Standard Specifications

Specifications for
Road and Bridge Construction

August 2001

Prepared by
The Delaware Department of Transportation

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For sale by the Delaware Department of Transportation
PO Box 778, Dover, Delaware 19903 (Attn.: Contract Administration)

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DIVISION 100 – GENERAL PROVISIONS

SECTION 101 – GENERAL INFORMATION, DEFINITIONS, AND TERMS

101.01 General. The titles and headings of the Sections, Subsections, and subparts herein are intended for convenience of reference and shall not be considered as having bearing on the interpretation of these Specifications.

Where a publication is referenced, the reference applies to the most recent date of issue as of the date bids are advertized, including interim publications, unless the reference includes a specified date or year.

Portions of these Specifications are written in the imperative mood. In sentences using imperative mood, the subject "the Contractor" is implied. Also implied in the language are "shall" or "shall be" or similar words and phrases. In all instances where "the Contractor" and "shall" or "shall be" are implied, the actions specified are solely the responsibility of the Contractor. In the referenced material sections, the subject may also be a vendor, fabricator, manufacturer, or combination thereof, who may be supplying the material, products, or equipment for the Project. The word "will" generally applies to decisions or actions of the Department or Engineer.

In the Contract as defined in Subsection 101.17, the following words: contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, satisfactory, unsatisfactory, sufficient, insufficient, rejected, condemned, or words with similar intent; mean by or to the Department, subject in each case to the determination of the Secretary, and subject to further review, as permitted by law or permitted elsewhere in these Specifications.

In the Contract, the words "or equal", referring to a product, material, or process, mean "equal as determined by the Department".

In the Contract, the words "as indicated" or "indicated" mean "as indicated or indicated by the Contract".

The Plans referred to in any Contract awarded using these Standard Specifications are normally presented in either U.S. customary (English) or metric units developed independently within each system. The Standard Specifications, Supplemental Specifications and Special Provisions for a particular Contract may be presented in either form of units. The relationship between the metric and U.S. customary values is neither an exact (soft) conversion nor a completely rationalized (hard) conversion. The metric values are those that would have been used had the Contract been presented exclusively in metric units; the U.S. customary values are those that would have been used if the Contract had been presented exclusively in U.S. customary units. Users are directed to work entirely in the system set forth in the Plans, and to make no attempt to convert directly between the two.

101.02 Abbreviations. Wherever the following abbreviations, terms or pronouns are used in the Contract, the intent and meaning shall be interpreted as follows:

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
AED	Associated Equipment Distributors
AGC	Associated General Contractors of America

AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ARA	American Railway Association
AREA	American Railway Engineering Association
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 of Testing and Materials
AWPA	American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
CFR	Code of Federal Regulations
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards
MIL	Military Specifications
MUTCD	Manual on Uniform Traffic Control Devices (For Streets and Highways)
NEC	National Electrical Code
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PTI	Post Tensioning Institute
SAE	Society of Automotive Engineers
SSPC	Steel Structures Painting Council
Traffic Control Manual	Delaware Traffic Control for Streets and Highway Construction, Maintenance, Utility and Emergency Operations
UL	Underwriters' Laboratory, Incorporated

101.03 Addendum. Contract revisions issued after advertisement of the proposal and before bid opening.

101.04 Additional Work. Work for which a Contract item is already provided by the Contract.

101.05 Adjustment (or Contract Adjustment). A revision to the Project cost or time provided in accordance with Subsections 108.07 and 109.04.

101.06 Advertisement. A public announcement inviting proposals for work to be performed or material to be furnished.

101.07 Award. The Department acceptance of a proposal.

101.08 Bidder. Any individual or legal entity submitting a proposal.

101.09 Bid Documentation. All writings, working papers, computer printouts, charts, and data compilations that contain or reflect information, data, or calculations used by the bidder to prepare 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

Any manuals standard to the industry used by the bidder in determining the bid proposal are also considered bid documentation. These manuals may be included in the bid documentation by reference and shall show the name and date of the publication and the publisher.

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

101.10 Bid Proposal. The bound book consisting of: General Description; General Notices; Supplemental Specifications; Special Provisions including Utility Statements, Certificate of Right-Of-Way Status, and location and environmental requirements; and the Bid Proposal Form.

101.11 Bid Proposal Form. The approved form on which the Department requires formal bids to be prepared and submitted for the work.

101.12 Bridge. A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of the roadway of more than 20′ (6.096 m) between undercopings of abutments or extreme ends of openings for multiple boxes. Structures having an opening of 20 ft^2 (1.86 m^2) or greater are included on the Department bridge inventory.

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

101.14 Change Order. A written order issued by the Engineer to the Contractor for a change to the Contract. Changes to the Contract are extra work, increases or decreases in Contract item quantities, or alterations to the Contract, and are within the scope of the Contract. A change order also establishes the basis and amount of payment for the change to the Contract and provides for any time extension necessitated by the change to the Contract.

101.15 Channel. A natural or artificial water course.

101.16 Completion. Completion of the Project occurs when the work has been satisfactorily concluded under the Contract and the Contractor has satisfactorily executed and delivered to the Engineer all documents, certificates, and proofs of compliance required by the Contract.

101.17 Contract. The written Agreement between the Department and the Contractor setting forth the obligation of the parties for the performance of the work.

The Contract may include, but is not limited to, the advertisement, bid proposal, Agreement, Contract form; proposal, performance, payment, and other bonds or guaranties; Specifications; working

drawings; general and detailed plans; all required notices with respect to any of the foregoing; change orders; supplemental agreements; and Engineer's written directives. The Contract shall not be modified, altered, or otherwise changed by any oral promise, statement, or representation made either by the Department or Contractor, unless such modification, alteration, or change is reduced to writing in accordance with the Contract.

101.18 Contract Item (Pay Item). A specifically described item of work for which a price is provided in the Contract.

101.19 Contract Payment and Performance Bond. The security furnished by the Contractor and the Contractor's surety or sureties to guarantee payment and performance of all obligations incurred by the Contractor on any Contract.

101.20 Contract Time. The number of working days or number of calendar days allowed for the substantial completion of the Contract. When a calendar date of completion is specified, the work shall be substantially completed on or before that specified completion date. Calendar day contracts shall be completed on or before the day indicated even when that date is Saturday, Sunday, or holiday.

101.21 Contractor. The individual or legal entity contracting with the Department for performance of the work.

101.22 County. The county in which the work is to be performed.

101.23 Culvert. Any structure which provides an opening under any roadway, but is not classified as a bridge.

101.24 Days. Days as used in the Contract means calendar days.

101.25 Department. Delaware Department of Transportation.

101.26 Differing Site Conditions. Subsurface or latent physical conditions encountered at the site that, 1) differ materially from those indicated in the Contract, or are 2) unknown physical conditions of an unusual nature, differing materially from those conditions ordinarily encountered and generally recognized as inherent in the work provided for in the Contract.

101.27 District. Subdivisions of the Department for the purpose of management, construction, and maintenance.

101.28 District Engineer. The Engineer in charge of a district of the Department.

101.29 Easement. A right acquired by public authority to use or control property for a designated transportation purpose.

101.30 Embankment. A structure constructed of material as described in Section 202, between the existing ground and subgrade.

101.31 Engineer. The Chief Engineer of the Department, acting directly or through an assistant or other authorized representative responsible for engineering and administrative supervision of the Contract.

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

101.33 Extra Work. Work not included in the Contract, but within the scope of the Contract and desired by the Engineer for the satisfactory completion of the Contract.

101.34 Falsework. Any temporary construction work used to support the weight of a permanent structural element until it becomes self-supporting. Falsework would include steel or timber beams, girders, columns, piles and foundations, and any proprietary equipment including modular shoring frames, post shores, and adjustable horizontal shoring.

101.35 Force Account. Prescribed work paid on the basis of actual costs and appropriate additives.

101.36 Formwork. A temporary structure or mold used to retain the plastic or fluid concrete in its designated shape until it hardens. Formwork must have enough strength to resist the fluid pressure exerted by plastic concrete and any additional fluid pressure effects generated by vibration.

101.37 Final Inspection. The inspection, conducted by the Engineer, to determine if the Project, or any substantial portion thereof, has been satisfactorily completed, in accordance with Contract requirements.

101.38 General Notices. Federal and State regulations contained in the bid proposal which govern Contract operations.

101.39 Holidays. The following days shall be considered legal holidays in the State of Delaware.

A. New Years Day
B. Martin Luther King's Birthday
C. President's Day
D. Good Friday
E. Memorial Day
F. Independence Day
G. Labor Day
H. Columbus Day
I. General Election Day (biennial)
J. Return Day (Sussex County only after 12:00 Noon)
K. Veteran's Day
L. Thanksgiving Day
M. Friday after Thanksgiving
N. Christmas Day

If any additional days are designated as legal holidays for State employees by Executive Order of the Governor, and the Contractor chooses to honor the days by not working, the State will extend the Contract time accordingly.

If any holiday falls on Sunday, the Monday following shall be the holiday. If any holiday falls on Saturday, the Friday preceding shall be the holiday.

101.40 Inspector. An authorized representative of the Engineer assigned to make detailed inspections of the material or work to determine compliance with the Contract.

101.41 Invitation for Bids. The advertisement for proposals for work or materials on which bids are requested. The advertisement will indicate with reasonable accuracy the quantity and location of the work to be performed and the time and place of the opening of proposals.

101.42 Laboratory. The Department testing laboratory or any other testing laboratory designated by the Engineer.

101.43 Limits of Construction. An area with established boundaries, identified within the right-of-way or easements, where the construction is permitted. When not specifically identified, limits of construction shall be the right-of-way and easement.

101.44 Liquidated Damages. An amount due and payable to the Department by the Contractor for additional costs incurred by the Department resulting from the Contractor's failure to complete within the Contract time.

101.45 Lump Sum. The single price submittal by a Contractor as a single amount for a complete Contract item.

101.46 Major and Minor Contract Items. Any Contract item having an original value in excess of 10% of the original Contract amount is a major item. All other original Contract items are considered minor.

101.47 Materials. Any substances other than equipment used in the construction of the Project.

101.48 Median. The portion of a divided highway separating the traveled ways for traffic in opposite directions.

101.49 Notice of Award. A written notice to the selected bidder stating that the bid proposal has been accepted by the Department and that the selected bidder is required to execute the Contract Agreement and furnish Performance and Payment bonds satisfactory to the Department.

101.50 Notice to Contractors. The official notice stating the time and place for the submission of bid proposals.

101.51 Notice to Proceed. Written notice to the Contractor to begin the Contract work. When applicable, the notice will include the starting date of Contract time.

101.52 Pavement Structure. The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load.

A. *Base Course.* The layer or layers of specified or selected material of designated thickness placed on a subbase or a subgrade to support a surface course.

B. *Subbase.* One or more layers of specified material thickness placed on a subgrade to support a base course (or in the case of rigid pavement, the portland cement concrete slab).

C. *Subgrade.* The top surface of the roadbed upon which the pavement structure is constructed.
D. *Subgrade Treatment.* Modification of roadbed material by stabilization.
E. *Surface Course.* Layer(s) 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".

101.53 Pay Item - See Contract item.

101.54 Plans. The approved Contract plans, typical sections, and supplemental drawings, or exact reproductions thereof, which show the location, character, dimension, and details of the work to be done, and which are considered a part of the Contract supplemental to these Specifications.

101.55 Profile Grade. The trace of a vertical plane intersecting the top surface, usually along the longitudinal centerline of the surface coarse. Profile grade means elevation of such trace.

101.56 Project. The specific section of highway or other public improvement together with all appurtenances and construction to be performed thereon under the Contract. The Project may include work by others under other contracts.

101.57 Project Resident. The field representative of the Engineer having direct supervision of the administration of the Contract.

101.58 Proposal. A written offer by a bidder on Bid Proposal Forms furnished by the Department to perform the work.

101.59 Proposal Guaranty. The security furnished with a proposal to ensure that the bidder will enter into the Contract if the Contract is awarded.

101.60 Responsive Bid. A proposal that complies with all requirements of the invitation for bids.

101.61 Responsible Bidder. A bidder determined by the Department to possess the potential to perform the Contract work.

101.62 Right-Of-Way. A general term denoting land, property, or interest therein possessed by the Department.

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

101.64 Roadside. The areas between the outside edges of the shoulders and the right-of-way boundaries. Unpaved median areas between inside shoulders of divided highways and infield areas of interchange are included.

101.65 Roadside Development. Those items necessary for the preservation or replacement of landscape materials and features that may include suitable plantings and other improvements or ground cover to

preserve and enhance the appearance and stability of the highway right-of-way or acquired easements for scenic improvements.

101.66 Roadway. The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

101.67 Scaffolding. An elevated work platform used to support workers, materials, and equipment, but not intended to support the structure.

101.68 Schedule of Items. The list of Contract items of work in the rear of the proposal on which bidders submit their bid prices.

101.69 Schedule of Work. The approved progress schedule submitted by the Contractor containing dates of commencement and completion of the various items of work within the Contract time.

101.70 Secretary. Secretary of the Department of Transportation of the State of Delaware.

101.71 Section. When referring to the Specifications, a numbered article or group of related articles forming a part of the Specifications.

101.72 Shoulder. The portion of the right-of-way adjacent to the traveled way for accommodation of stopped vehicles for emergency use, and for lateral support of the pavement structure.

101.73 Sidewalk. That portion of the road primarily constructed for the use of pedestrians.

101.74 Specifications. The compilation of provisions and requirements for the performance of the prescribed work.

A. *Standard Specifications.* A book of specifications approved for general application and repetitive use.

B. *Supplemental Specifications.* Approved additions and revisions to the Standard Specifications, which is part of the bid proposal.

C. *Special Provisions.* Special directions, provisions, or requirements particular to the Project not otherwise detailed in the Standard or Supplemental Specifications.

101.75 Standard Construction Details. Drawings of standard details of construction which have been adopted by the Department for miscellaneous items of work and are a part of the bid proposal.

101.76 State. The State of Delaware.

101.77 Structures. Bridges, culverts, storm sewer appurtenances, slope and retaining walls, sign support structures, and other similar items.

