lengths are included in the specified post lengths. Perform all tapering before treatment. Treat the posts and rails meeting Subsection 706.04.1.

Use minimum 4-inch (105 mm) diameter brace rails.

Ensure the posts and rails are straight so that a line running from the center of both ends is within the body of the post or rail.

- B. Posts for Farm Fence.** Furnish posts meeting the dimensional requirements in Subsection 712.02.8(C).

Treat the posts with a minimum 5 percent by weight pentachlorophenol solution or Chromated Copper Arsenate (CCA), Type B or C, or Ammoniacal Copper Arsenate (ACA) meeting AWPA Standards. Assure the treatment penetrates the wood at least 1/2-inch (13 mm) or full sap, with a minimum retention of 0.4 pounds per cubic foot (6.50 kg per cubic meter).

Extend the treatment for at least 36 inches (915 mm) for line posts and 48 inches (1,220 mm) for all other posts. Post treatment must be at a Department approved plant.

- C. Posts for Interstate Fence.** Furnish line posts and brace rails from a minimum 4-inch (105 mm) diameter, naturally round, or a minimum 4-inch x 4-inch (105 mm x 105 mm) square sawn. Furnish corner, end, gate, pull, and brace posts from a minimum 5-inch (130 mm) diameter naturally round post or a 5 x 5-inch (130 mm x 130 mm) square sawn post.

Treat all wood fence material meeting Subsection 706.04.1 requirements.

712.02.9 Metal Gates

Furnish each gate complete with hinges, latch, and all other hardware used with the type of gate and gate post specified.

712.02.10 Gates for Interstate Fence

Use plain-top single-drive metal gates of tubular steel frame with wire fabric filler. Fit the gate to the opening between the gate posts of the approximate widths shown in the Detailed Drawings. Provide a centered steel upright brace for gates for openings of less than 14 feet (4.3 m), two upright steel braces at third points for gates for openings of 14 feet (4.3 m) or greater.

Fill the metal gates with galvanized wire fabric securely fastened to the top, bottom, ends of the gate frame.

Use fabric meeting Subsection 712.02.1, Class 1 or better.

The approximate weight of the gate frames (less fabric) must meet Table 712-4 requirements.

**TABLE 712-4
APPROXIMATE GATE FRAME WEIGHTS**

WIDTH OF OPENING	APPROXIMATE WT¹
8 feet (2.4 m)	48 pounds (22 kg)
10 feet (3.0 m)	55 pounds (25 kg)
12 feet (3.7 m)	62 pounds (28 kg)
14 feet (4.3 m)	72 pounds (33 kg)
16 feet (4.9 m)	80 pounds (36 kg)

Notes:

1. Heavier gates will be permitted if they meet all other requirements.

712.02.11 Gates for Farm Fence

Furnish farm fence gates meeting the Detailed Drawings and contract requirements.

712.02.12 Deadman or Anchor

Furnish deadman and anchor(s) meeting the Detailed Drawing requirements.

712.02.13 Miscellaneous

Bolts, nuts, fittings, hinges, and all other metal parts for constructing fences and gates must be galvanized meeting the specified ASTM specification.

**SECTION 713
MISCELLANEOUS MATERIALS**

713.01 WATER

Furnish water for mixing and curing concrete that meets AASHTO M 157, 4.1.4 requirements. Water will be tested under AASHTO T 26. Known potable water may be used without testing.

Use irrigation quality water for irrigating trees, plants, and seeded areas, free of elements harmful to plant growth.

713.02 HYDRATED LIME

Furnish hydrated lime meeting AASHTO M 303 requirements.

713.03 CALCIUM CHLORIDE

Furnish calcium chloride meeting AASHTO M 144 requirements.

713.04 CEMENT GROUT

Produce grout consisting of 1 part portland cement to 3 parts of sand thoroughly mixed with water to produce a uniform thick mortar. Use mortar within 30 minutes of adding water. Mortar cannot be re-tempered.

Use sand for mortar meeting Subsection 701.01.1 and Table 713-1 gradation requirements.

**TABLE 713-1
MORTAR SAND GRADATION REQUIREMENTS**

SIEVE SIZE	% PASSING
No.4 Sieve (4.75 mm)	100
No.8 Sieve (2.36 mm)	90-100
No.16 Sieve (1.18 mm)	60-90
No.50 Sieve (0.300 mm)	15-40
No.100 Sieve (0.150 mm)	0-10

713.05 TOPSOIL

Furnish topsoil meeting Table 713-2 gradation requirements.

**TABLE 713-2
TOPSOIL GRADATION REQUIREMENTS**

FRACTION	PARTICLE SIZE (mm)	MAX. % OF SOIL (-10 MESH) (2mm) FRACTION
Sand	0.05-2.0	85
Silt	0.005-0.05	80
Clay	Less than 0.005	50
Gravel	Larger than 2.0	Max. % of Total Sample ¹

Notes:

1. A maximum of 20 percent is allowable. Any quantity exceeding 10 percent is not included in the basis for payment. Gradation is tested under AASHTO T 88.

Meet the following:

1. Soil pH between 5.5 and 8.0 or up to 8.5 if the exchangeable sodium is less than 10 percent;

2. Soil conductivity factor less than 4; and
3. Organic content between 1 percent and 20 percent.

Topsoil is sampled and tested under Montana Test Method MT-412.

713.06 MINERAL FILLER

Mineral filler is portland cement, ground limestone dust, fly ash, or graded fines free of silt or clay produced from crushing stone, gravel, slag, or other non-plastic mineral matter. Mineral filler and their sources are subject to the Project Manager's approval.

Furnish mineral filler meeting Table 713-3 gradation requirements when tested under MT-301.

**TABLE 713-3
MINERAL FILLER GRADATIONS**

SIEVES	TOTAL PERCENT PASSING
No. 30 (0.600 mm)	98-100
No. 80 (0.180 mm)	95-100
No. 200 (0.075 mm)	65-100

Meet the following:

1. Dry and free from fine particle lumps;
2. Free carbon less than or equal to five percent by weight as measured by the loss on ignition test; and
3. Silica content less than or equal to ten percent for un-calcined materials.

AASHTO T 165, T 167, and Montana Test Method MT-306 or other tests may be used to determine the need for mineral fillers.

713.07 CONCRETE CURING AND PROTECTIVE COATINGS

713.07.1 Water-soluble or Emulsified Liquid Membrane-forming Linseed Oil Compounds

Furnish water-soluble or emulsified liquid membrane-forming linseed oil compounds meeting AASHTO M 148 requirements. Linseed oil compounds, when used as a protective coat must contain a minimum 2.7 pounds (0.32 kg) of linseed oil per gallon (liter).

Furnish a manufacturer's written certification showing the formulated weight of linseed oil per gallon (liter) meets or exceeds this limit.

713.07.2 Miscellaneous Combination Curing and Protective Coating Compounds

Obtain the Project Manager's written approval before using a commercial product.

Meet AASHTO M 148 requirements for a liquid membrane-forming compound for curing concrete.

713.07.3 Membrane Curing Compounds

Use membrane curing compounds meeting AASHTO M 148 requirements.