101.78 Subcontractor. An individual or legal entity contracting with the Contractor to perform any part of an item of work of the Contractor's contract with the Department.

Exceptions to this definition are suppliers limited to delivering and depositing, but not incorporating material, and the work performed as maintenance which does not advance the completion of the Contract and is not considered as an item of work.

101.79 Substantial Completion. The point at which all Contract items are complete and accepted excluding any warranties or vegetation growth.

101.80 Substructure, Bridge. All of the structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, including backwalls, and wingwalls.

101.81 Superintendent. The Contractor's authorized representative in responsible charge of the work.

101.82 Superstructure, Bridge. Approach slabs and the entire structure except the substructure.

101.83 Supplemental Agreement. A written agreement signed by the Department and the Contractor for the performance of work which is beyond the scope of the original Contract, but which the Department elects to perform in conjunction with the existing Contract.

101.84 Surety. The legal entity or individual other than the Contractor, authorized to do business in the State, executing a bond furnished by the Contractor.

101.85 Town or City. A subdivision of the State used to designate or identify the location of the proposed work.

101.86 Traveled Way. The portion of the right-of-way designated for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.87 Unbalanced Bid, Materially. A proposal that generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the Department.

101.88 Unbalanced Bid, Mathematically. A proposal containing Contract 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.

101.89 Unit Price. The price provided by the Contractor in the proposal for a Contract item.

101.90 Work. The furnishing of all labor, materials, equipment, and other incidentals necessary to complete the Contract.

101.91 Working Day. Any calendar day, except: 1) Saturdays, Sundays, and holidays; 2) days where conditions identified in the Contract require the Contractor to suspend construction operations; 3) days with inclement weather that prevent prosecution of the scheduled work; 4) days from December 16 to March 15 inclusive. On inclement weather days that result in partial prosecution of the work, partial working days will be charged as determined by the Engineer. Partial working days will be charged in one-quarter day increments. If the Contractor receives permission from the Engineer to work on any Sunday or holiday, full working days will be charged, weather permitting. No time charge will be assessed if the Contractor elects to work on Saturdays. Should the Contractor prepare to begin work on any day on which inclement weather prevents the work from beginning at the usual starting time and the crew is dismissed as a result, the Contractor will not be charged for a working day whether or not conditions change during the day and the rest of the day becomes suitable for construction operations.

101.92 Working Drawings. Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

SECTION 102 – BIDDING REQUIREMENTS AND CONDITIONS

102.01 Registration of Bidders. Prospective bidders must obtain registration status prior to submitting a proposal. In order to obtain registration status, prospective bidders must provide the Department with the following information:

A. Legal title, address, Federal Employer Identification Number, and phone number of organization.
B. Type of organization (corporation, partnership, etc.).
C. If organization is a corporation, name the parent company and all subsidiary or affiliated companies, if applicable, and list all stockholders who own shares of stock equal to or more than 10% of the organization′s stock.
D. List the name and title of corporate officers authorized to sign Contract documents, change orders, estimates, and other pertinent Contract forms.

Upon receipt of this information, the prospective bidder will be listed on the Department′s Registry of Highway/Bridge/Building/Construction Contractors. Contractors registered on the Department′s registry will receive mailed notification of all public works contracts advertised by the Department. It is the responsibility of all registered contractors to provide the Department on a continuous basis any changes to the information contained in the registry. Failure to provide current information may result in the loss of bidding privileges.

102.02 Contents of Proposal. The proposal will state the location and description of the contemplated construction, show the estimate of the various pay item quantities, and show the kinds of work to be performed or materials to be furnished. A schedule of items for which unit prices are invited will be included along with the specified time in which the work must be completed, amount of the proposal guaranty, and the date, time, and place of the opening of bid proposals. If the basis of proposal comparisons by the Department is to be other than total cost, the comparison basis to be used will be defined. The bid proposal will also include or designate any Supplemental Specifications, Special Provisions, and any other specifications or requirements that vary from or are not contained in the Standard Specifications.

All papers bound with or attached to the bid proposal are considered as part of the proposal.

The Plans, Specifications, and other documents designated in the bid proposal will be considered a part of the proposal whether attached or not.

102.03 Issuance of Proposal. The Department reserves the right to refuse to issue a proposal to a bidder for any of the reasons stated in Subsection 102.12.

The prospective bidder will be required to pay the Department a non-refundable sum stated in the advertisement for each copy of the proposal.

Bid proposals without plans, marked "Duplicate", will be made available at a cost established by the Department. Such "Duplicates" are not valid for use in the submission of bids.

102.04 Interpretation of Quantities in Bid Proposal Form. The quantities appearing in the Bid Proposal Form are estimates used for the bid comparison. Payment to the Contractor will be made for

the actual quantities of work performed and accepted, or for materials furnished in accordance with the Contract. The estimated quantities of work to be done and materials to be furnished may be increased, decreased, or eliminated in their entirety.

102.05 Examination of Plans, Specifications, Bid Proposal, and Site of Work. The bidder is required to examine the site of the proposed work, the bid proposal, and all items designated in the bid proposal before submitting a proposal. If no site investigation is performed, the bidder assumes responsibility for all site conditions that should have been discovered had a reasonable site investigation been performed. The submission of a proposal will be considered conclusive evidence that the bidder is aware of and accepts the conditions to be encountered in performing the work and the requirements of the proposed Contract.

Boring logs and other records of subsurface investigations, when such investigations have been performed, are available for inspection by bidders. It is understood that such information was obtained and used for Department design and estimating purposes only. They are made available to bidders so that all bidders have access to subsurface information identical to that available to the Department and to other bidders, and are not intended as a substitute for the personal investigation, interpretations, and judgment of the bidders.

The Department will not be bound by any statement or representation concerning conditions or descriptions of the work unless they are included or designated in the bid proposal. Oral explanations or instructions given before the bid of the Contract by Department employees or agents will not be binding.

Any request for explanation of the meaning or interpretation of the proposal or items designated in the bid proposal shall be submitted, in writing, to the administrative manager no less than six business days prior to the proposal opening date. Interpretations or explanations made by the Department in response to such requests will be issued as an addendum to the bid proposal, and will be furnished to all prospective bidders in writing before the time set for opening of the proposals.

102.06 Preparation of Proposal. The bidder shall submit the proposal either upon the Bid Proposal Forms, or magnetic media and the hard copy generated thereof, provided. The Bid Proposal Forms shall be detached from the bid proposal. Specify a unit price in figures for each Contract item for which a quantity is given and show the product of the respective unit price and quantities typewritten in figures in the column provided. The total amount of the proposal is to be obtained by adding the amounts of the several Contract items. The figures shall be typewritten. In case of a discrepancy between the typewritten unit prices and the typewritten bid amount, the typewritten unit prices shall govern. In case of a discrepancy between the unit prices contained on the magnetic media and the unit prices on the hard copy generated by the magnetic median, the hard copy unit prices shall govern.

Last minute handwritten substitutions of the typewritten unit prices on the typewritten Bid Proposal Forms or hard copy generated by the magnetic media, shall be executed by striking a single line through the figure being substituted and legibly writing in ink the new unit price. Each last minute substitution shall be initialed by the bidder authorizing the substitution. Legibility of the substitution shall be solely determined by the Department.

When the proposal permits an alternate to be used by the bidder, the bidder shall indicate on the Bid Proposal Form the alternate that is the basis of the bid submitted.

All Department addenda to the bid proposal must be acknowledged in the certification and shall be submitted with the modified Bid Proposal Forms. The proposal submitted must be signed in ink by a representative of the bidder authorized to execute proposals. The name and address of the individual signing the proposal is to be provided as well as the following names and addresses as applicable:

Type of Bidder	*Names and Office Addresses Required*
Individual	Individual
Partnership	Each member of the partnership
Joint Venture	Each member or officer of firms represented in the joint venture
Corporation	Corporation officer, corporation name, and corporate address

Bid proposals, Bid Proposal Forms and magnetic media are serially numbered and are not transferable. Unless otherwise provided in the proposal, joint ventures may submit a proposal for a joint venture of bidders qualified for that project on a bid proposal issued to the joint venture or on a bid proposal issued to any one of the joint participants. The proposal must be signed by each covenant followed by the title "Joint Venturer".

102.07 Irregular Proposals. Proposals shall be considered irregular and shall be rejected as non-responsive for any of the following reasons:

A. The proposal is on a form (or in a format if computer generated) other than that approved by the Department, or if the form is altered or any part detached or incomplete.

B. There are unauthorized additions, conditional bids, or irregularities of any kind that may tend to make the proposal incomplete, indefinite, or ambiguous.

C. The bidder adds provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

D. If the bidder specifies a unit price of zero or fails to provide a unit price for every pay item indicated except in the case of authorized alternate pay item.

E. The proposal does not include the bid documentation in a sealed container and the affidavit of bid documentation if required by the Contract.

F. The proposal is materially unbalanced.

G. The proposal is not properly signed.

H. If any last minute hand written substitution of any unit price is illegible, as determined by the Department, or is not initialed by the bidder authorizing the substitution.

I. The Contractor fails to provide a properly executed proposal guaranty.

J. The bidder fails to sign the non-collusive bidding certification.

K. The proposal fails to comply with any other material requirements of the invitation for bids.

L. A bid shall be held to be non-responsive and not considered if specific DBE information is not provided at the time of bid: Good Faith Effort Documentation; failure to present written and notarized assurance that the goals on the Contract will be met; and, failure to present written copies of all DBE subcontracts within 10 calendar days after the bid opening.

102.08 Proposal Guaranty. All bids shall be accompanied by a deposit of either a good and sufficient bond to the State for the benefit of the agency involved, with a corporate surety authorized to do business in this State or a security of the bidder assigned to the Department. The form of the bond and the surety to be used, must be approved by the Department. The sum of the proposal guaranty must be equal to at least 10% of the bid. The bid bond need not be for a specific sum, but may be stated to be for a sum equal to 10% of the bid to which it relates and not to exceed a certain stated sum, if said sum is equal to at least 10% of the bid. "Securities" shall include certified checks, cashier's checks,

treasurer's check, and other negotiable or transferrable instruments evidencing an unconditional debt to the State or Department.

102.09 Delivery of Proposals. The proposal shall be placed in the sealed envelope provided, and plainly marked to indicate its contents, including the Contract designation and the name and address of the bidder. Proposals shall be delivered prior to the time and place specified in the advertisement. Bidder bears the risk of delays in delivery. Proposals received after the specified time will be returned to the bidder unopened. Proposals forwarded by the United States Postal Service or other delivery service must be addressed as follows:

Administrative Manager Office of Administration Department of Transportation P.O. Box 778 Dover, DE 19903	or	Administrative Manager Office of Administration Department of Transportation 800 Bay Road Dover, DE 19901

102.10 Withdrawal or Revision of Proposals. A bidder may withdraw or revise a proposal after it has been delivered to the Department, provided the request for withdrawal or revision is received by the Department in writing or in person with proper identifications before the time set for receipt of proposals. When the proposals have been read, any low bidder may withdraw any other unopened proposal which it may have submitted for another contract.

Any bidder exercising the privilege of so withdrawing its bid or bids waives all claims that may arise should it be found that its opened proposal is irregular or for any reason is unacceptable to the Department.

102.11 Public Opening of Proposals. Proposals will be opened and read publicly at the place and time set for opening of proposal.

102.12 Disqualification of Bidders. Any of the following reasons may be considered sufficient for the disqualification of a bidder and the rejection of a proposal for future work until reinstated as a registered bidder.

A. The bidder has defaulted on previous contract(s).
B. Unsatisfactory past performance evaluations(s) as determined and documented by the Department.
C. Failure to submit required Contract release documents, such as Certification of Payment (CN-91), Release of Contractor (CN-102), Release of Subcontractors (CN-103), Statement of Materials and Labor Used by Contractors on Highway Construction Involving Federal Funds (FHWA 47), or failure to sign a contract final change order for completed contracts.

The Department requires all releases within 90 calendar days after the date of the final change order or date of the acceptance of the Contract, whichever is later, or within 30 calendar days following the resolution of any Contract claims.

102.13 Rejection of Proposal. Any of the following reasons may be considered sufficient for the rejection of a proposal.

A. More than one proposal for the same work from an individual, firm, or corporation under the same or different name.
B. Participants in collusion among bidders.

C. Uncompleted work which, in the judgement of the Department, might hinder or prevent the timely completion of further work, if awarded.

D. Failure to pay or satisfactorily settle all bills due for labor and materials on contracts current at the time of bidding.

102.14 Materials Guaranty. The successful bidder may be required to furnish a complete statement of the origin, composition, and manufacture of materials used in the construction of the work, together with a sample to be tested for conformance with the Contract provisions.

102.15 Non-Collusive Bidding Certification. Every proposal submitted to the Department shall contain the following statement subscribed to and affirmed by the bidder as true under the penalties of Law. This statement, in the form of a certification, shall be signed by the bidders and submitted with the bid documents.

Non-Collusive Bidding Certification

By submission of this proposal, each bidder and each person signing on behalf of any bidder, certifies as to its own organization, under penalty of perjury, that to the best of each signer's knowledge and belief:

1. *The prices in this proposal have been arrived at independently without collusion, consultation, communication, or Agreement with any other bidder or with any competitor for the purpose of restricting competition.*
2. *Unless required by law, the prices which have been quoted in this proposal have not been knowingly disclosed and will not knowingly be disclosed by the bidder, directly or indirectly, to any other bidder or competitor prior to the opening of proposals.*
3. *No attempt has been made or will be made by the bidder to induce any other person, partnership, or corporation to submit or not to submit a proposal for the purpose of restricting competition.*

A bid proposal will not be considered for award nor will any award be made where there has not been compliance with 1., 2., and 3. above.

If the bidder cannot make the foregoing certification, the bidder shall so State and shall furnish with the proposal a signed statement which sets forth in detail the reasons why the certification cannot be made. Where 1., 2., and 3. above have not been complied with, the proposal will neither be considered for award nor will any award be made unless the Department determines that such disclosure was not made for the purpose of restricting competition.

The fact that a bidder has 1) published price lists, rates, or tariffs covering items being procured, 2) informed prospective customers of proposed or pending publication of new or revised price lists for such items, or 3) sold the same items to other customers at the same prices being bid does not constitute a disclosure within the meaning of 1. above.

SECTION 103 – AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Bids. After the proposals are opened and read, the Department will compare the proposals on the basis of the summation of the products of the quantities and the unit prices unless otherwise defined in the bid proposal. The results of the comparison will be available to the public upon award of the Contract. In the event of a discrepancy between unit prices and extensions, the unit price shall govern. The Department reserves the right to reject proposals, waive technicalities, proceed to do the work otherwise, or advertise for new proposals. Unit bid prices may also be affected by maximum price provisions noted elsewhere in these Specifications.

103.02 Award of Contract. The award of the Contract will be made within 30 days after the opening of the proposals to the responsible bidder who submits the lowest responsive proposal. The successful bidder will be notified in writing, mailed to the address indicated on the proposal, of the acceptance of the proposal and the award of the Contract. By mutual consent, the Department and the lowest responsible bidder can agree to extend the time within which the Department may make an award.

103.03 Cancellation of Award. The Department reserves the right to cancel the award of any contract before execution without liability.

103.04 Return of Proposal Security. Proposal securities, except that of the lowest bidder, will be returned upon award of the Contract, but in no event, later than 30 days after opening of the bid proposals. The retained proposal guaranty of the lowest bidder will be returned after satisfactory Contract performance and payment bond has been furnished and the Contract has been executed. A Contractor will not be released from this obligation because of an alleged error in the preparation of the proposal unless the Department retains the proposal guaranty.

103.05 Performance and Payment Bonds. Simultaneous with the execution of the Contract, the successful bidder shall furnish a surety bond or bonds in a sum equal to 100% of the Contract price to the State. The bond shall be for the benefit of the Department, as well as for the use and benefit of the Division of Revenue of the State in the case of claims under this bond for any and all taxes due to the State. The bond shall be issued by a corporate surety authorized to do business in this State.

The Contractor shall on a form provided by the Department obtain a release from the Division of Revenue indicating that all tax obligations for the Division of Revenue have been satisfied. This form shall be presented to the Department as a condition for the release of bond.

The bond shall be conditioned upon the faithful compliance and performance by the successful bidder of each and every term and condition of the Contract, at the time and in the manner prescribed by the Contract, including the payment in full to every person furnishing material or performing labor or services in the performance of the Contract, of all sums of money due the Contractor for such labor, services, or material. The bond shall also contain the successful bidder′s guarantee to indemnify and save harmless the State and the Department from all costs, damages, and expenses growing out of or by reason of the successful bidder′s failure to comply and perform the work and complete the Contract in accordance with the Contract.

The bond shall provide that every person furnishing materials or performing labor for the successful bidder under the Contract may maintain an action on the bond for its own use in the name of the State in any court of competent jurisdiction, for recovery of such sum or sums of money as may be due the person from the successful bidder.

The form of such bond shall be provided by the Department and the surety must be acceptable to the Department.

103.06 Execution and Approval of Contract. The successful low bidder shall return the signed Contract and Contract bond to the Department within 20 days after the notice that the Contract has been awarded. If the Contract is not executed by the Department within 15 days following receipt of the signed Contracts and bonds, the bidder has the right to withdraw the bid without penalty. The Contract will not be considered effective until it has been fully executed by all parties to the Contract.

Prior to the execution of the Contract, provide proof of compliance with the requirements of Sections 2502 and 2503, Chapter 25, Title 30 of the Delaware Code. If the successful bidder is a non-resident corporation, provide proof of compliance with the requirements of Subchapter XIV of Title 8 of the Delaware Code, and as further amended at the time of bid.

103.07 Failure to Execute Contract. Failure by the successful bidder to execute the Contract and file an acceptable bond within 20 days after the notice of award shall be considered a revocation of the notice of award and forfeiture of the proposal guaranty to the Department. Contract award may then be made to the next lowest responsive bidder or the work may be readvertised.

103.08 Escrow of Bid Documentation. If required by the Special Provisions, submit to the Department legible copies of the bid documentation.

A. *Scope and Purpose.* The purpose of escrowing the bid documentation is to preserve the Contractor's bid documents for use by the Contractor and the Department in the resolution of any disputes, claims, arbitration proceeding, or litigation arising from this Contract.

The submitted bid documentation shall be placed in escrow with a banking institution and preserved by that institution as specified in the following Subsections of this Section.

B. *Submittal and Return of Bid Documentation.* Within 24 hours of the execution of the Contract, the Contractor shall submit the bid documentation in a sealed container as per the custody Agreement form. The container shall be clearly marked "Bid Documentation" and shall show on the face of the container the Contractor's name and address, the date of submittal, the Contract number, and the Project designation.

C. *Affidavit.* In addition to the bid documentation, submit an affidavit, signed under oath by a representative of the Contractor authorized to execute bidding proposals, listing each bid document submitted by author, date, nature, and subject matter. The affidavit shall attest that 1) the affiant has personally examined the bid documentation, 2) the affidavit lists all of the documents relied upon by the Contractor in preparing its proposal for the Project, and 3) all such bid documentation is included in the sealed container submitted to the Department.

D. *Duration and Use.* The Department and the Contractor will jointly deliver the sealed container and affidavit to a banking institution or other bonded document storage facility selected by the Department for placement in a safety deposit box, vault or other secure accommodation.

The document depository Agreement shall reflect that the bid documentation and affidavit will remain in escrow during the life of the Contract or until the Contractor and the Department jointly agree to remove such documentation, or the Contractor notifies the Department of intention to file a claim or initiate litigation against the Department related to the Contract. Notification of the Contractor's intention to file a claim or initiation of

litigation against the Department will be sufficient grounds for the Department to obtain the release and custody of the bid documentation. If the bid documentation is not removed from escrow, upon completion of the Contract and provided that the Contractor has signed the final Standard Release Form, the Department will instruct the document depository to release the sealed container to the Contractor.

In accordance with the Contractor's representation that the sealed container placed in escrow contains all of the materials relied upon in preparing its proposal, the Contractor agrees to waive the right to use any bid documentation other than that placed in escrow to resolve all disputes arising out of the Contract.

E. *Refusal or Failure to Provide Bid Documentation.* Failure to provide bid documentation will render the proposal non-responsive, and the proposal guaranty will be forfeited in accordance with Subsection 103.07.

F. *Confidentiality of Bid Documentation.* The bid documentation and affidavit in escrow are, and will remain, the property of the Contractor. The Department has no interest in, or right to, the bid documentation unless mutually agreed by the Contractor and the Department or upon notification of the intention to file claim is received or litigation ensues between the Department and Contractor. In the event of such notification or litigation, the bid documentation and affidavit shall become the property of the Department until complete resolution of the claim or litigation is achieved. These materials, and all copies made by the Department, shall be returned to the Contractor upon execution of a final release. The Department shall make every reasonable effort to ensure that the bid documentation it has gained access to will remain confidential within the Department and will not be made available to anyone outside the Department or used by a former Department employee.

G. *Cost and Escrow Instructions.* The cost of the storage of bid documents will be borne by the Department. The Department will provide escrow instructions to the document depository consistent with this clause.

H. *Payment.* There will be no separate payment for the cost of compilation of data, the sealed container, or verification of the bid documentation. All costs shall be included in the Contract bid price.

Subsection 103.09 Withdrawal of Bid. If, at any time, after the acceptance of bids by the Department and before full execution of the Contract the low bidder determines a need to withdraw their bid, they shall put the request in writing to the Department's representative stating their reason(s) for such withdrawal. The Department reserves the right to accept/reject the bidder's request to withdraw upon review of the merits. The Department reserves the right to retain the bid bond or certified check in full or in part as liquidated damages. The Department may then proceed to the next lowest responsive bidder, or reject all proposals and readvertise for new proposals.

SECTION 104 – SCOPE OF WORK

104.01 Intent of Contract. The Contractor shall complete the work described, furnishing all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the Contract.

104.02 Signs. The Contractor shall, with the Engineer, inventory all signs (i.e., Traffic, Bus Stops, Street Names, etc.) within the limits of the Contract. Necessary bus stops and traffic signs shall be maintained in operation during construction, and all other signs shall be properly stored. The Contractor is responsible for any loss or damage to signs.

104.03 Bus Stops. Bus stops shall be maintained as close as possible to the original location by use of temporary roadway materials during construction activity.

104.04 Accident Notification. Notify the appropriate police agency and District Engineer immediately concerning any accidents which result in damage to property or cause personal injury.

104.05 Changes in the Character of Work. The Department reserves the right to, at any time prior to the completion of the Contract, issue plan revisions, make adjustments in Contract item quantities, or make such other alterations considered necessary to satisfactorily complete the Contract. A change will also be considered to have occurred when a major item of work, as defined elsewhere in the Contract, is increased in excess of 125% or decreased below 75% of the original Contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125% of original Contract item quantity, or in case of a decrease below 75%, to the actual amount of work performed.

A. Such changes will be issued in writing by the Engineer.
B. Such changes do not invalidate the Contract or release the Contract surety.
C. If as a result of such changes the Contractor requires additional time to complete the Contract, adjustments in the Contract time will be made under Subsection 108.07.
D. Payment for changes will be made as provided in Subsection 109.03 or 109.04. Payment shall exclude any amount for loss of anticipated profits alleged to result from the change.
E. Adjustments to the unit price of a Contract item based on increases or decreases in Contract quantities will be considered only on major items and then only for the increase in excess of 125% or decrease below 75% of the original bid quantity. The increase or decrease in the unit price of a Contract item shall apply only to that portion in excess of 125% of the Contact quantity. In cases of a decrease below 75% of Contract quantity, the increase and decrease in the unit price shall apply to the entire quantity. The amount of the increase or decrease in the unit price will be determined in accordance with Subsection 109.04.
F. When payment for the Contract work cannot be agreed upon by the Contractor and the Department prior to starting such work ordered, the Department may direct the Contractor to perform the work under the Force Account provisions of Subsection 109.04. The Contractor will proceed immediately with work so ordered and such direction shall neither invalidate the Contract, nor release the surety.

104.06 Differing Site Conditions. If differing site conditions are encountered at the work site, the Contractor shall promptly notify the Department as specified in Subsection 104.08. No further disturbance of the site or performance of the affected work is to be done after the alleged differing site conditions are noted unless directed in writing by the Engineer.

Upon written notification, the Engineer will investigate the conditions and determine if they differ materially as defined in Subsection 101.26. If so, and the conditions cause an increase or decrease in the cost or time required for the Contractor to perform the work, an adjustment, excluding loss of anticipated profits, will be made and the Contract modified in writing accordingly. The Engineer will notify the Contractor whether or not an adjustment of the Contract is warranted.

No Contract adjustment resulting in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice as specified in Subsection 104.08.

Adjustments in the Contract price will be made under Subsection 109.04, and adjustments in Contract time will be made under Subsection 108.07.

104.07 Suspension of Work. The Engineer may suspend the work in whole or in part by written order to the Contractor, for any reason or condition which would be in the best interest of the Department.

The Engineer may also suspend the work when the Contractor fails to perform any provisions of the Contract. The Contractor shall immediately comply with the written order of the Engineer to suspend the work wholly or in part. The work shall be resumed when conditions are favorable as determined by the Engineer or when methods are corrected as approved in writing by the Engineer.

A. If the delay resulting from the written suspension order is considered unreasonable, the Contractor shall submit a written request to the Engineer providing the reasons and justification for any Contract adjustment considered necessary as a result of the suspension. The justification for a time extension shall follow the notification and documentation procedures defined in Subsection 108.07. The written request for the Contract adjustment must be submitted to the Engineer in writing seven calendar days following receipt of the Engineer's notice to resume work.

   An adjustment will not be made unless the request has been submitted within the prescribed time.

B. There will be no adjustment under the provisions of this Subsection if the work performance would have been suspended or delayed by any other cause, under any other terms or conditions of the Contract.

C. The request for an adjustment will be reviewed by the Engineer. If there is Agreement that 1) there has been an increase in the Contract performance cost or time as a result of the suspension, and 2) the suspension was caused by conditions beyond the control and not the fault of the Contractor or those parties for whom the Contractor is responsible, adjustments in the Contract price, excluding profit, will be made according to Subsection 109.04. Any adjustments to Contract time will be made according to Subsection 108.07.

104.08 Notification of Differing Site Conditions, and Extra Work. The Contractor shall immediately notify the Engineer of alleged changes to the Contract due to differing site conditions, extra work, altered work beyond the scope of the Contract, or action(s) or lack of action(s) taken by the Department that have allegedly changed the Contract terms and conditions.

A. No further work is to be performed or Contract costs incurred on the change after the date the change occurs unless directed otherwise by the Engineer.

B. Within seven days of the initial notification, the Contractor shall provide the following applicable information to the Engineer in writing:

   1. The date of occurrence and the nature and circumstances of the occurrence that constituted the alleged change.
   2. Name, title, and activity of each Department representative knowledgeable of the alleged change.
   3. Identify any documents and the substance of any oral communications involved in the alleged change.
   4. Basis for an allegation of accelerated schedule performance, if applicable.
   5. Basis for an allegation that the work is not required by the Contract, if applicable.

6. Particular elements of Contract performance for which additional compensation may be sought under this Section including:
   a. Contract item(s) that have been or may be affected by the alleged change.
   b. Labor or materials, or both, that will be added, deleted, or wasted by the alleged change and what equipment will be idled or required.
   c. Delay and disruption to the manner and sequence of performance that has been or will be caused by the alleged change.
   d. Estimated adjustments to Contract price(s), delivery schedule(s), staging, and Contract time necessary due to the alleged change.
   e. Estimate of the time within which the Department must respond to the notice to minimize cost, delay, or disruption of performance.

The failure of the Contractor to provide required notice in accordance with this Subsection shall constitute a waiver of any and all entitlement to adjustments in the Contract price or time as a result of the alleged change.