713.08 SEED

713.08.1 Grass Seed

Furnish all seed that meets and is labeled under Montana Seed Law and meeting the contract requirements.

Furnish seed originating from the North American Continent above 41 degrees latitude. Make written request for waivers of the above requirements to the Department Agronomist.

Furnish seed free of prohibited noxious weed seed with restricted weed seed not exceeding Montana Seed Law.

Wet, moldy, or otherwise damaged seed will be rejected.

Calculations of "pure live seed" may be made based on either a germination test or a tetrazolium test, in addition to the purity analysis.

Submit a purity analysis and germination test of the seed proposed for use. A germination test must have been performed within 12 months of the seeding date.

Apply seed on a "pure live seed" basis. The quantity of "pure live seed" per 100 pounds (45.4 kg) of seed is determined as follows:

$$\% \text{ Pure Live Seed} = \text{Germination \%} \times \text{Purity} \times 100$$

$$\text{Bulk Seed Needed} = \text{Total Lbs. Pure Live Seed Required} / \% \text{ Pure Live Seed} \times 100$$

Submit a written notification of the seed source and the approximate date the seeding is planned to begin. Do not begin seeding until the germination and purity test results are known.

Make each species of seed available in separate bags for sampling and inspection.

713.08.2 Legume Seed

Meet Subsection 713.08.1 requirements for source, grade, purity, germination, and "live seed" definition. Use the inoculant's specified in the contract when seeding legumes.

713.09 FERTILIZER

Use commercially manufactured fertilizer meeting the contract requirements.

The fertilizer must be labeled with the manufacturer's guaranteed analysis, meeting Montana fertilizer laws.

Contaminated or damaged fertilizer will be rejected.

Apply fertilizer at the rate specified in the contract.

713.10 MULCH

713.10.1 Vegetative Mulch

Vegetative mulch is pliable cereal grain straw or grass hay at least 8 inches (205 mm) in length.

Mulch will be rejected for the following reasons:

1. Chopped or ground mulch; or
2. Mulch that is musty, moldy, rotted, or contains noxious weed or grass seed-bearing stalks; or
3. Mulch containing stones, dirt, roots, stumps, and other foreign material.

713.10.2 Reserved

713.10.3 Fabricated Netting

Fabricated netting is composed of burlap, kraft paper string, or similar products and may be fabricated on the project.

Submit samples for testing and approval before use.

713.10.4 Wood Cellulose Fiber Mulch

Wood cellulose fiber mulch is specially prepared wood cellulose fibers free of growth or germination inhibiting materials that forms a homogeneous slurry when combined with water, fertilizer, and other approved additives and remains uniformly suspended under agitation. Color the mulch with a water-soluble, nontoxic dye to aide visual metering during application. Apply the mulch to produce a mat-like cover on the seeded ground.

At least 30 percent of the mulch fibers must average 0.15 inches (4 mm) or longer with 50 percent or more retained on a Clark Fiber Classifier 24-mesh screen.

Furnish wood cellulose fiber mulch meeting Table 713-4 requirements.

TABLE 713-4
WOOD CELLULOSE FIBER MULCH
PHYSICAL AND CHEMICAL PROPERTIES

PROPERTY	LIMIT	TOLERANCE
Moisture Content (total wt. basis)	12%	± 3%
Organic Matter (oven-dried wt. basis)	99.2%	± 0.2%
Inorganic Content (Ash)	0.8%	± 0.2%
Min. Water-holding Capacity (oven-dried wt. basis)	1080 g/minute	100 g/minute

Supply the mulch in 50 pound (22.7 kg) bags net weight. Each bag must be marked by the manufacturer showing the air-dry weight content.

Supply a minimum one-pound (0.454 kg) bag of the mulch proposed for use for testing when requested.

Provide a manufacturer's certificate of compliance under Subsection 106.03, attesting that the material meets these specifications.

713.10.5 Recycled Paper Fiber Mulch

Recycled paper fiber mulch is waste paper of at least 85 percent by weight, cellulose fiber. The mulch must:

1. Not contain any germination or growth inhibiting material nor non-biodegradable material;
2. Contain at least 90 percent organic matter (oven dry) when tested under ASTM D 586;
3. Have a pH of between 5.5 and 8.0;
4. Supplied in the manufacturers packages, clearly marked showing the package weight and contents; and
5. Packaged mulch moisture content cannot exceed 15 percent by weight.

The mulch, when mixed with water and fertilizer and agitated, must be a uniform, homogenous mixture. The mulch or slurry must contain a green non-toxic dye making the mulch clearly visible once applied.

Apply the mulch hydraulically to form a moisture-retaining surface that holds the seed in contact with the ground without smothering the seed.

713.11 SOD

Furnish sod that is a living, vigorous growth of grass of the type and thickness specified.

Provide sod native to the general locality of the project, having a dense root system, is free of noxious weeds, noxious grasses, and other foreign substances harmful to the development and maintenance of the sod.

Cut the sod when the grass length is approximately 2 inches (50 mm) high but not exceeding 3 inches (75 mm). Assure the sod is free of debris before cutting.

Wet the sod to permit cutting, rolling, and hauling without crumbling or breaking.

Water the sod using water from a municipal, domestic, or other source suitable for irrigation.

713.12 SOIL RETENTION/EROSION CONTROL BLANKETS AND MATS**713.12.1 Wood Excelsior Fiber Blankets**

- A. Type EX 1.** Type EX 1 wood excelsior fiber blanket is a machine produced mat uniform in thickness and weighing at least 1 pound per square yard (545 g per square meter). The top side of the blanket must be covered with a photo-degradable extruded plastic mesh netting.
- B. Type EX 2.** Furnish Type EX 2 wood excelsior fiber blankets meeting the requirements of Type EX 1. Sandwich blankets between a high strength extruded plastic mesh netting.
- C. Type EX 3.** Type EX 3 wood excelsior fiber blanket is a machine-produced mat of cured wood excelsior meeting the following requirements:
1. Minimum weight of 1.6 pounds per square yard (86 g per square meter);
 2. Minimum width of 36 inches (915 mm);
 3. Minimum roll length of 80 feet (24.4 m);
 4. Eighty percent of the wood fibers must be at least 6 inches (155 mm) long, evenly distributed throughout the mat; and
 5. Encased top and bottom with a high strength plastic mesh netting that resists ultraviolet breakdown.

713.12.2 Straw Blankets

- A. Type ST 1.** Type ST 1 straw blanket is a machine produced mat:
1. Made from 100 percent clean agricultural straw weighing a minimum 0.50 pounds per square yard (270 g per square meter) with a uniform thickness throughout the blanket; and
 2. The top side is covered with a lightweight photo-degradable polypropylene net weighing approximately 1 pound per 1,000 square feet (488 g per 100 square meter).
- B. Type ST 2.** Type ST 2 straw blanket meets Type ST 1 requirements and the following:
1. Sandwiched between a top cover of heavyweight UV resistant polypropylene netting weighing approximately 3 pounds per 1,000 square feet (1,460 g per 100 square meter) and on the bottom cover of a lightweight photo-degradable polypropylene netting weighing approximately 1 pound per 1,000 square feet (485 g per 100 square meters).
- C. Type STC.** Furnish Type STC blanket that is a machine-produced mat:
1. Of 70 percent agricultural straw weighing 0.35 pounds per square yard (190 g per square meter) and 30 percent coconut fiber weighing 0.15 pounds per square yard (82 g per 100 square meter);
 2. Having a uniform thickness with the straw and coconut evenly distributed within the mat;
 3. That is sandwiched between a top heavy weight, UV resistant polypropylene netting weighing approximately 3 pounds per 1,000 square feet (1,460 g per 100 square meter) and the bottom being a lightweight photo-degradable polypropylene netting weighing approximately 1 pound per 1,000 square feet (485 g per 100 square meter);
 4. Sewn together with durable thread; and
 5. Treated to sterilize all weed seed.

Provide the Project Manager a manufacturer's certification stating the blankets supplied for the project have been sterilized and a statement detailing the method of sterilization used, before the blanket is installed on the project.

713.12.3 Jute Mat

Type JUTE mat must be:

1. New unbleached jute yarn, uniformly open weaved;
2. Loose twisted yarn not varying in thickness by more than one half its nominal diameter;
3. Having a minimum yarn warp count of 78 per width and a minimum weft of 41 per linear yard (0.9 m); and
4. Weighing 0.92 pounds per square yard (500 g per square meter), untreated and 0.97 pounds per square yard (528 g per square meter), treated to be smolder resistant.

713.12.4 Coconut Mat and Blankets

A. Type C Coconut Mat. Type C mat:

1. Is coconut mat made of 100 percent coconut fiber woven into a high strength matrix; and
2. Has a minimum weight of 0.8 pounds per square yard (0.43 kg per square meter).

B. Coconut Blanket. Coconut Blanket:

1. Is a 100 percent coconut fiber matrix sewn between two heavy weight UV stabilized nets; and
2. Weighs a minimum 0.5 pounds per square yard (0.27 kg per square meter).

713.12.5 Synthetic Polypropylene Mesh

Furnish a mesh made from polypropylene fibers spun in one direction and meeting the following:

1. Beige or Natural in color;
2. Minimum weight measured under ASTM D 3776 of 2.25 ounces per square yard (76 g per square meter);
3. Tensile strength measured under ASTM D 4632 of 225 x 120 LbF (3,280 x 1,750 N/m);
4. Elongation at break measured under ASTM D 1682 of 32 percent by 40 percent; and
5. Mullen burst strength measured under ASTM D 3786 of 120 psi (827 kPa).

713.12.6 Polypropylene Roving

Furnish polypropylene roving from continuous strands of fibrillated polypropylene yarn. Wind the roving into a cylindrical package so the roving can be continuously fed from outside of the package through a compressed air injector and expanded into a mat of polypropylene strands. The material must not contain agents toxic to plant or animal life and must meet the following requirements:

1. Contain 20 to 28 strands per rove measured by end count;
2. Have a fiber diameter, denier of 360, by calculation;
3. Rove of 170 to 515 yards per pound (340 to 1,050 km per kg) (ASTM D 1907);
4. Strand of 12,400 to 14,000 yards per pound (25 to 28.2 km/kg) (ASTM D 1907);
5. A maximum one percent organic content (ASTM D 1907); and
6. A package weight of 18 pounds to 25 pounds (8 to 11 kg).

713.12.7 Synthetic Erosion Control and Revegetation Mat

Furnish a flexible mat of polyolefin monofilament fibers positioned between 2 biaxially oriented nets and mechanically bound together by parallel stitching with polyolefin thread to form a 3 dimensional web-like weave, highly resistant to environmental and chemical deterioration, and meeting the following:

1. Green in color;
2. Minimum mat thickness of 0.125-inch (3 mm), measured under ASTM D 1777;

3. A minimum tensile strength of 108 x 36 LbF (1,580 x 525 N/m), measured under ASTM D 1682;
4. Maximum elongation¹ of 150 percent by 100 percent, measured under ASTM D 1682;
5. Calculated² minimum porosity of 85 percent;
6. Resiliency³ of 80 percent, measured under ASTM D 1777; and
7. Ultraviolet stability⁴ of 80 percent, measured under ASTM D 4355.

Notes:

1. Values for both machine and cross machine directions under dry or saturated conditions. Machine direction specimen for 2-inch (50 mm) strip test includes one machine direction polyolefin stitch line centered within its width and extending the full length of the specimen.
2. Calculation based upon weight, thickness, and specific gravity.
3. The percent of original thickness retained after 3 cycles of a 100-psi (690 kPa) load for 60 seconds followed by 60 seconds without load. Thickness measured 30 minutes after load removed.
4. Tensile strength retained after 1,000 hours in a Xenon ARC weatherometer.

713.12.8 Turf Reinforcement Mat

Furnish a web of mechanically or melt bonded polymer netting, monofilaments, or fibers that are entangled to form a strong and dimensionally stable mat. Bonding methods include polymer welding, thermal or polymer fusion, or the placement of fibers between 2 high-strength, biaxially oriented nets mechanically bound together by parallel stitching with polyolefin thread. The mat must be resistant to biological, chemical, and ultra-violet degradation and must meet the following:

1. Black in color;
2. Minimum mat thickness of 0.50-inch (13 mm), measured under ASTM D 1777;
3. Minimum tensile strength¹ of 94 x 54 LbF (1,370 x 790 N/m), measured under ASTM D 1682;
4. Maximum elongation¹ of 75 percent by 75 percent, measured under ASTM D 1682;
5. Minimum calculated² porosity of 90 percent;
6. Resiliency³ of 80 percent, measured under ASTM D 1777; and
7. Ultraviolet stability⁴ of 80 percent, measured under ASTM D 4355.

Notes:

1. Values for both machine and cross machine directions under dry or saturated conditions using 2-inch (50 mm) strip method.
2. Calculation based upon weight, thickness, and specific gravity.
3. The percent of original thickness retained after 3 cycles of a 100-psi (690 kPa) load for 60 seconds followed by 60 second without load. Thickness measured 30 minutes after load removed.
4. Tensile strength retained after 1,000 hours in a Xenon ARC weatherometer.

SECTION 714

PAVEMENT MARKING MATERIALS

714.01 TEMPORARY PAVEMENT MARKING TAPE

Furnish temporary pavement marking tape that is 4-inch (105 mm) wide, retro-reflective, pressure-sensitive tape specifically manufactured for use as pavement stripping. The tape must be available in white and yellow.

714.02 TEMPORARY PAVEMENT MARKING TABS

Furnish temporary pavement marking tabs meeting the following:

1. Types I and II: "L" shaped, extruded polyurethane, at least 4 inches (105 mm) wide by 2 inches (50 mm) high with a reflectorized strip meeting requirement No. 4 below; attached horizontally across the top of the vertical portion of the tab; an adhesive strip meeting requirement No. 5 below:
 - a. Type I tabs: white reflectorized tape on one side with white bodies;
 - b. Type II tabs: yellow reflectorized tape on both sides with yellow bodies;
2. A minimum tape reflectance of 1,200 candlepower per square foot (138,892 lux per square meter) at 0.1 degrees observation and 0.0 degrees entrance angles;
3. An adhesive strip at least 3/4 inch wide x 1/8-inch thick (19 mm x 3 mm) on the tabs underside; and
4. A cover protecting the reflective strip that does not come off under traffic but is manually removable.