C. Within ten days after the receipt of notice, the Engineer will respond in writing to the Contractor to:
   1. Confirm that a change occurred and, when necessary, direct the method and manner of further performance.
   2. Deny that a change occurred and, when necessary, direct the method and manner of further performance.
   3. Advise the Contractor that additional time is required to evaluate the allegation or adequate information has not been submitted to decide whether 1. or 2. above applies, and indicate the needed information and date it is to be received by the Engineer for further review.

Any adjustments made to the Contract shall not include increased costs or time extensions for delays resulting from the Contractor's failure to provide requested additional information in accordance with this clause.

104.09 Maintaining Traffic. The Contractor shall keep all roads open to all traffic during the construction. Where provided in the Contract or approved by the Engineer, traffic may be bypassed over an approved detour route. The Contractor shall keep the section of the Project being used by public traffic in a condition that safely and adequately accommodates traffic. The Contractor shall furnish, erect, and maintain barricades, drums, warning signs, delineators, striping, and flaggers, in accordance the Traffic Control Manual. The Traffic Control Manual may be obtained from the Contract Administration Office.

The Contractor shall bear all expense of maintaining the section of road undergoing improvement including all temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages, farms, and other features as may be necessary. Snow removal will not be required of the Contractor. Payment for the furnishing, installation, and maintenance of traffic control will be as provided in Division 700.

If the Contractor does not complete the Work within the Contract completion time (including approved extension time), the cost of all traffic control items to maintain traffic as required in accordance with the Traffic Control Manual (including all subsequent revisions up to the date of the advertisement of the Project), the Plans, and Specifications shall be borne by the Contractor to complete the remaining work beyond the Contract time. Traffic control items shall include but not be limited to warning lights, warning signs, barricades, plastic drums, portland cement concrete safety barrier, flaggers, police officers, arrow panel, message board, and portable impact attenuator.

104.10 Rights In and Use of Materials Found on the Work. The Engineer may authorize the Contractor's use of materials found in the excavation. Payment will be made both for the excavation of such materials at the corresponding Contract unit price and for the Contract item for which the excavated materials are used.

The removed material shall be replaced if necessary with acceptable material at no cost to the Department. Do not excavate or remove any material from within the highway location that is not within grading limits without written authorization from the Engineer.

104.11 Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the highway or street or to grant permits to construct or reconstruct is, at any time during construction, hereby expressly reserved by the Department. The Contractor shall not be entitled to any damages for unauthorized digging or any delay occasioned thereby.

Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit from the Department. The Contractor shall allow parties bearing such permits and only those parties, to make openings in the highway. When ordered, the Contractor shall make all necessary repairs due to such openings and such necessary work will be paid for as extra work or as provided in the Contract and will be subject to the same Contract conditions as the original work performed.

104.12 Value Engineering Proposals (VEP) by the Contractor. Any cost savings generated to the Contract as a result of VEP offered by the Contractor and approved by the Department will be shared by the Contractor and the Department on a 50-50 basis.

Bid prices shall not to be based on the anticipated approval of a VEP. If the VEP is rejected, the Contract is to be completed at the Contract bid prices.

If the Department determines that the time for response indicated in the submittal under B.5. below is insufficient for review, the Contractor will be promptly notified. Based on the additional time needed by the Department for review and the affect on the Contractor's schedule occasioned by the added time, the Department will evaluate the need for a time extension to the Contract. The Contractor shall have no claim against the Department for delays to the Contract based on the failure to respond within the time indicated in B.5. below if additional information is needed to complete the review. Until the proposal is accepted by the Department, the Contractor shall remain obligated to the terms and conditions of the existing Contract.

A. *General.* VEP contemplated are those that could produce a savings to the Department without impairing essential functions and characteristics of the facility, including but not limited to, service life, economy of operation, ease of maintenance, desired appearance, and safety.

B. *Submittal of Proposal.* The following materials and information shall be submitted with each proposal.

1. A statement that the proposal is submitted as a VEP.
2. A description of the difference between the existing Contract and the proposed change, and the cooperative advantages and disadvantages of each, including effects on service life, economy of operations, ease of maintenance, desired appearance, and safety.
3. A complete set of the Plans and Specifications showing the proposed revisions relative to the original Contract features and requirements.
4. A complete analysis indicating the final estimated costs and quantities to be replaced by the VEP compared to the new costs and quantities generated by the VEP.

5. A statement specifying the date by which a change order adopting the VEP must be executed to obtain the maximum cost reduction during the remainder of the Contract.
6. A statement detailing the effect the VEP will have on the time for completing the Contract.
7. A description of any previous use or testing of the VEP and the conditions and results. If the VEP was previously submitted on another Department project, indicate the date, Contract number, and the action taken by the Department.

C. *Conditions.* VEP will be considered only when all of the following requirements are met:

1. VEP, approved or not approved by the Department, apply only to the ongoing contract(s) referenced in the VEP and become the property of the Department. The VEP shall contain no restrictions imposed by the Contractor on their use or disclosure. The Department shall have the right to use, duplicate, and disclose in whole or in part any data necessary for the use of the VEP. The Department retains the right to use any VEP or part thereof on other projects without obligation to the Contractor. This provision is not intended to deny rights provided by law with respect to patented materials or processes.
2. If the Department is already considering certain revisions to the Contract or has approved certain changes in the Contract for general use that are subsequently incorporated in a VEP, the Department will reject the VEP and may proceed without obligation to the Contractor.
3. The Contractor shall have no claim against the Department for costs or delays due to the Department's rejection of a VEP, including but not limited to, development costs, loss of anticipated profits, increased material or labor costs.
4. The Engineer will be the sole judge as to whether a VEP qualifies for consideration and evaluation. It may reject any VEP that requires excessive time or costs to review, evaluate, or investigate, or that is not consistent with the Department's design policies and criteria for the Project.
5. The Department will reject all or any portion of work performed under an approved VEP if unsatisfactory results are obtained. The Department may direct the removal of such rejected work and require the Contractor to proceed in accordance with the original Contract requirements without reimbursement for work performed under the proposal, or for its removal. Where modifications to the VEP are approved to adjust to field or other conditions, reimbursement will be limited to the total amount payable for the work at the Contract bid prices as if it were constructed under the original Contract requirements. The rejection or limitation of reimbursement shall not constitute the basis of any claim against the Department for delay or for other costs.
6. The proposed work shall not contain experimental features but shall be proven features that have been used under similar or acceptable conditions on other projects or locations acceptable to the Department.
7. VEP will not be considered if equivalent options are already provided in the Contract.
8. The savings generated by the VEP must be sufficient to warrant a review and processing.
9. A proposal changing the type or thickness of the pavement structure will not be considered.

10. Additional information needed to evaluate VEP will be provided in a timely manner. Untimely submittal of additional information will result in rejection of the VEP. Where design changes are proposed the additional information could include results of field investigations and surveys, design computations, and field change sheets.

D. *Payment.* If the VEP is accepted, the changes and payment will be authorized by a change order. Reimbursement will be made as follows:

1. The changes will be incorporated into the Contract by changes in quantities of unit bid items, and/or new agreed price items, as appropriate, under the Contract.
2. The cost of the Value Engineering work as determined from the changes will be paid directly. In addition, the Department will pay the Contractor 50% of the savings to the Department as reflected by the difference between the cost of the revised work and the cost of the related construction required by the original Contract computed at Contract bid prices.
3. The Contractor′s costs for development, design, and implementation of the VEP are not eligible for reimbursement.
4. The Contractor may submit VEP for an approved subcontractor. Subcontractors may not submit a VEP except through the Contractor.

104.13 Final Cleaning of Project Site. Before final inspection of the Project, the Project, publicly owned borrow source, and all areas affected by the Contractor in connection with the work within the right-of-way shall be cleaned of all rubbish, excess materials, temporary structures, and equipment. All surfaces and slopes, whether old or new, shall be trimmed to the cross-section, all grass and weeds, which are taller than 6″ (150 mm), shall be cut, and all parts of the work shall be left in an acceptable condition. The cost of the final cleanup shall be incidental to the Contract and no separate payment will be made.

104.14 Contractor′s Responsibility for Work. Until the Contractor has achieved substantial completion, the Contractor shall have the sole and absolute responsibility for the work and to provide for the protection and safety of employees of the Department, Contractor, subcontractors, suppliers, and members of the general public. In no case, including but not limited to, supervisory acts or administration of the Contract by the Engineer, will the Contractor be relieved of the responsibility to indemnify the Department pursuant to the provisions of the Contract.

Rebuild, repair, restore, and make good all losses, injuries, or damage to any portion of the work under the control of the Contractor or due to his/her fault or inactivity, at no cost to the Department. Rebuild, repair, restore, and make good all losses, injuries, or damage to any portion of the work, not under the control of the Contractor, under agreed unit prices or as extra work under Subsection 109.04. "Items not under the control of the Contractor" shall be defined for purposes of this Subsection as Acts of God such as earthquakes, tidal waves, tornadoes, or hurricanes; catastrophic conditions such as hazardous waste materials spills, explosions, etc., or acts of the public enemy or of governmental authorities.

In case of the suspension of work the Contractor shall be responsible for the Project and shall take such precautions as may be necessary to prevent damage to the Project, provide for normal drainage and normal traffic operations, and to erect any necessary temporary structures, signs, or other facilities. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings

furnished under the Contract, and shall take adequate precautions to protect new tree growth and other vegetative growth against injury.

SECTION 105 – CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer is the administrator of the Contract and not a supervisor of the work. All work shall be performed to the satisfaction of the Engineer, but in no case shall the Contractor be relieved of complete responsibility for the work. The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the manner of performance and rate of progress of the work; all questions which may arise as to the interpretation of the Plans and Specifications; all questions as to the acceptable fulfillment of the Contract on the part of the Contractor; all disputes and mutual rights between contractors; and all questions as to compensation. At the preconstruction meeting the Engineer will determine and communicate to the Contractor the chain of command and the extent of authority Department personnel shall have to make changes to the Contract during the life of the Contract.

The Engineer has the authority to suspend the work, wholly or in part, due to the failure of the Contractor to correct conditions unsafe for the general public; for failure to carry out provisions of the Contract; for failure to carry out orders; for such periods as may be deemed necessary due to conditions the Engineer considered unsuitable for the prosecution of the work or for any other condition or reason deemed to be in the public interest.

The Engineer′s authority to impose any Contract sanction, including suspension of the work, withholding payments, or the like, will not relieve the Contractor of sole and absolute responsibility for the Project, performance of the work, and the safety of workers and the general public. The Contractor saves the Department harmless pursuant to Subsection 107.10 for any violation, breach, or omission of the above Contract provision.

105.02 Authority and Duties of Inspectors. Inspectors, acting under the authority of the Engineer, are administrators of the Contract and not supervisors of the work. Inspectors employed by or designated by the Department are authorized to inspect all work done and all material furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The inspector is not authorized to revoke, alter, or waive any requirements of the Plans or Specifications. The inspector may call the attention of the Contractor to any failure of the work or materials to conform to the requirements of the Contract and shall have the authority to reject materials or suspend the work until any questions at issue can be referred to and decided by the Engineer. Such inspection will not relieve the Contractor from the obligation to perform the work in accordance with the requirements of the Contract.

The inspector shall in no case act as foreman or perform other duties for the Contractor, nor interfere with the management of the work by the latter. Any advice which the inspector may give the Contractor shall in no way be construed as binding the Engineer in any way or releasing the Contractor from fulfilling all of the terms of the Contract.

If the Contractor refuses to suspend operations on verbal order, a written order giving the reason for shutting down the work shall be issued. After placing the order in the hands of the Contractor′s representatives in charge, the inspector shall immediately leave the job, and in such cases work done during the absence of the inspector will not be paid for and may not be accepted.

105.03 Inspection of Work. All materials and each part or detail of the work shall be subject at all times to inspection by the Engineer. Such inspection may include mill, plant, or shop inspection, and any material furnished under these Specifications is subject to such inspection. The Engineer will be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the Contract. Should the work thus exposed or examined prove acceptable, the uncovering, removing, and replacing of the covering or making good of the parts removed shall be paid for as extra work. Should the work so exposed or examined prove unacceptable, the uncovering, removing, and the replacing of the covering or making good of the parts removed, shall be at the Contractor's expense.

Any work done or materials used without supervision or inspection by the Department representative may be ordered removed and replaced at the Contractor's expense.

When any unit of government or political subdivision or any railroad corporation is to pay a portion of the cost of the work covered by this Contract, its respective representatives shall have the right to inspect the work. Such inspection shall not make any unit of government or political subdivision or any railroad corporation a party to this Contract, and shall in no way interfere with the rights of either party hereunder.

105.04 Plans and Working Drawings. Plans consisting of general drawings and showing such details as are necessary to give a comprehensive understanding of the work specified will be furnished by the Department. The Contractor shall furnish working drawings as may be required by the Engineer. Working drawings shall not incorporate any changes from the requirements of the Contract unless the changes are specifically denoted, together with justification, and are approved in writing by the Engineer. Any change from the requirements of the Contract shall be signed and sealed by a Professional Engineer registered in Delaware. Working drawings and submittals shall be identified by the Contract number. Items or component materials shall be identified by the specific Contract item number and specification reference in the Contract.

The Contractor is responsible for the preparation of all working drawings. However, drawings submitted directly by the supplier or the Contractor's representative will be accepted by the Department, if the letter of submittal indicates that the Contractor has been notified of the submission.

Working drawings for metal structures shall consist of shop detail, erection, and other working drawings showing details, dimensions, sizes of units, and other information necessary for the fabrication and erection of metal work.

Working drawings for concrete structures shall provide such details as are required for successful prosecution of the work. These shall include plans for items such as falsework, bracing, cofferdams, formwork, masonry layout diagrams, and bending diagrams for reinforcing steel.

Working drawings for electrical and mechanical equipment shall consist of nine copies of the manufacturer's catalog cuts, drawings, wiring diagrams, etc., and shall be submitted to the appropriate District Engineer section designated at the preconstruction meeting for review. Two sets will be returned with review or corrections noted.