714.03 PREFORMED PLASTIC PAVEMENT MARKING MATERIAL

714.03.1 Composition Requirements

Furnish preformed plastic pavement marking material consisting of plastics and plasticizers, pigments, and reflective glass beads combined and proportioned to meet the following:

1. Available in both yellow and white color;
2. The total pigment in white marking material a minimum 20 percent by weight titanium dioxide;
3. The total pigment in yellow marking material a minimum 18 percent by weight medium chrome yellow;
4. Marking material colors that match the Federal Standard Highway Color # 595 A, 33538 for yellow, 37925 for white;
5. Non-yellowing white material;
6. Non-fading yellow material during the expected life of the materials; and
7. Having reflective glass beads meeting Subsection 714.05 requirements uniformly distributed throughout the entire material.

714.03.2 Adhesive Requirements

Furnish material having a pre-coated pressure-sensitive adhesive on the base to adhere to bituminous and portland cement concrete pavements. The adhesive must:

1. Be sufficiently free of tack so the material can be handled or repositioned on the pavement before being permanently fixed in position;
2. Mold to the pavement contours, breaks, faults under traffic at normal pavement temperatures;
3. Reseal itself so that, under normal use, it fuses with itself and previously applied markings of similar composition;
4. Capable of being inlaid in pavement at temperatures up to 275 °F (135 °C); and

5. Not lose its adhesive and reflective properties when exposed to water used in rolling operations.

714.03.3 Dimensional Requirements

Furnish the pavement marking material in standard manufactured widths of 4 inch, 6 inch, 8 inch, 12 inch, and 24 inch (105 mm, 155 mm, 205 mm, 305 mm, and 610 mm).

Furnish the material for words and symbols in pre-cut configurations matching the shapes and dimensions specified in the publication *Standard Alphabets for Highway Signs and Pavement Markings*.

Furnish the pavement marking material in the thickness specified in the contract.

Cut the edges of plastic pavement marking material clean and true.

714.03.4 Physical Requirements

- A. Tensile Strength.** Furnish plastic material having a minimum tensile strength of 40 psi (276 kPa) when tested under ASTM D 638. The break resistance is based on an average of at least 3 samples tested at a temperature of 70 °F to 80 °F (21 °C to 27 °C) using a jaw speed of 0.25-inch (6 mm) per minute.
- B. Plastic Pull Test.** A 1-inch by 6-inch (25 mm x 155 mm) sample of the plastic material must support a dead weight of 0.66 pounds per 0.01 inch (1.2 kg per mm) of material thickness for at least five minutes at a temperature of 70 °F to 80 °F (21 °C to 27 °C).
- C. Bend Test.** At 80 °F (27 °C) bend a 3-inch by 6-inch (75 mm x 155 mm) sample over a 1-inch (25 mm) diameter mandrel until the end faces are parallel and 1-inch (25 mm) apart. The sample must not show any fracture lines in the uppermost surface under unassisted visual inspection.
- D. Skid Resistance.** The plastics surface friction properties must be at least 35 BPN when tested under ASTM E 303.
- E. Reseal Test.** The plastic must re-seal itself without adhesives when tested as follows: Overlap two 1-inch x 3-inch (25 mm x 75 mm) pieces face-to-face forming a single 1-inch x 5-inch (25 mm x 130 mm) piece with a 1 square inch (645 square mm) overlap in the center. Place the 1-inch x 5-inch (25 mm x 130 mm) piece on a hard surface with a 1000-gram weight resting uniformly on the entire overlap area and maintain at 140 °F to 190 °F (60 °C to 88 °C) for 2 hours. Maintain the temperature within the specified range. Cool to room temperature. The pieces must not separate without tearing.
- F. Reflectivity.** Meet the reflective values listed in Table 714-1. Reflective values are measured on a 2-foot x 2 1/2-foot (610 mm x 762 mm) panel under the Instrumental Photometric Measurements of Retro-reflective Materials and Retroreflective Devices, Federal Test Method Standard 370.

TABLE 714-1

MINIMUM SIA¹ (CANDELAS PER FOOTCANDLE PER SQUARE FOOT (m²))
PLASTIC PAVEMENT MARKING MATERIAL

OBSERVATION ANGLE	ENTRANCE ANGLE	WHITE	YELLOW
0.2°	86°	0.20 (2.1)	0.15 (1.6)
0.5°	86°	0.15 (1.6)	0.10 (1.0)

Notes:

1. SIA - Specific Intensity Per Unit Area

714.03.5 Samples

Submit a 4-inch by 1-foot (105 mm x 305 mm) sample from each lot of material proposed for use on the project to the Materials Bureau for approval. Obtain approval before using in the work.

714.03.6 Certification

Submit the manufacturer's certification meeting Subsection 106.03. Include evidence from the manufacturer that the material proposed for use in the work has performed successfully under similar climatic conditions and traffic usage. This evidence of successful use is required for the product to be approved for use.

714.04 TEMPORARY AND INTERIM PAINT MARKINGS

The Contractor may furnish either liquid pavement markings or solid pavement marking tape for temporary and interim pavement markings. Submit a manufacturer's formulation sheet or data sheet for the product to be used.

A. Temporary Pavement Markings. Furnish marking materials that meet the following:**1. Color.**

- a. **White.** Color to match Federal color chip # 37875. Colorimeter readings may be taken on the white portion of a Leneta form 5c.1 Color Coordinates are $Y=79.80$, $x=0.3136$, $y=0.3244$. A ± 6 percent tolerance applies to the coordinates.
- b. **Yellow.** Color to match Federal color chip # 595B-33538. Colorimeter readings may be taken on the white portion of a Leneta form 5c. Color coordinates are $Y=48.32$, $x=0.4851$, $y=0.4455$. A ± 6 percent tolerance applies to the coordinates.

B. Interim Pavement Markings. Furnish marking materials that meet the following:**2. Color.**

- a. **White.** Color to match Federal color chip # 37875. Colorimeter readings may be taken on the white portion of a Leneta form 5c1 if requested by the Project Manager. Color Coordinates are $Y=79.80$, $x=0.3136$, $y=0.3244$. A ± 6 percent tolerance applies to the coordinates.
- b. **Yellow.** Color to match Federal color chip # 595B-33538. Colorimeter readings may be taken on the white portion of a Leneta form 5c if requested by the Project Manager. Color coordinates are $Y=48.32$, $x=0.4851$, $y=0.4455$. A ± 6 percent tolerance applies to the coordinates.

714.05 REFLECTIVE GLASS BEADS

- A. General.** Provide glass beads for reflectorizing traffic pavement markings that are spherical, transparent, have a smooth, lustrous surface and meet the pavement marking manufacturer's recommendations. Ensure the delivered beads are free from extraneous material and bead clumps easily break up while handling and distributing onto the stripe.
- B. Imperfections.** Ensure the glass beads do not contain more than 20 percent irregularly shaped particles when tested under ASTM D 1155.
- C. Color.** Ensure the glass beads do not impart a noticeable daytime hue to white pavement markings.
- D. Chemical Stability.** Ensure the beads can withstand refluxing in distilled water in a Soxhlet extractor for 90 hours without noticeable dulling of the surface luster and not more than 2.5 percent loss in weight.
- E. Gradation.** Meet Table 714-2 gradations, tested using ASTM D-1214.

**TABLE 714-2
REFLECTIVE GLASS BEAD GRADATION**

SIEVE NUMBER	PERCENT PASSING
20 (0.850 mm)	100
30 (0.600 mm)	75-95
50 (0.300 mm)	15-35
100 (0.150 mm)	0-5

F. Packaging and Marking. Package glass beads in moisture-proof containers marked to identify the contents, manufacturer, lot number, batch number and net weight.

G. Samples. Furnish a sample of the beads upon request. The Department will furnish the containers.

714.06 REFLECTIVE THERMOPLASTIC PAVEMENT MARKINGS

714.06.1 General

Furnish white and yellow thermoplastic marking material that is hydrocarbon-based. Meet AASHTO M 249 except as modified and supplemented herein.

714.06.2 Color

Furnish yellow marking material matching color chip 33538 of Federal Standard No. 595a, Table 5.

Furnish white marking material matching color chip 37875 of Federal Standard No. 595a, Table 9.

White material must have no tint or coloration after weathering.

714.06.3 Glass Beads

Furnish glass beads meeting Subsection 714.05 requirements.

Submit a manufacturer's certification under Subsection 106.03 that the glass beads supplied meet specifications.

714.06.4 Spraying Consistency

Applying hot thermoplastic marking material by spraying must not adversely affect the specified reflectivity, durability, color, line and edge quality, tolerances, thicknesses, and bonding requirements.

714.06.5 Requirements for Hydrocarbon-based Materials

Meet AASHTO M 249 requirements for hydrocarbon-based thermoplastic marking material, modified and supplemented as follows:

A. Specific Gravity. Cannot vary from the manufacturer's product specification by more than 0.05.

B. Composition. Table 1, Composition, of AASHTO M 249 is replaced with Table 714-3.

**TABLE 714-3
HYDROCARBON BASED MATERIAL COMPOSITION**

COMPONENT	WHITE	YELLOW
Binder, Hydrocarbon Base	16.0% min.	16.0% min.
Glass Beads	25% min.	25% min.
Titanium Dioxide, Type I or II	10% min.	—
Calcium Carbonate and Inert Fillers	42% max.	—
Yellow Pigments	—	See note 1

Notes:

1. The quantity of yellow pigments, calcium carbonate, and inert fillers is the manufacturer's option providing all other requirements of this specification are met.

Furnish a manufacturer's certification under Subsection 106.03 that the titanium dioxide contains a minimum of 5.0 percent each of anatase and rutile for all batches of material supplied on the project.

C. Modifications. The following modifications are made to AASHTO M 249:

1. **Subsection 4.3:** Subsections 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.5, 4.3.6, 4.3.7, 4.3.9: add "or the manufacturer's recommended application temperature range" wherever the temperatures "211 °C ± 7 °C (412.5 °F ± 12.5°F)" and "218 °C ± 2 °C (425 °F ± 3 °F)" appear.
2. **Subsection 4.3.4:** Change "-9.4 °C ± 1.7°C (15 °F ± 3 °F)" to "-20 °C (-4 °F)". Add "after being exposed to ambient room temperature of 20 °C to 23 °C (68 °F to 74 °F) after cooling." to the last sentence.
3. **Subsection 4.3.5:** Change "218 °C ± 2°C (425 °F ± 3 °F)" to "the manufacturer's recommended application temperature."
4. **Subsection 5.1:** Add "or as recommended by the manufacturer." after "211 °C ± 7 °C (412.5 °F ± 12.5 °F)".
5. **Subsection 6.1:** Rescind the last sentence and replace with the following: "The label shall show the manufacturer's recommended application temperature range."

714.06.6 Reserved

714.07 WATERBORNE PAVEMENT MARKING PAINT

714.07.1 Water-borne Pavement Marking Paint

Furnish acrylic latex white and lead-free yellow water-borne pavement marking paint meeting the following requirements.

- A. Composition.** The exact composition is at the manufacturer's discretion except that the vehicle is to be 100 percent acrylic polymer and the paint is not to contain any ingredient listed below.
- Lead or chromate compounds; Mercury; Lead; Chromate compounds; Chlorinated Solvents; Hydrolyzable chlorine derivatives; Ethylene based glycol ethers and their acetates.
- Meet Table 714-4 requirements.

**TABLE 714-4
WATERBORNE PAVEMENT MARKING PAINT COMPOSITION**

		WHITE	YELLOW
Pigment, % solids	ASTM D-3723	68 max.	68 max.
Total Solids, % by weight	ASTM D-2369	75 min.	75 min.
Titanium Dioxide, pounds per gal.	ASTM D-4563 & D-1394	1 lb. min.	0.15 lbs. min.
% Non-volatile vehicle of total vehicle weight	ASTM D-2697	41 min.	41 min.
VOC content, maximum	EPA Method 24	150 g/L	150 g/L
pH, min.	ASTM E-70	9.6	9.6
Viscosity (Krebs Stormer), K.U. at 77 °F (25 °C)	ASTM D-562	80-95	80-95
Grind, Hegman, min.	ASTM D-1210	2	2
Deviation in weight per gallon, max. pounds (from manufacturer specified wt.)		± 0.30 lbs.	± 0.30 lbs.
Daylight Reflectance, min. ¹	ASTM D- 2805	85	59.1 ²
Contrast Ratio, 15 mils wet min.	ASTM D-2805	0.92	0.88

Notes:

- The Y-Tristimulus value (luminance) is obtained using a standardized Tristimulus colorimeter using a C illuminant at a two-degree observation angle. The paint sample is drawn to a 15 mil wet film thickness over a white substrate. The Department uses a Hunter Lab Miniscan XE Colorimeter and Leneta Corporation Form 5C opacity charts to determine this value.
- Color to match the V+ color on the Hale color chart ± 6 percent

	ASTM Test	White and Yellow
D 711 mod. ¹	Dry Time, 15 mil wet film, 65% RH, minutes, max.	10
D 1640 mod. ²	Dry Through at 90% RH, 15 mil wet film, minutes, max.	130
D 2243 ³	Freeze-thaw, White and Yellow	Pass
D 2486	Scrub Resistance, cycles, min.	1000
D-969	Bleeding Ratio, min.	0.95

Notes:

- Use a wet film thickness of 15 ± 1 mil. Immediately place in a humidity chamber controlled at 65 ± 3% relative humidity and 72.5 °F ± 2.5 °F (22.5 °C ± 1.4 °C) with minimal air flow.
- Apply a 15 ± 1 mil thick film to a non-absorbent substrate and place in a humidity chamber controlled at 85 ± 5% R.H. and 72.5 °F ± 2.5 °F (22.5 °C ± 1.4 °C). Determine dry through time under ASTM D 1640 exerting the minimum pressure needed to maintain contact with the thumb and film.
- See B (7), Freeze-thaw Stability.