After all items of a particular system have been reviewed, the Contractor shall prepare an "Instruction Book" especially for the system. The "Instruction Book" shall contain an equipment list, a complete description of the equipment, the sequence of operation including inter-locking and protective features, the use of by-pass switches, and a detailed description of all wiring circuits. The book shall also contain a recommended spare parts list, renewal parts bulletins, and instruction bulletins for the

equipment furnished. Diagrams and drawings shall be of reduced size suitable for binding. A proper index listing all items shall be included. All shall be properly fastened and bound in a suitable leather or heavy plastic cover book with a title clearly shown.

Prior to final inspection, five copies of the book shall be supplied to the District Engineer. The books must be available during the period when electrical and mechanical systems are being connected and energized, and the final bound copies must reflect any changes or adjustments made during this period.

The Contractor shall submit to the Engineer the number of sets of working drawings indicated on the flowchart in Figure 105-1. Work shall not be performed or materials ordered prior to review of the working drawings. The number of sets of working drawings marked with any suggested modifications or comments that will be returned to the Contractor are shown in Figure 105-1. The other sets will be retained by the Department.

The returned drawings will be stamped as follows:

A. *"Returned for Resubmission"*. In this case, revisions or corrections must be made, and the drawings resubmitted for review.

B. *"Reviewed for General Conformity with Plans and Specifications"*. In this case if the Contractor agrees with the comments, the comments shall be incorporated, and the Contractor does not need to resubmit the drawings. If the Contractor does not agree with the comments, then the Contractor shall state this in writing and submit this to the Department within ten working days after receipt of the comments.

The Department does not review every detail of every working drawing or other submittal made by the Contractor. As a consequence, responsibility for the completeness, accuracy, and conformance to Contract requirements of all submittals rests with the Contractor. The Department accepts no responsibility for the completeness and accuracy of approved submittals or the failure of approved submittals to conform with the requirements of the Contract.

Reviewed working drawings, submittals, or resubmittals will be transmitted to the Contractor within 45 days from the date of receipt by the Department. If a railroad, the U.S. Coast Guard, Municipality, or other entity as specified in the Contract is required to review the working drawings, the reviewed working drawings will be returned within 60 days from the date of receipt by the Department. If the working drawings are not returned by the time specified, no additional compensation will be allowed except that an extension of time in accordance with Subsection 108.07 will be considered. Upon completion of the work, the original drawings of structural steel work shall be supplied to the Department.

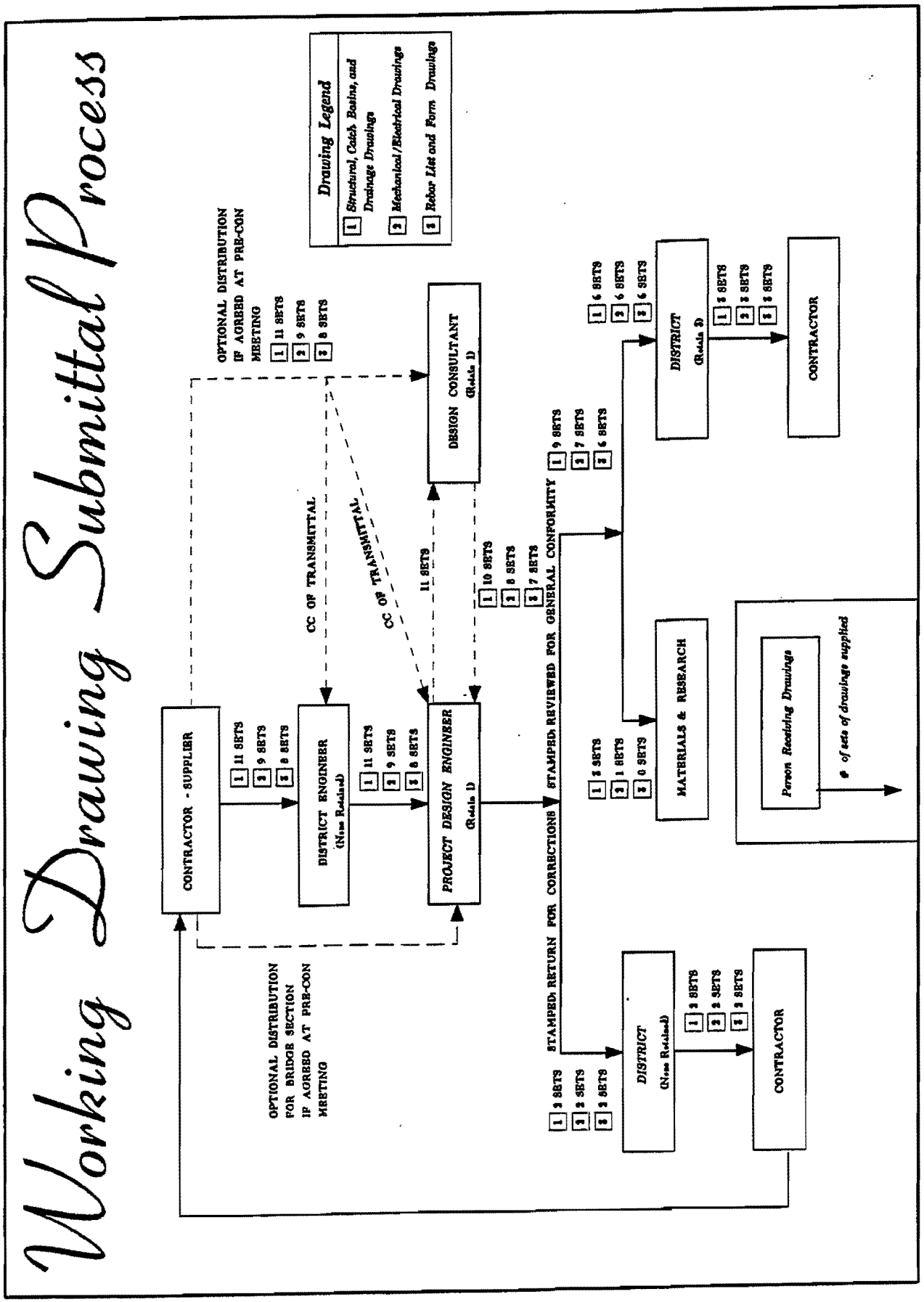
Working Drawing Submittal Process
Drawing Legend
[1] Structural, Catch Basins, and Drainage Drawings
[2] Mechanical/Electrical Drawings
[3] Rebar List and Form Drawings
CONTRACTOR - SUPPLIER
DISTRICT ENGINEER (Name Required)
PROJECT DESIGN ENGINEER (Grade 11)
DESIGN CONSULTANT (Grade 11)
DISTRICT (Name Required)
DISTRICT (Grade 2)
MATERIALS & RESEARCH
CONTRACTOR
CONTRACTOR
Person Receiving Drawings
# of sets of drawings supplied
OPTIONAL DISTRIBUTION IF AGREED AT PRE-CON MEETING
[1] 11 SETS
[2] 9 SETS
[3] 6 SETS
CC OF TRANSMITTAL
CC OF TRANSMITTAL
11 SETS
[1] 10 SETS
[2] 8 SETS
[3] 7 SETS
[1] 11 SETS
[2] 9 SETS
[3] 6 SETS
[1] 11 SETS
[2] 9 SETS
[3] 6 SETS
OPTIONAL DISTRIBUTION FOR BRIDGE SECTION IF AGREED AT PRE-CON MEETING
STAMPED RETURN FOR CORRECTIONS
STAMPED REVIEWED FOR GENERAL CONFORMITY
[1] 9 SETS
[2] 7 SETS
[3] 6 SETS
[1] 6 SETS
[2] 6 SETS
[3] 6 SETS
[1] 5 SETS
[2] 5 SETS
[3] 5 SETS
[1] 2 SETS
[2] 1 SETS
[2] 0 SETS
[1] 3 SETS
[2] 2 SETS
[3] 3 SETS
[1] 3 SETS
[2] 2 SETS
[3] 3 SETS

FIG. 105-1

105.05 Conformity with Plans and Specifications. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross-section, dimensions, and material requirements, including tolerances, shown on the Plans or indicated in the Specifications.

In the event the Engineer finds the materials or the finished product in which the materials used are not within reasonably close conformity with the Plans and Specifications, but that reasonably acceptable work has been produced, the Engineer will then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance which will provide for an appropriate adjustment in the Contract price for such work or materials if deemed necessary.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the Plans and Specifications, and the result is an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor. If there are provisions in the Contract for the acceptance of materials or work that are not in full compliance with the minimum requirements stated, pay adjustment factors reflecting the payment to be made for the work or materials will be included in the applicable Sections.

105.06 Coordination of the Plans, Standard Specifications, Supplemental Specifications, and Special Provisions. These Specifications, Supplemental Specifications, Plans, Special Provisions, and all supplementary documents are essential parts of the Contract and a requirement occurring in one is binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete Contract. In case of a discrepancy between these Contract components the governing ranking will be:

1. General Notices
2. Special Provisions
3. Plans
4. Supplemental Specifications
5. Standard Construction Details
6. Standard Specifications

The Contractor shall not take advantage of any apparent error or omission in the Contract. If the Contractor discovers an error or omission, the Engineer shall be promptly notified. The Engineer will make corrections and interpretation as necessary to fulfill the intent of the Contract. Scaled measurements shall not be used when the dimensions on the Plans are given or can be computed.

105.07 Cooperation by the Contractor. The Contractor will be supplied with two copies of the Plans and bid proposal. One copy shall be kept at the Project site at all times. The Contractor shall give the work constant attention necessary to facilitate progress and cooperate with the Engineer in every way possible.

The Contractor shall have on the Project site at all times a competent superintendent capable of reading and understanding the Contract and experienced in the type of work being performed. The superintendent shall receive instructions, be authorized to act for the Contractor, and have full authority to execute orders or the directions of the Engineer without delay.

105.08 Cooperation Between Contractors. The Department reserves the right to contract for and perform other or additional work on or near the limits of construction covered by the Contract.

It shall be the responsibility of contractors working on the same project to coordinate their work and cooperate with each other. In case of a dispute, the Engineer will be the referee, and the Engineer′s

decision will be final and binding on all. When separate contracts are let within the limits of any one project, each contractor shall conduct the work without interfering or hindering the progress or completion of the work by other contractors.

Each contractor involved shall assume all liability, financial or otherwise, in connection with their contract and shall protect and save harmless the Department, from any and all damages or claims that may arise because of inconvenience, delays, or loss experienced because of the presence and operations of other contractors working within the limits of construction of the same project.

The Contractor shall arrange the work and place and dispose of materials being used without interfering with the operations of other contractors within the limits of the same project. The work shall be coordinated with the work and sequence of other contractors.

105.09 Utilities. Bidders are hereby notified that within the limits of the work under this Contract, several utility lines may be encountered. The location of all utilities shown on the Plans or mentioned herein are approximate locations only.

The Department will notify all utility companies, pipeline owners, railroads, or other parties known to be affected, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other facilities and appurtenances within or adjacent to the limits of construction made as soon as practicable. Notwithstanding any other provision of this Contract, the Contractor shall not proceed with the work until the Contractor has conferred with the Engineer, the utility companies, and the municipal or county authorities in an effort to secure the most accurate and most recent information as to utility locations. As required by Chapter 8, Title 26 of the Delaware Code, the Contractor shall not begin any construction around or adjacent to utilities without notifying the utility owners at least two working days, but not more than ten working days in advance of starting the work.

Water lines, gas lines, wire lines, services connections, water and gas meter boxes, water and gas valve boxes, light standards, cable ways, signals, and all other utility facilities and appurtenances within the limits of the proposed construction that require moving, including the work involved in relocating or otherwise altering such utilities, are to be moved by others at no expense to the Contractor, except as otherwise provided for in the Special Provisions or as noted on the Plans.

Any relocation or rearrangement of utilities made for the Contractor′s sole convenience shall be paid for by the Contractor.

It is understood and agreed that the Contractor has considered in the bid all the permanent and temporary utility appurtenances in their present or relocated positions as shown on the Plans or as readily discernable and that no additional compensation will be allowed for any delays, inconvenience, or damage due to any interference from the utility facilities and appurtenances or the operation of moving them.

The relocation of any existing utilities which will interfere with the proposed construction may also be in operation simultaneously with the work to be performed under this Contract.

Any damage to utility services caused by the Contractor must be repaired at the Contractor′s expense. Such damage shall be repaired immediately.

Prior to performing any work on the Project, the Contractor shall contact all utility companies, pipeline owners, railroads, or other known parties affected and "Miss Utility" of DELMARVA in order to ensure that all such utilities have received notice and in order that all utility adjustments may be made.

"Miss Utility" is a report center system that enables the public, contractors, utilities, and other excavators to notify participating member utilities of planned digging activities by making one call.

"Miss Utility" is operated jointly by the Utilities Service Protection Center of DELMARVA (USPC) on behalf of the following utilities:

Adelphia Business Solutions
Adesta Communications
AIRCO
Artesian Water Co.
AT&T of Delaware
Bell Atlantic
Bethel Township Sewer Dept.
Broadwing Communications
Camden-Wyoming Sewer & Water
Cereza Energy, Inc.
Charter Communications
Chesapeake Utilities
City of Delaware City
City of Dover
City of Harrington
City of Lewes Public Works
City of Milford
City of Newark
City of New Castle
City of Seaford
City of Wilmington
Colonial Pipeline Co.
Columbia Gas Transmission
Comcast Cable Communications
Conectiv Comm
Conectiv Power
Delaware Dept.of Transportation
Delaware Electric Cooperative
Delaware Terminal
Eastern Shore Gas
Equilon Pipeline
Falcon Classic Cable
Genuity Solutions, Inc.
GTE Global Networks, Inc.
IXC Communications, Inc.
Kent County Engineering Dept.
Kent County Sanitary District
Level 3 Communications
Long Neck Water Co.
MCI/Worldcomm
Mediacomm of Lower MD/DE
MFS Network Technologies
Municipal Utility Commission
NEXTLINK
NUI Elkton Gas
Paradee Gas Co.
Pep-Up, Inc.
Public Water Supply Co.
Qwest Communications
Sea Colony Water Co.
Sharp Energy
Steeplechase Waterworks
Suburban Cable
Sussex County Engineering Dept.
Sussex Shores Water Co.
T&C Utility Corporation
TCG Delaware Valley
Tidewater Utilities
Town of Blades
Town of Bridgeville
Town of Clayton
Town of Georgetown
Town of Laurel
Town of Middletown
Town of Milton
Town of Smyrna
Tristate Cable Communications
Tunnell Companies, Inc.
United CATV/Eastern
United Water
University of Delaware
Utility Systems, Inc.
Verizon Communications
Viking Communications
Williams One Call SVC
XO Communications

The report center is essentially a message center, to which all participating parties are connected by a private line teletype network. The work location report is called in over two primary numbers, toll free, 1-800-441-8355 and 1-800-282-8555 in Delaware only. The area covered is the entire DELMARVA Peninsula.