1. Titanium. Use Titanium Dioxide meeting ASTM D-476, Type I or II.

B. Characteristics.

- 1. Flexibility and Adhesion.** Apply 15 mil wet film thickness to a 3-inch by 5-inch (75 mm by 130 mm) tin panel. Dry at 77 °F (2 °C) for 24 hours followed by two hours at 122 °F (50 °C). Bend sample over a 1/2-inch (13 mm) mandrel. Paint to adhere firmly without showing cracking or flaking.

2. **Water Resistance.** Apply 15 mil wet film thickness to a 4 inch by 8-inch (102 mm by 203 mm) glass plate. Dry at 77 °F (25 °C) for 72 hours. Immerse in distilled water at 77 °F (25 °C) for 24 hours. Air dry for two hours on a flat surface. Paint to not show blistering or adhesion loss.
 3. **Skinning and Lumps.** Fill a pint (0.473 L) container 3/4 full of paint and seal tightly. After 72 hours, strain paint through a 100 mesh screen. No lumps or skin retained on the screen is permissible.
 4. **Settling.** Fill a centrifuge tube with paint and revolve for two hours at 250 LbF (1112 N). Separation from top of vehicle to top of pigment is not to exceed 1/2-inch (13 mm).
 5. **Skinning.** Fill 1/2-pint (0.236 L) container half full of paint and seal. Let stand for 24 hours. No skinning is to be visible.
 6. **Bleeding.** When tested under ASTM D-969, paint must not show perceptible bleeding when painted on a bituminous surface.
 7. **Freeze-thaw Stability.** When tested under ASTM D-2243, paint must not show coagulation or viscosity change exceeding 10 Krebs units.
 8. **Static Heat Stability.** Pour paint into a pint (473 mL) within 1/4 inch (6.4 mm) of the top, put the lid on and seal with tape, and place the container in an oven heated to 140 °F ± 2 °F (60 °C ± 1 °C) for seven days. Equilibrate the paint at standard conditions and thoroughly mix by stirring for at least five minutes. Ensure the paint does not show signs of livering, hard settling, coagulation, lumps, or coarse particles. Perform a consistency test meeting ASTM D-562 at 77 °F (25 °C). Paint viscosity to not vary 10 K.U. from the original viscosity measured at 77 °F (25 °C).
- C. Packaging and Marking.** Meet Subsection 714.04.9 requirements.
- D. Sampling and Acceptance.** Draw three samples meeting Subsection 714.04.8 requirements.
- E. Retro-reflective Glass Beads.** Use silene-coated moisture resistant glass beads meeting Subsection 714.05 requirements.
- F. Application.** Follow the manufacturer's requirements for pavement cleaning and traffic paint application or as follows, whichever is more restrictive. Apply to a dry surface.
- Clean the pavement of all loose rock, dirt, and debris immediately before applying the traffic paint.
- Do not heat the traffic paint to exceed 110 °F (43.3 °C) before and during application.
- Apply the traffic paint when the ambient temperature is 50 °F (10 °C) and rising. Stop application when the temperature is 50 °F (10 °C) and dropping and when rain or other weather adverse to the traffic paint during its drying time is imminent.
- Apply traffic paint at 15 mils ± 1 mil (0.38 mm ± 0.025 mm), wet thickness in a single application meeting Subsection 620.03.3(A).
- Re-paint using materials meeting specifications, at Contractor expense, all striping represented by paint samples where any specified property is outside 20 percent of the specified value. Subsection 620.05 tolerances do not apply.

714.08 Epoxy Pavement Marking Material - 100 Percent Solid

- A. Description.** This work is the furnishing of epoxy pavement markings.
- B. Materials.**
1. **General.** Furnish a two-component 100 percent solids epoxy material not containing fillers or pigment extenders. Follow the manufacturer's mixing ratio when mixing the two components. Mix the components within ± 2.5 percent of the manufacturer's

recommended mix ratio. Ensure the components, when combined, do not contain or produce volatile solvents.

Use resin/pigment component meeting Table 714-5 requirements.

TABLE 714-5
RESIN / PIGMENT COMPONENT (% BY WEIGHT)

PIGMENT	WHITE	YELLOW
TiO ₂ , meeting ASTM D-476, Type II	18-25	12-17
Organic Yellow		7-9
Epoxy Resin	75-82	74-82

Test the epoxy content of the epoxy resin following ASTM D 1652 and calculate as the weight per epoxy equivalent (WPE) for both white and yellow. Determine the epoxy content on a pigment free basis. The accepted epoxy content range (WPE) is ± 50 of the manufacturer's target value.

Ensure the activator/curing agent meets the following requirements:

- Test the amine value under ASTM D 2074.
- Ensure the total amine value meets the manufacturer's target value with the acceptance range being ± 50 of the target value.

2. Combined Materials Requirements

- Hardness.** Ensure the epoxy has a Shore D hardness of between 75 and 100 when tested under ASTM D 2240. Apply the epoxy to a metal substrate.
- Tensile Strength.** Test the tensile strength under ASTM D 8638. Meet a minimum 6,000-psi (42 MPa) tensile strength. Cast the Type IV specimens in a mold not exceeding 1/4-inch (6.38 mm) thick. Ensure the pull rate is 1/4-inch (6.38 mm) per minute.
- Compressive Strength.** Test the epoxy under ASTM D 695, as modified below. Meet a minimum compressive strength of 12,000 psi (83 MPa), using a maximum compression rate of 1/4-inch (6.38 mm) per minute with the sample measuring 1/2-inch (12.7 mm) high by 1/2-inch (12.7 mm) in diameter.
- Weather Resistance.** Apply the mixed epoxy, both white and yellow, at 15 mils ± 1 mil thick to 3-inch x 6-inch (75 mm x 150 mm) aluminum panels. Do not apply beads to the epoxy sample. Expose the cured sample in an Environmental Test Chamber meeting ASTM G 53. Conduct the test for 80 hours at 122 °F (50 °C), alternating four-hour cycles of condensation and ultraviolet light.
- Color.**
 - White.** Color is to match Federal color chip # 37875. Colorimeter readings may be taken on the white portion of a Leneta form 5c¹ if requested by the Project Manager. Color Coordinates are Y = 79.80, x = 0.3136, y = 0.3244. A ± 6 percent tolerance applies to the coordinates.
 - Yellow.** Color is to match Federal color chip # 595B-33538. Colorimeter readings may be taken on the white portion of a Leneta form 5c if requested by the Project Manager. Color coordinates are Y = 48.32, x = 0.4851, y = 0.4455. A ± 6 percent tolerance applies to the coordinates.

Notes:

1. The Y-Tristimulus value (luminance) is obtained using a standardized Tristimulus colorimeter using a C illuminant at a two-degree

observation angle. The sample is drawn to a 15 mil wet film thickness over a white substrate. The Department uses a Hunter lab Miniscan XE Colorimeter and a Leneta Corporation Form 5C opacity chart to determine this value.