A minimum of two but not more than ten working days advance notice of starting time is required. This assures the person calling of having the underground facility located prior to excavation.

The party reporting a digging operation is asked a standard format of questions to provide the utilities with the necessary information required to ensure an adequate location of the activity. The caller is given a ticket number for reference purposes. The center specifically locates reported areas of activity on a master map and determines the spot by grid coordinates. This information is then transmitted to the participating parties via high speed teletype network.

Messages received are sent out immediately during normal work hours (7:30 AM to 5:00 PM, Monday through Friday). Messages received after normal working hours, Saturdays, Sundays, or holidays are taken, logged, and transmitted within one hour the next normal work day.

The work location report is received by the participating utility which immediately locates the work area by the information transmitted from the message center. The utility must then respond to the person originating the call by 1) stating they have no underground facilities at the designated location or 2) stating there are facilities in the area and dispatching a locating crew to the site and marking their underground facility with stakes, flags, and/or paint horizontally over the ground.

USPC recommended safety color codes will be used: Orange for communications, red for power, blue for water, green for sewer, yellow for gas and petroleum products, brown for slurry pipes, purple for radioactive material. This will enable the reporting party to visually see if the utility has responded.

105.10 Construction Stakes, Lines, and Grades. The Engineer will furnish and set control and construction stakes unless otherwise specified.

The Engineer will establish right-of-way, limit of construction, and easements if needed, and construction stakes establishing right-of-way easement lines, slopes, profile grades, centerline or off-set lines, and benchmarks. The Department may furnish the Contractor with information relating the lines, slopes, and grades. The Engineer will establish structure working points, elevations, and all the necessary points and off-set to complete the structure. These stakes and marks constitute the field control by which the Contractor shall establish other necessary controls and perform the work. Before beginning of the work, the Contractor shall determine the meaning of all stakes, indicated measurements, and marks provided by the Department.

The Engineer will also perform preliminary and final cross-sections of borrow pit sites and cross-sections for bedrock and undercut excavation.

The Contractor is responsible for the preservation of all stakes and marks. The labor cost of the survey crew replacing disturbed stakes and marks will be deducted from the payment due for the work.

The Department is responsible for the accuracy of lines, slopes, grades, and other engineering work set forth under this Subsection. The Department will not be responsible for staking delays unless the Engineer is provided ten calendar days notice prior to beginning work on an item and thereafter 48 hours notice that stakes are needed.

105.11 Removal of Defective and Unauthorized Work. Defective or unauthorized work shall be removed and disposed of immediately upon rejection. Work done without lines and grades being given, or work done beyond the lines and grades shown on the Plans or any change order or supplemental agreement or work done without written authority will be considered as unauthorized and will not be measured or paid for by the Department. Work so done may be ordered removed and replaced at the Contractor's expense. Failure of the Contractor to remove and properly dispose of rejected work immediately after receiving written notice to do so shall be sufficient cause for the termination of the Contract. Furthermore, the Engineer will have authority to cause unacceptable work to be remedied or removed and replaced and unauthorized work to be removed and to deduct the costs from the amount due or to become due the Contractor.

105.12 Load Restrictions. The Contractor shall comply with all legal and contractual load restrictions in the hauling of materials or equipment on public roads. A hauling permit or other special permit will not relieve the Contractor of liability for damage to public or private property which may result from the movement of such loads or equipment.

Vehicles transporting construction materials to Department projects shall not exceed the gross vehicle weight (GVW) or licensed weight, if less, as specified in the Delaware Code. Materials inspection weigh tickets will not be issued by Department personnel for GVWs in excess of the allowable maximum.

Payment for materials delivered to the Project shall not exceed the allowable GVW minus the truck tare weight. An average tare weight may be established on a basis approved by the Engineer so that empty weighing is not necessary before every load. No payment will be made for any excess material weight.

It shall be the responsibility of the Contractor to notify its subcontractors, vendors, and suppliers of this requirement.

The maximum GVW for different vehicle axle configurations is as follows; provided that in the case of three-axle vehicles the extra weight fee has been paid and is so noted on the registration card:

Customary Values

Single Unit Values	***GVW, Maximum***
2-axle vehicle (e.g., 2-axle dump truck)	40,000 lb.
3-axle vehicle (e.g., 3-axle dump truck)	65,000 lb. *70,000 lb.
4-axle vehicle (e.g., 4-axle dump truck)	73,280 lb.
Tractor-Semi-Trailer Combinations	
3-axle combination unit	60,000 lb.
4-axle combination unit	70,000 lb.
5-axle combination unit	80,000 lb.

* When extra weight fee has been paid and is so noted on registration card.

Metric Values

Single Unit Values	***GVW, Maximum***
2-axle vehicle (e.g., 2-axle dump truck)	18 144 kg
3-axle vehicle (e.g., 3-axle dump truck)	29 484 kg *31 752 kg
4-axle vehicle (e.g., 4-axle dump truck)	33 240 kg
Tractor-Semi-Trailer Combinations	
3-axle combination unit	27 216 kg
4-axle combination unit	31 752 kg
5-axle combination unit	36 288 kg

* When extra weight fee has been paid and is so noted on registration card.

The Contractor shall be responsible for all damages done by hauling equipment.

105.13 Maintenance During Construction. The Contractor shall maintain the work during construction and until the Project is accepted. This maintenance shall be performed every day continuous, and effective with adequate equipment and forces to keep the roadway and structures in a satisfactory condition.

The Engineer will notify the Contractor if there is a failure to comply with these provisions. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of the notice, the Engineer may proceed to maintain the Project. The entire cost of this maintenance will be deducted from monies due or to become due the Contractor.

If the Contract involves the placement of material on or the use of a previously constructed subgrade, base course, pavement or structure, the previously constructed work shall be maintained by the Contractor during construction operations.

The cost of maintenance work during construction and before the Project is accepted shall be incidental to the Contract.

In the event that the Contractor's work is ordered shut down for failure to comply with the provisions of the Contract, the Contractor shall maintain traffic, protect and maintain the roadway and structures, and provide ingress and egress for local residents as may be necessary during the period of suspended work or until the Contract has been declared in default.

105.14 Opening Sections of the Project to Traffic. The Engineer may order certain sections of work to be opened to traffic or other use prior to completion or acceptance of the work. Opening these sections shall not constitute acceptance of work or waiver of any Contract provisions.

On those sections opened, the cost of establishing maintenance and protection of traffic, maintaining the roadway or other work to accommodate traffic or other use, and repairing damage to the work that occurs after opening will be determined as follows:

A. If the Contract provided for total road closure, and the opening is not due to the fault or inactivity of the Contractor, the added costs will be at the Department's expense. Compensation for these added costs will be in accordance with Subsection 109.04.

B. If the opening was designated as part of the Contract in "phased" or "staged" construction (only when defined as such in the Contract), then the added work will be performed at the Department's expense unless damage was reimbursed by Contractor's insurance. Compensation for this added work will be in accordance with Subsection 109.04. This does not apply to Contracts that do not have defined "phased" or "staged" construction.

C. If the opening was due to the fault or inactivity of the Contractor, then the work will be performed at no additional expense to the Department. If the Contractor is dilatory in completing features of the work according to the Contract or progress schedule, the Engineer will give written notification establishing a time period for completing these features. If the Contractor fails to complete or make a reasonable effort to complete the work according to the written notification, the Engineer may order all or a portion of the Project opened to traffic. The Contractor shall not be relieved of liability or responsibility for maintaining the work and shall conduct the remaining construction operations with minimum interference to traffic at no additional expense to the Department for any added cost of the work.

105.15 Claims for Adjustment and Disputes. In any case where the Contractor believes that extra compensation is due for work or material not clearly covered in the Contract or not ordered by the Engineer as an extra, or the Contractor feels that it has encountered unusual and unforeseen conditions beyond its control, as defined herein, not discoverable by reasonable inspection and diligence on the

Contractor's behalf and if all other Contract provisions have been complied with, the Contractor shall notify the Engineer orally or in writing of its intention to make claim for such extra compensation before the Contractor begins the work on which the claim is based on. If written notification is not given within five working days and the Engineer is not afforded proper facilities by the Contractor for keeping strict account of actual costs as required, then the Contractor waives the claim for extra compensation.

A. *Contractor Written Notification.* The written notification to the Engineer shall include:
   1. the date of occurrence and the nature and circumstances of the occurrence that constitute a change;
   2. name and title of Department representatives knowledgeable of the claimed change; and
   3. particular elements of Contract performance for which additional compensation may be sought under this Section.

   Such notice by the Contractor, and the fact that the Engineer has kept account of the cost as aforesaid, shall not in any way be construed as proving the validity of the claim. Nothing contained in this Subsection shall be construed as establishing any claim contrary to the terms of Subsection 104.05 or any other provision of the Specifications.

B. *Engineer Response.* Within ten calendar days after receipt of notice, the Engineer will respond in writing to the Contractor to:
   1. confirm that a change occurred and, it shall be allowed and paid as an extra as provided herein; or
   2. deny that a change occurred and, direct the Contractor to follow the claims submittal procedure as outlined; or
   3. advise the Contractor that adequate information has not been submitted to decide whether B.1. or B.2. above applies, and indicate the need for more information for further review. The Department will respond to such additional information within ten calendar days of receipt from the Contractor; or
   4. advise the Contractor that the District will review the claim, after obtaining the claims submittal as described herein.

   Any adjustments made to the Contract shall not include increased costs or time extensions for delay resulting from the Contractor's failure to provide requested additional information in accordance with this clause.

C. *Claim Submittal.* The Contractor must submit a formal claim in writing within 60 calendar days after the item claimed has been completed. The Contractor can only recover, and the formal claim shall only consist of those items allowed under Subsection 105.19 and must contain:
   1. the precise nature and basis for the claim;
   2. each fact upon which the Contractor relies, to support the claim;
   3. the precise reason the Contractor believes the claim should be granted;
   4. the language in the Contract upon which the Contractor relies, in support of the claim;
   5. the amount of money or nature and extent of relief to which the Contractor believes it is entitled; and
   6. any other factors which the Contractor believes support the claim.

   In complying with this requirement, the Contractor must certify the claim using the following form:

The undersigned is duly authorized to certify this claim on behalf of (the Contractor).

(The Contractor) *certifies that this claim is made in good faith, that the supporting data are accurate and complete to the best of the Contractor's knowledge and belief, and that the amount requested accurately reflects the Contract adjustment for which* (the Contractor) *believes that the Department is liable.*

(THE CONTRACTOR)

By: .....
(Name)
(Title)

Date of Execution: .....

The Contractor agrees to follow the procedure described in this Section and that any claimed dollar amount and/or relief sought, not made pursuant to this Section, within the time limits prescribed shall be forever waived and not raised at any subsequent meeting or hearing dealing with the claim. The Department shall establish a claims procedure to be followed, consistent with these Specifications, which claims procedure shall provide the means and methods by which the Contractor and the Department shall process the claim.

Claims and disputes submitted in accordance with this Section, will be first reviewed fully at the District level. Within 30 calendar days after receiving the claim submittal, the District Engineer will respond, in writing, with the District's decision. If additional time is required by the District to review the claim, the District Engineer will notify the Contractor. Rejection of the claim or dispute by the District may be appealed to the Claims Committee for review. The Contractor shall give notice of the appeal, in writing, within ten calendar days of the rejection by the District Engineer. The Claims Committee will conduct a claim review meeting attended by representatives of the Contractor and the District. The Committee will conduct the claims review meeting within 45 calendar days after receiving the Contractor's notice of appeal. The proceedings of the Claims Hearing will be recorded by a Court Reporter. The cost associated with the Court Reporter will be shared equally by the Department and the Contractor. A copy of the record of the Claims Hearing will be made available to the Contractor.

Within 15 calendar days of the Hearing, the Committee's Chairperson will notify the Contractor, in writing, of the Committee's decision.

The Contractor may appeal the Claims Committee's decision to the Chief Engineer of the Department requesting to proceed with the arbitration process as outlined in Subsection 105.17. The Contractor shall give notice of the appeal to the Claims Committee's Chairperson, in writing, within ten calendar days after receiving the Claims Committee's decision.

105.16 Chief Engineer's Decision. After receiving the written notification from the Contractor, appealing the Claims Committee's decision and requesting an Arbitration hearing as outlined in Subsection 105.17, the Chief Engineer will notify the Contractor, in writing, within 30 calendar days of

the receipt of the notice regarding the claim. The decisions upon all claims by the Chief Engineer shall represent the findings of the Department.

105.17 Arbitration. Any claim, properly presented pursuant to Subsection 105.15, processed through the claims procedure, and finally decided by the Chief Engineer pursuant to Subsection 105.16, in the absence of agreement by the Contractor and the Department as to the resolution thereof, and upon the demand of either party delivered in writing to the other within 30 calendar days from the date of the written decision by the Chief Engineer, as provided in the aforesaid Subsection 105.16; shall be decided by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association then in effect; except as otherwise modified by these Specifications. The arbitration proceeding may involve presentation of facts or such portions thereof as have previously been presented at prior administrative hearings held pursuant to Subsection 105.15 herein or may be based entirely upon the record, as established therein. The record established at prior administrative hearings pursuant to Subsection 105.15 shall be specifically admissible at such arbitration proceedings and such facts as have been established shall be specifically binding upon the parties; with the exclusion of opinions and conclusions thereon. Such arbitration shall be specifically based upon the claim presented at prior administrative hearings and no material, information, fact, and/or claim not presented at such hearings held pursuant to said Subsection 105.15 shall be admissible at any arbitration conducted pursuant to this Section. The arbitrators, in their final ruling on the claim shall include a summary of the evidence, findings of fact based upon the evidence, conclusions of law, and a concise statement of the relief awarded. This agreement to arbitrate shall be strictly enforceable as provided under Chapter 57, Title 10 of the Delaware Code, as amended.

105.18 Contractor and Subcontractor/Supplier Disputes. Any dispute arising between the Contractor and its subcontractor/supplier concerning payments held in trust, as required by Chapter 8, Title 17 of the Delaware Code, shall be resolved by arbitration. The Department shall not serve as the arbiter of such disputes, but shall, in the absence of agreement between the parties, designate the American Arbitration Association to resolve the matter.

105.19 Claims. All claims shall be submitted according to the procedure established in Subsection 105.15. Submit a written claim notification a maximum of five working days after the original oral notification. Provide in the written notification a brief statement of the reason and basis for the claim and a list of the items for which additional compensation is being claimed in order to permit the Engineer to keep a strict account of actual costs incurred. Within 60 calendar days after that portion of the work upon which the claim is based is completed, the Contractor shall submit to the Department an itemized list of labor, equipment, and materials used and such other costs as specifically allowed pursuant to this Subsection. The Contractor shall not be entitled to recover any costs other than those contained and allowed herein. As described below, A. through G. shall cover all direct and indirect costs allowed and H. identifies all non-allowable costs.

A. *Labor.* In accordance with Subsection 109.04 D.1.
B. *Bond, Insurance, and Tax.* In accordance with Subsection 109.04 D.2.
C. *Materials.* In accordance with Subsection 109.04 D.3.
D. *Equipment.* In accordance with Subsection 109.04 D.4.
E. *Percentage Markups.* In accordance with Subsections 109.04 D.6. and 109.04 D.7.
F. *Subcontractor Claims.* Any claim submitted by the Contractor on behalf of a subcontractor shall be submitted according to Subsection 105.15 and shall be solely limited to the list of all direct or indirect costs permitted by A. through D. above. For

work approved by the Department, the subcontractor will be allowed a percentage markup as permitted by Subsections 109.04 D.6. and 109.04 D.7. The Contractor will be allowed an additional percentage markup as permitted by Subsection 109.04 D.8. to be computed on the final sum total of such subcontractor cost claimed under A. through D. above for portions of subcontractor work approved by the Department.

G. *Waiver of Liquidated Damages.* A claim, not for additional costs, but for a waiver by the Department of an assessment of liquidated damages, in whole or in part, may also be made by the Contractor as part of this Subsection.

H. *Non-allowable Damages or Expenses.* The expenses listed above as A. through G. shall constitute the sole cost(s) and expense(s) to which the Contractor shall be entitled on any claim submitted for additional compensation or settlement of any claim made under these Specifications, except as further provided in Subsection 105.21. The parties agree that the Department will have no liability for the following items of damage or expense:

1. Profit in excess of that provided herein,
2. Loss of profit,
3. Labor and equipment inefficiencies,
4. Home office overhead in excess of that provided herein,
5. Consequential damages, including but not limited to loss of bonding capacity, loss of bidding opportunities and insolvency,
6. Indirect costs or expenses of any nature,
7. Attorneys fees, claim preparation expenses or costs of litigation, and
8. Interest on any claimed amounts.

I. Any claim submitted shall not affect in any manner the imposition or waiver of liquidated damages, except that any liquidated damages shall be waived for any delay for which a time extension is granted in accordance with Subsection 108.07.

J. The Contractor agrees to make its accounting records and cost information available at the time of submission of the claim and such other records as the Department may require, in order to determine the validity and amount of each item claimed. They shall be open to inspection or audit by representatives of the Department during the life of the Contract and for a period of not less than three years after the Contractor's acceptance of Final Payment as set forth in Subsection 109.10 and the Contractor shall retain such records for that period. Where payment for materials, equipment, or labor is based on the cost of forces other than the Contractor's, the Contractor shall make every reasonable effort to ensure that the cost records of such other forces are open to inspection and audit by representatives of the Department on the same terms and conditions as the cost records of the Contractor. Payment for the cost of such forces may be deleted if the records of such third parties are not made available to the Department's representatives. If an audit is to be commenced, the Contractor is to be provided with a reasonable notice of the time when such audit is to begin. In case all or a part of such records are not made available, the Contractor understands and agrees that any items not supported by reason of such unavailability of the records will not be allowed, or if payment therefor has already been made, the Contractor shall refund to the Department the amount so disallowed.

105.20 Project Acceptance. Final acceptance will not occur until completion of the Project in accordance with Subsection 101.16. However, at the request of the Contractor and at the sole discretion of the Engineer, the Contract time may be stopped without all the required documents, certificates, or proofs of compliance.

When the Contract time is stopped, the Contractor is to expeditiously provide the exempted documents, certificates, or proofs of compliance. Final acceptance and payment will not be made until all documents, certificates, or proofs of compliance have been executed and delivered to the Engineer.

A. *Partial Project Acceptance.* When a unit or portion of the Project, such as a structure, interchange, or section of road or pavement is substantially completed, the Contractor may request final inspection of that unit or portion. If the unit or portion has been completed in accordance with the Contract, the Engineer may accept it as completed. The decision to make partial acceptance of a unit is solely at the discretion of the Engineer. Partial acceptance will not void or alter any of the terms of the Contract.

B. *Project Acceptance.* Upon receiving notice from the Contractor of Project completion, the District will make a semi-final inspection. During this inspection, the District will note by stations and in detail all work or conditions requiring correction. The Contractor shall immediately prosecute the corrective work. When completion of the noted corrections are completed to the satisfaction of the District, a final inspection will be arranged. The Engineer will make a final inspection of the work to certify the Project can be used, occupied, or operated for its intended use. The Engineer will note any further corrective measures as deemed necessary. The Contractor shall prosecute corrective measures immediately. When the work is satisfactorily completed, together with receipt of proper documentation as noted herein, the Engineer will notify the Contractor in writing of the date of acceptance of the Project.

105.21 Claims for Delay Damages. The Department may grant time extensions in the performance of work for delays caused by acts of God, acts of the public enemy, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, unusually severe weather, or other causes, only when these delays are not the fault or responsibility of the Contractor, are beyond the Contractor's control, and could not have been anticipated by the Contractor. For such delays that are also beyond the control and not the fault of the Department, the Contractor shall be entitled to a time extension, but shall not be entitled to recover any damages resulting from such delays.

In the event a delay is not caused by the Contractor's fault or negligence but is caused wholly by actions of the Department, or determined by an arbitrator and/or judicial proceeding to be the Department's sole responsibility, an extension of time shall be granted in an amount equivalent to the actual critical delay caused by the Department, and the Contractor shall not be entitled to any additional compensation except as allowed herein.

All direct and indirect costs allowed are covered in A. below, and B. below identifies all non-allowable costs. Compensation provided by A. below shall not be duplicative of compensation already provided as part of Subsection 105.19 or 109.04:

A. *Allowable Direct and Indirect Expenses.* Only the additional costs associated with the following items will be recoverable by the Contractor for delay compensation:

1. *Extended Field Overhead.* Field overhead costs necessary for the prosecution of the work during the delay period, as follows:

a. *General Field Supervision.* Such costs include but are not limited to general field supervision, assistants, watchman, clerical and other field support staff. Compute these labor costs in accordance with Subsection 109.04 D.1. For salaried personnel, calculate the rate of wage (or scale) actually paid by dividing the weekly salary by seven days per week.

b. *Field Office Facilities and Supplies.* Such costs include but are not limited to field office trailers, tool trailers, office equipment rental, temporary

toilets, and other incidental facilities and supplies. Compute these costs on the basis of the actual added costs incurred by the Contractor to provide these services as a result of the delay.

c. *Maintenance of Field Operations.* Such costs include but are not limited to telephone, electric, water, and other similar expenses. Compute these costs on the basis of the actual added costs incurred to maintain these services as a result of the delay.

These extended field overhead costs are not duplicative of those compensated in Subsection 109.04 D.7.

2. *Labor.* For all necessary, non-salaried, idle labor that must remain on the Project during such periods of delay due to collective bargaining contracts or other reasons approved by the Engineer, compute the labor costs in accordance with Subsection 109.04 D.1.
3. *Bond, Insurance, and Tax.* In accordance with Subsection 109.04 D.2.
4. *Equipment.* For any idle equipment other than small tools that must remain on the Project site during delays, the Contractor is to receive compensation at the rate calculated in Subsection 109.04 D.4. Should it not be necessary for machinery or equipment to remain on the Project during delays, the Contractor is to receive transportation costs to remove the machinery or equipment and return it to the Project at the end of the delay period.
5. *Materials.* Costs for material escalation due to the delay or the cost of storage of materials due to the delay are recoverable. Obtain the Engineer's approval prior to storing any material due to a delay.
6. *Percentage Markups.* An additional 10% markup of the total of 1., 2., 3., and 4. above will provide full compensation for home office overhead and any other costs attributed to the delay for which no specific allowance is herein provided. Payment under this Subsection constitutes full compensation for all items of expense related to such delay. No profit is allowed under this Subsection. The markup is not duplicative of those provided in Subsections 105.19 E., 109.04 D.6., and 109.04 D.7.
7. *Records.* Payment will not be made for delays until the Contractor has furnished the Engineer with duplicate itemized statements of the cost as hereinabove specified and detailed as follows:
   a. Name, classification, date, daily hours, total hours, rate, and extension for each worker and foreman.
   b. Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment.
   c. Transportation costs.
   d. Cost of bonds, property damage, liability, and workers compensation insurance premiums; unemployment insurance contributions; and social security taxes.

   The Engineer will compare the Department's records with those furnished by the Contractor and make any necessary adjustments. When these records are agreed upon and signed by both parties, said records become the basis of payment for the expenses incurred, but do not preclude subsequent adjustment based on a later audit by the Department.

The Contractor's cost records pertaining to expenses under this Subsection shall be open to inspection or audit by representatives of the Department as provided in Subsection 105.19 J.

B. *Non-Allowable Damages or Expenses.* The expenses listed in A. above shall constitute the sole cost(s) and expense(s) to which the Contractor shall be entitled on any delay claim submitted for additional compensation or settlement of any claim made under these Specifications. The parties agree that the Department will have no liability for the items listed in Subsection 105.19 H.1. through H.8.

SECTION 106 – CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. All materials used shall meet the requirements of the Contract. The Contractor shall promptly notify the Engineer of the proposed sources of materials to be used in the work prior to delivery. The Engineer has the option of conditionally approving materials at the supply source. If it is determined during use of conditionally approved material that the materials do not meet the Contract requirements, material incorporated in the work shall be corrected to the satisfaction of the Engineer or removed. All materials incorporated in the work shall be new unless otherwise specified in the Contract.

106.02 Samples, Tests, and Referenced Specifications. Materials will be inspected, tested, and approved by the Engineer before incorporation into the work. Work in which untested materials are used without approval are used at the Contractor's risk and may be deemed unacceptable. Payment will not be made for materials found to be unacceptable. Unacceptable materials shall be removed from the work solely at the Contractor's expense.

Unless otherwise designated, material tests will be performed by and at the expense of the Department in accordance with the most recent test methods of the Department, AASHTO, or ASTM in effect on the date of advertisement for bid proposals. When any specification or test is identified in the form of an AASHTO or ASTM number succeeded by "Modified" it refers to an AASHTO or ASTM specification or test as modified by the Department's Materials Manual in effect on the date of advertisement for bid proposals. If there is a difference in the test methods, the order of precedence in the test procedure used will be as follows:

A. Materials Manual
B. AASHTO
C. ASTM

Material sampling or splitting operations will be performed or observed by the Department. The Department reserves the right to retest and subsequently reject materials not meeting the Contract requirements that have been previously tested and conditionally accepted at the source of supply. Materials to be used are subject to inspection, testing, or rejection prior to or during incorporation into the work. Copies of any or all test results will be made available to the Contractor upon request.

When in the judgement of the Engineer, inconsequential quantities and use of materials are required, they may be covered by a field inspection report of materials in lieu of the minimum requirements for sampling materials.

106.03 Certification of Compliance. The Contract or the Department's Materials and Testing Schedule will designate materials that can be incorporated in the work if accompanied by certificates of compliance from the manufacturer. The certificates of compliance shall state that the materials or

assemblies provided fully comply with the specification requirements of the Contract, and shall be signed by the manufacturer. Each lot of certified materials or assemblies delivered to the Project must be accompanied by a certificate of compliance clearly identifying the materials delivered and the specification requirement satisfied.

Materials or assemblies used on the basis of certification of compliance may be sampled and tested by the Department and if determined not to be in conformance with Contract requirements will be rejected in accordance with Subsection 105.03.

The form and distribution of the certificates of compliance shall be as provided in the Contract or the Department's Materials and Testing Schedule requirements.

106.04 Manufacturing Plant Inspection. The Engineer may inspect materials at the acquisition or manufacturing source. Manufacturing plants may be inspected for compliance with specified manufacturing methods. Material samples will be obtained for testing for compliance with material quality requirements.

In the event plant inspection is undertaken, the following conditions shall be met:

A. The Engineer will have the cooperation and assistance of the Contractor and producer of the materials;

B. The Engineer will have full access at any time to all parts of the plant concerning the manufacture or production of the materials being furnished;

C. The Contractor shall arrange for an approved building for the use of the inspector with such building to be located conveniently near the plant and conforming to the requirements of Subsection 106.05;

D. Provide and maintain adequate safety measures; and

E. It is understood that the Department reserves the right to retest all materials which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of these Specifications.

106.05 Field Laboratory. The Contractor shall provide a field laboratory consisting of a suitable building in which to house equipment for performing all required tests. The field laboratory for testing at portland cement concrete plants shall conform to the requirements of Subsection 812.07. The field laboratory for testing at asphalt cement concrete plants shall conform to the requirements of Subsection 823.06. Payment for all field laboratories shall be incidental to the work in the Section for which the laboratory or facility is provided.