- f. Laboratory No-track Time.** Mix the epoxy marking material at the manufacturer's specified ratio and apply at 15 mils \pm 1 1/2 mils (0.381 mm \pm 0.0381 mm) thick wet film at 75 °F \pm 2 °F (24 °C \pm 1 °C) with the specified glass bead application. Ensure it has a maximum no tracking time of 30 minutes when tested using ASTM D 711.
- g. Viscosity.** Ensure the individual components viscosity is within ten percent of each other at the recommended spray temperature and that the activator/curing agent has a constant viscosity at the manufacturer's recommended spray temperature.
- h. Mixing and Application.** Mix and apply the components following all of the manufacturer's recommendations.
- i. Packaging and Storage.** Transport and store the epoxy marking material at the project in the manufacturer's original container. Follow the manufacturer's instructions for material storage and handling. Ensure each container is marked identifying the color, batch or lot number, manufacturer's name, address, and date of manufacture.
- j. Material Acceptance.** Furnish a manufacturer's certification that has a certified copy of a laboratory report listing the results of the specified tests and certifying that the materials furnished meet the specifications. Refer to the applicable specification in the certification. Perform the tests in the manufacturer's laboratory or another qualified independent laboratory. Conduct the tests on samples obtained from the lot or lots of material supplied for the work.
- k. Glass beads.** Use glass beads meeting Subsection 714.05 requirements and treated with coatings recommended by the pavement marking manufacturer.

SECTION 715

TRAFFIC CONTROL DEVICES

715.01 SIGNS AND CHANNELIZING DEVICES

Meet the Detailed Drawings and MUTCD requirements.

Construction signs may be horizontally hinged at the midpoint of the sign face provided the hinge gap does not exceed 1/2-inch (13 mm) and the sign legend is legible.

715.02 PORTABLE SIGN SUPPORT ASSEMBLIES

Construct portable sign support assemblies from lightweight yielding material. Meet the following requirements:

- A.** Use wood members with a maximum 16 square inch (10.3 square meter) cross section for base construction and 8 square inch (5.2 square meter) cross section for uprights and braces.
- B.** Use tubular metal members with a maximum 9 square inch (5.8 square meter) cross section.
- C.** Use solid metal members with a maximum 1 square inch (645 square mm) cross section.

Portable signs may be trailer mounted if:

- 1.** The weight of the trailer assembly does not exceed 250 pounds (113.5 kg);
- 2.** The axle, frame, support assembly, and other structural members cannot exceed the dimensions of the portable sign support assembly; and
- 3.** The trailer tire outside diameter does not exceed 28 inches (715 mm). Automotive and equipment axle assemblies cannot be used for trailer-mounted sign supports.

715.03 ADVANCE WARNING ARROW PANELS

Furnish advance warning arrow panels (arrow boards) meeting Part 6 of the MUTCD, equipped with at least 25 lamps.

Use 36-inch x 72-inch (915 x 1,830 mm) Type "B" Arrow boards on striping units and shadow vehicles. Use Type "C", 48-inch x 96-inch (1,220 mm x 2,440 mm) for all other applications.

Equip the arrow board with a dimming device to automatically reduce the intensity of the flasher at night.

715.04 WARNING LIGHTS

Equip all vehicles, hauling units, and mobile construction equipment operating within the project limits and operating on roadways used by the traveling public with an amber flashing or strobe light visible from all directions for at least 0.4 mile (0.6 km) during daylight and clear weather conditions.

715.05 ADVANCE FLAGGER AHEAD WARNING SIGNS

Equip the W20-7a (advance flagger ahead) sign with two 12-inch (305 mm) amber signals, each mounted 36 inches (915 mm) from the center of the sign panel on a line 45 degrees above horizontal. Provide each lens with a 22-inch x 22-inch (560 x 560 mm) square backplate with a dull black finish and a 12-inch (305 mm) cut-away tunnel visor. Use 116-watt traffic signal light bulbs. Furnish 115/120 V.A.C. electrical current to the flasher unit. Assure the signals flash alternately and continuously at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each flash must be not less than one-half nor more than two-thirds of the total flash cycle.

Meet Subsection 715.02 requirements for mounting portable sign support assemblies.

SECTION 716 GEOTEXTILES

716.01 GENERAL PHYSICAL REQUIREMENTS

Use geotextiles and thread used in joining geotextiles manufactured from fibers consisting of long-chain polymers, composed of at least 95 percent by weight of polyolefins or polyesters. Use geotextiles with fibers formed into a stable network such that the fibers or yarns retain their dimensional stability relative to each other, including selvages (edges) during shipping, handling, placement, and in service. Use geotextile free from defects or tears.

A. Minimum Average Roll Values. All property values, with the exception of Apparent Opening Size (AOS), represent Minimum Average Roll Values (MARV) in the weakest principal direction. Provide geotextiles whose average test results from any roll sampled in a lot for conformance or quality assurance testing meets or exceeds minimum values provided in this Section.

B. Apparent Opening Size. Values for Apparent Opening Size (AOS) represent maximum average roll values. Acceptance will be based on ASTM D 4759.

Furnish geotextiles meeting the strength property requirements of Table 716-1 and the AOS, permittivity, and ultraviolet stability requirements of Table 716-2 for separation geotextile, Table 716-3 for stabilization geotextile, Table 716-4 for subsurface drainage geotextile filter, and Table 716-5 for erosion control geotextile. Furnish temporary silt fence geotextile meeting the requirements of Table 716-6. The geotextile properties required for each class of survivability are dependent upon geotextile type, i.e. woven or nonwoven. When sewn seams are used, the strength of the sewn seams must be equal to or greater than 90 percent of the specified grab tensile strength.

**TABLE 716-1
GEOTEXTILE STRENGTH PROPERTY REQUIREMENTS**

			GEOTEXTILE SURVIVABILITY ¹			
			Moderate Survivability		High Survivability	
PROPERTY	TEST METHODS	UNITS	Woven	Nonwoven	Woven	Nonwoven
Grab Elongation	ASTM D 4632	%	< 50	≥ 50	< 50	≥ 50
Grab Strength	ASTM D 4632	lbs.	250	160	315	200
Sewn Seam Strength ²	ASTM D 4632	lbs.	225	145	285	180
Tear Strength	ASTM D 4533	lbs.	90	55	110	80
Puncture Strength	ASTM D 4833	lbs.	90	55	110	80
Apparent Opening Size	ASTM D 4751	Sieve Size	Required property values for AOS, permittivity, and UV stability are based on the geotextile applications. Refer to Table 716-2 for separation geotextile, Table 716-3 for stabilization geotextile, Table 716-4 for subsurface drainage geotextile filter, and Table 716-5 for erosion control geotextile.			
Permittivity	ASTM D 4491	sec. ⁻¹				
Ultraviolet Stability (retained strength)	ASTM D 4355	%				

Notes:

1. All numeric values represent Minimum Average Roll Value (MARV) in the weaker principal direction.
2. When sewn seams are required. Refer to Subsection 622.03 for overlap requirements.

**TABLE 716-1 (METRIC)
GEOTEXTILE STRENGTH PROPERTY REQUIREMENTS**

			GEOTEXTILE SURVIVABILITY ¹			
			Moderate Survivability		High Survivability	
PROPERTY	TEST METHODS	UNITS	Woven	Nonwoven	Woven	Nonwoven
Grab Elongation	ASTM D 4632	%	< 50	≥ 50	< 50	≥ 50
Grab Strength	ASTM D 4632	N	1100	700	1400	900
Sewn Seam Strength ²	ASTM D 4632	N	990	630	1260	810
Tear Strength	ASTM D 4533	N	400	250	500	350
Puncture Strength	ASTM D 4833	N	400	250	500	350
Apparent Opening Size	ASTM D 4751	mm	Required property values for AOS, permittivity, and UV stability are based on the geotextile applications. Refer to Table 716-2 for separation geotextile, Table 716-3 for stabilization geotextile, Table 716-4 for subsurface drainage geotextile filter, and Table 716-5 for erosion control geotextile.			
Permittivity	ASTM D 4491	Sec. ⁻¹				
Ultraviolet Stability (retained strength)	ASTM D 4355	%				

Notes:

1. All numeric values represent Minimum Average Roll Value (MARV) in the weaker principal direction.
2. When sewn seams are required. Refer to Subsection 622.03 for overlap requirements.

716.02 SEPARATION GEOTEXTILE

Provide geotextile meeting the strength requirements from Table 716-1 for the level of survivability specified on the plans or in the special provisions. Provide geotextile meeting the permittivity, apparent opening size, and ultraviolet stability requirements of Table 716-2.

**TABLE 716-2
SEPARATION GEOTEXTILE PROPERTY REQUIREMENTS**

	TEST METHODS	UNITS	REQUIREMENTS
Geotextile Survivability	As specified from Table 716-1		
Permittivity ¹	ASTM D 4491	sec. ⁻¹	≥ 0.02
Apparent Opening Size	ASTM D 4751	Sieve Size (mm)	#30 (≤ 0.60)
Ultraviolet Stability (Retained Strength)	ASTM D 4355	%	≥ 50 after 500 hrs. of exposure

Notes:

1. Minimum value. Permittivity of the geotextile must be greater than that required for the soil. Use greater value as specified on the plans or in the special provisions.

716.03 STABILIZATION GEOTEXTILE

Do not use woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character). Provide geotextile meeting the strength requirements for high survivability from Table 716-1. Provide geotextile meeting the permittivity, apparent opening size, and ultraviolet stability requirements of Table 716-3.

**TABLE 716-3
STABILIZATION GEOTEXTILE PROPERTY REQUIREMENTS¹**

	TEST METHODS	UNITS	REQUIREMENTS
Geotextile Survivability	High Survivability from Table 716-1		
Permittivity ²	ASTM D 4491	sec. ⁻¹	≥ 0.10
Apparent Opening Size	ASTM D 4751	Sieve Size (mm)	#40 (≤ 0.43)
Ultraviolet Stability (Retained Strength)	ASTM D 4355	%	≥ 50 after 500 hrs. of exposure

Notes:

1. Do not use woven slit film geotextiles.
2. Minimum value. Permittivity of the geotextile must be greater than that required for the soil. Use greater value as specified on the plans or in the special provisions.

716.04 SUBSURFACE DRAINAGE GEOTEXTILE FILTER

Do not use woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character). Provide geotextile meeting the strength requirements from Table 716-1 for the level of survivability specified on the plans or in the special provisions. Provide geotextile meeting the permittivity, apparent opening size, and ultraviolet stability requirements of Table 716-4.

**TABLE 716-4
SUBSURFACE DRAINAGE GEOTEXTILE FILTER PROPERTY REQUIREMENTS¹**

	TEST METHODS	UNITS	REQUIREMENTS ²		
			Class A	Class B	Class C
Geotextile Survivability			As specified from Table 716-1		
Permittivity ³	ASTM D 4491	sec. ⁻¹	≥ 0.5	≥ 0.4	≥ 0.3
Apparent Opening Size	ASTM D 4751	Sieve Size (mm)	#40 (≤ 0.43)	#60 (≤ 0.25)	#80 (≤ 0.18)
Ultraviolet Stability (Retained Strength)	ASTM D 4355	%	≥ 50 after 500 hrs. of exposure		

Notes:

1. Do not use woven slit film geotextiles.
2. Use Class A subsurface drainage geotextile when the in situ soil has less than 15 percent fines (gravel or sand). Use Class B subsurface drainage geotextile when the in situ soil has 15 to 50 percent fines (silty or clayey sand or gravel). Use Class C subsurface drainage geotextile when the in situ soil has more than 50 percent fines (silt or clay).
3. Minimum values. Permittivity of the geotextile must be greater than that required for the soil. Use greater values as specified on the plans or in the special provisions.

716.05 PERMANENT EROSION CONTROL GEOTEXTILE

Do not use woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character). Provide geotextile meeting the strength requirements from Table 716-1 for the level of survivability specified on the plans or in the special provisions. Provide geotextile meeting the permittivity, apparent opening size, and ultraviolet stability requirements of Table 716-5.

**TABLE 716-5
PERMANENT EROSION CONTROL GEOTEXTILE PROPERTY REQUIREMENTS¹**

	TEST METHODS	Units	REQUIREMENTS ²		
			Class A	Class B	Class C
Geotextile Survivability			As specified from Table 716-1		
Permittivity ³	ASTM D 4491	sec. ⁻¹	≥ 0.7	≥ 0.4	≥ 0.2
Apparent Opening Size	ASTM D 4751	Sieve Size (mm)	#40 (≤ 0.43)	#60 (≤ 0.25)	#70 (≤ 0.22)
Ultraviolet Stability (Retained Strength)	ASTM D 4355	%	≥ 70 after 500 hrs. of exposure		

Notes:

- Do not use woven slit film geotextiles.
- Use Class A permanent erosion control geotextile when the in situ soil has less than 15 percent fines (gravel or sand). Use Class B permanent erosion control geotextile when the in situ soil has 15 to 50 percent fines (silty or clayey sand or gravel). Use Class C permanent erosion control geotextile when the in situ soil has more than 50 percent fines (silt or clay).
- Minimum values. Permittivity of the geotextile must be greater than that required for the soil. Use greater values as specified on the plans or in the special provisions.

716.06 TEMPORARY SILT FENCE GEOTEXTILE

Provide geotextile meeting the requirements of Table 716-6.

**TABLE 716-6
TEMPORARY SILT FENCE PROPERTY REQUIREMENTS**

	TEST METHODS	UNITS	STABILIZED SILT FENCE ¹	UNSTABILIZED SILT FENCE ²
Grab Strength, Machine Direction	ASTM D 4632	lb. (N)	≥ 90 (≥ 400)	≥ 125 (≥ 550)
Grab Strength, X-Machine Direction	ASTM D 4632	lb. (N)	≥ 90 (≥ 400)	≥ 100 (≥ 450)
Permittivity ³	ASTM D 4491	sec. ⁻¹	≥ 0.05	≥ 0.05
Apparent Opening Size	ASTM D 4751	Sieve Size (mm)	#30 (≤ 0.60)	#30 (≤ 0.60)
Ultraviolet Stability (retained strength)	ASTM D 4355	%	≥ 70 after 500 hrs. of exposure	

Notes:

- Unstabilized silt fence is supported with either wood or metal fence posts.
- Stabilized silt fence is supported with metal fence posts and with woven wire backing.
- Minimum values. Use greater values as specified on the plans or in the special provisions.

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