106.06 Buy American Contract Requirement. In accordance with Section 165 of the Surface Transportation Assistance Act of 1982, Title 23 of the United States Code, the following applies to all contracts:

For this Contract, all iron, coating materials, steel materials, and coating of steel must be produced in the United States, except a minimal amount of foreign steel materials may be used provided the cost of materials does not exceed 0.1% of the total Contract cost or $2,500.00, whichever is greater.

A. *Certificate of Compliance.*

A Certificate of Compliance shall be furnished to the Department by the Contractor. The Certificate shall be signed by the Contractor to the effect that the materials and/or assembled materials will be of domestic origin and will comply in all respects with the requirements of the

Contract. Mill test reports verifying that steel products are of domestic origin as defined in the Special Provisions shall be provided. All materials accepted on the basis of Certificate of Compliance may be sampled and tested at any time. Use of material on the basis of Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating material in the Project conforming to the requirements of the Contract. Any material not conforming to such requirements shall be subject to rejection whether in place or not. The Department reserves the right to refuse to permit the use of material on the basis of Certificate of Compliance.

B. *Domestic Material.*

Domestic materials are those which are melted, cast-formed, shaped, drawn, extruded, forged, fabricated, or otherwise processed in the United States.

106.07 Storage and Handling of Materials. Materials shall be stored and handled to preserve their fitness for the work. Bulk materials shall be transported in vehicles constructed to prevent loss or segregation after loading and measuring. Stored materials shall be stored in a manner to facilitate prompt inspection and will be subject to inspection and retesting prior to incorporation in the work in accordance with Subsection 106.04.

An approved portion of the right-of-way may be used for the storage of materials and the Contractor's plant and equipment. Additional storage space required shall be provided at the Contractor's expense and option. Private property shall not be used for storage purposes without written permission of the owner or lessee. If requested, copies of such written permission shall be furnished to the Engineer.

Storage and plant sites shall be restored to their original condition by and at the Contractor's expense.

106.08 Unacceptable Materials. Materials not conforming to the requirements of the Contract will be rejected and removed immediately from the Project unless the defects have been corrected and approved by the Engineer.

106.09 Disposal of Unacceptable Materials. All waste materials removed by earthwork operations shall become the property of the Contractor and shall be removed from the Project or otherwise disposed of as specified. Unless specific disposal sites for waste materials generated by the clearing and grubbing operation are designated on the Plans, the Contractor shall procure disposal sites. Such disposal sites shall be submitted to and approved by the Engineer prior to utilization by the Contractor. The submittal shall include a plan of the disposal area, proposed sediment and erosion control devices, existing and proposed final contours, and proposed security measures. All permit requirements such as those required by the Department of Natural Resources and Environmental Control (DNREC) and the U.S. Army Corps of Engineers shall be met by the Contractor when preparing and utilizing off-site disposal areas. The Contractor shall submit a similar proposal for use of designated disposal sites if such detail is not included in the Contract documents. Costs for preparing these plans are incidental to Section 201. For disposal sites designated on the Plans, payment will be made separately under applicable bid items for

all necessary erosion and sediment controls, seeding, and mulching. For Contractor-procured disposal sites, such costs are incidental to Section 201.

106.10 Department-Furnished Material. Material furnished by the Department will be delivered or made available to the Contractor at locations specified in the Contract.

The cost of handling and placing Department-furnished materials after they are delivered to the Contractor shall be included in the Contract price for the item in which they are used. Deductions will be made from any monies due for any shortages, deficiencies, and damage that may occur to the material after delivery. Demurrage charges resulting from the Contractor's failure to accept the materials at the designated time and location of delivery will also be deducted from monies due the Contractor.

SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 Laws to be Observed. The Contractor is required to investigate and shall strictly comply with, all Federal, State, or county laws and regulations, and city or town ordinances and regulations. The Contractor shall indemnify and save harmless the State of Delaware, the Department of Transportation, its Secretary and all officers, agents, and servants against any claim or liability arising from or based upon the violation of any such laws, ordinances, regulations, orders, or decrees whether by its employees.

If the Contractor should discover any provisions in the Contract that are contrary to or inconsistent with any law, ordinance, regulation, order, or decree, the Contractor shall immediately report it to the Engineer in writing.

107.02 Permits, Licenses and Taxes. The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful prosecution of the work.

Prior to the execution of any contract, the successful bidder shall be required to show that it has satisfied the requirements of Sections 2502 and 2503, Chapter 25, Title 30 of the Delaware Code, and if the bidder is a non-resident corporation, that the bidder has complied with the requirements of Subchapter XIV, Title 8 of the Delaware Code, Annotated Revised 1974, and as amended.

107.03 Patented Devices, Materials, and Processes. The Contractor and the surety shall hold and save harmless the State, the Department, their officers or agents, in accordance with the terms of these Specifications, from any and all claims because of the use of any patented design, device, material, or process in connection with the work agreed to be performed under this Contract. Any patent agreement between patentee and the Contractor shall be furnished to the Department.

107.04 Contractor's Responsibility for Utility Property and Services. At points where the Contractor's operations are adjacent to properties of railway, telegraph, telephone, power companies, or other utilities, or are adjacent to other properties, facilities, or appurtenances, damage to which might result in considerable expense, loss, or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

In the event of interruption to water or utility services as a result of accidental breakage, or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority. The Contractor shall cooperate with said authority in the restoration of service as promptly as possible. No

work shall be undertaken around fire hydrants until appropriate plans for continued service have been approved by the local fire authority.

Fire hydrants on or adjacent to the highway shall be kept accessible to fire apparatus at all times and no material or obstruction shall be placed within 15′ (4.5 m) of any such hydrant. Work shall be left entirely accessible at all points to fire apparatus at all times.

107.05 Federal Aid Participation. When the United States Government pays all or any portion of the cost of a project, the Federal laws authorizing such participation and the rules and regulations made pursuant to such laws must be observed by the Contractor, and the work shall be subject to the inspection of the appropriate Federal agency.

Such inspection shall not make the Federal Government a party to this Contract and will in no way interfere with the rights of either party hereunder.

107.06 Construction Safety, Health, and Sanitary Standards. It is a condition of all contracts, and shall be made a condition of each subcontract entered into pursuant to the prime contract, that the Contractor, and any subcontractor, shall not require any person employed in performance of the Contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to such person′s health or safety.

The Contractor shall provide and maintain in a neat and sanitary condition, such accommodations for the use of its employees as may be necessary to comply with the requirements of the State and local Boards of Health, or of other bodies or tribunals having jurisdiction.

107.07 Public Convenience and Safety. In performing the work, the Contractor shall interfere as little as possible with traffic. The Contractor shall provide and maintain ingress and egress for all residences and places of business located along the construction route. So far as practicable, materials stored upon the highway shall be placed so as to cause as little obstruction to the traveling public as possible. If, as determined by the Engineer, it is necessary to keep the road or any portion of it open to travel during the construction thereof, the Contractor shall so perform the work and provide such means that travel will not be obstructed or endangered. The Contractor shall provide and maintain in an acceptable condition such temporary roadways and bridges as may be necessary to accommodate the traffic using or diverted from the roadway under construction, and shall provide and maintain in a safe condition temporary approaches to and crossing of intersecting highways. All sidewalks, gutters, sewers, inlets, and portions of the highway adjoining the roadways under construction shall not be obstructed more than is absolutely necessary.

107.08 Use of Explosives. When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property, including new work. The Contractor shall be responsible for all damage resulting from the use of explosives.

All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and not closer than 1000′ (300 m) from the road or from any building or camping area or place of human occupancy.

The Contractor shall notify each public utility company having structures in proximity to the site of the work of its intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

The use of explosives will not be permitted within 200′ (65 m) of any existing, newly finished, or partly finished structure on a project unless authorized in writing by the Engineer. No explosives shall be stored overnight on the Project.

107.09 Protection and Restoration of Property. The Contractor shall be responsible for the preservation of all public and private property, trees, monuments, etc., along and adjacent to the roadway not designated on the Plans for repair, removal, or construction. The Contractor shall take the precautions necessary to prevent damage to pipes, conduits, and other underground structures, and shall protect from disturbance or damage all land monuments and property markers until authorized by the Engineer. Any land monument or property markers damaged or disturbed shall be located and reset by Registered Land Surveyors or a Registered Professional Engineer. The Contractor shall not injure or destroy trees or shrubs outside the limits of the graded roadway section, nor remove or cut them without proper authority. Where any direct or indirect damage is done to public or private property on account of any act, omission, neglect, or misconduct in the execution or non-execution of the work on the part of the Contractor, such property shall be restored at the Contractor′s expense to a condition similar or equal to that existing before such damage.

In case of the failure on the part of the Contractor to restore such property or make good such damage, the Engineer may upon giving 48 hours notice proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof will be deducted from any monies due to the Contractor under the Contract.

107.10 Responsibility for Damage Claims. The Contractor shall assume the responsibility and liability for, and shall indemnify and save harmless the Department, its officers, and employees, from and against all suits, actions, claims, and all damages, direct or indirect, of whatever nature, caused to any person(s) or property or resulting to the work from any act, work, or plan performed or submitted by the Contractor or upon its behalf; including but not limited to responsibility of the Contractor to provide for the protection and safety of all persons and property. This indemnification and save harmless requirement shall apply, but not be limited to, all suits, actions, claims brought, and all damages resulting from any death, injury, or damage received or sustained by any person(s), third person(s), or property based upon:

A. Operations of the Contractor, including but not limited to work performed; neglect in safeguarding the work; use of unacceptable materials; any act, work, or plan performed or submitted by the Contractor on its behalf or resulting from performance, nonperformance of the work, or any omission, neglect, or misconduct occurring during the course of the Contract.

B. Any claim(s) or amount(s) recovered from any infringement(s) of patent, trademark, or copyright.

C. Any claim(s) or amount(s) arising or recovered under the "Workers Compensation Act", for any violation or alleged violation of any law, ordinance, rule, regulation, order, or decree.

The Department may withhold as retainage for the use of the State to pay any amount claimed or anticipated, as determined by the Engineer, except that such money shall not be withheld when the Contractor produces satisfactory evidence that it is adequately protected by public liability and property damage insurance. In any event, the surety shall be liable to pay any amount recovered as a result of any suit, action, claim, injuries, or damages sustained and until such time as the matter has been settled or otherwise legally resolved.

107.11 Furnishing Right-Of-Way. The Department will be responsible for the securing of all necessary rights-of-way in advance of construction. Any exceptions will be indicated in the Contract.

107.12 Personal Liability of Public Officials. The Department, Director, Engineer, or their authorized agents will incur no personal liability as a result of carrying out any of the provisions of the Contract, as the result of exercising any power or authority granted to them thereby, or as the result of any act by the Contractor. In such matters they act as the agents and representatives of the State.

107.13 No Waiver of Legal Rights. Upon completion of the work, the Department will expeditiously make final inspection and notify the Contractor of acceptance. Such final acceptance, however, shall not preclude or estop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Department be precluded or estopped from recovering from the Contractor or its surety, or both, such overpayment as it may sustain, or recovering the cost of the failure on the part of the Contractor to fulfill its obligations under the Contract. A waiver on the part of the Department of any breach of any part of the Contract shall not be held to be a waiver of any other or subsequent breach.

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

107.14 Hazardous Material. If any abnormal condition is encountered or exposed that indicates the presence of a hazardous material or toxic waste, construction operations shall be immediately suspended in the area and the Engineer notified. Work shall be continued in other areas of the Project unless otherwise directed by the Engineer.

Abnormal conditions include but are not limited to the following: presence of barrels, obnoxious odors, excessively hot earth, smoke, or any other condition that indicates a hazardous material or toxic waste. The conditions shall be treated with extreme caution.

Disposition of the hazardous material or toxic waste shall be made under the requirements and regulations of the applicable State agency.

SECTION 108 – PROSECUTION AND PROGRESS

108.01 Subletting of Contract. The Contractor shall not subcontract, sublet, sell, transfer, assign, purchase work or materials from an organization other than its own, or otherwise dispose of the contract or contracts or any portion thereof, or of its right, title or interest therein, without written consent from the Engineer. The Contractor shall perform with its own organization work amounting to not less than 50% of the total Contract bid price, except that any items designated in the Contract as "specialty items" may be performed by subcontract and the cost of any such specialty items so performed by subcontract may be deducted from the original total bid price before computing the amount of work required to be performed by the Contractor with its own organization. Only the original Contract bid price and the value of subcontracted work approved by the Engineer will be used to compute the percentage of subcontracted work. Adjustments in quantities or additional items of work will not require an adjustment of the percentage computed as described above. The Contractor's organization shall be construed to include only those workers on its payroll, employed and paid directly by the Contractor, and equipment owned or rented by the Contractor with or without the operator(s) as is consistent with normal industry practice.

If the Contractor to whom a contract is awarded proposes to subcontract any part of work, the scope and value of the work to be done by the subcontractor shall be outlined. The cost of materials to be used by the subcontractor shall be outlined. The cost of materials to be used by the subcontractor shall be included in the value of the subcontracted work. A subcontractor shall not subcontract further a portion of the work intended to be done by the original subcontractor organization.

All traffic control work and related items shall either be performed entirely by the Contractor's own organization or totally subcontracted. Maintenance of the equipment shall not be subject to this requirement.

When the Contractor has sublet a portion of the Contract or a bid item to a subcontractor, the actual payment to the subcontractor shall be applied to fulfill Disadvantaged Business Enterprise (DBE) requirements of the Contract, were applicable. The cost of a portion of the Contract or bid item performed by a DBE shall be applied against the Contractor to determine if the Contractor is performing at least 50% of the total Contract bid price, as required herein.

The Contractor must obtain written permission from the Engineer for each subcontractor to whom the Contractor intends to subcontract or sublet a portion of the work prior to execution of the subcontract agreement. As a prerequisite to payment for any work done by a subcontractor or on a subcontractor's behalf and prior to any work being done on the Project by the said subcontractor, the Contractor shall submit a certified copy of the Contractor-subcontractor agreement and any and all other contracts with suppliers or any other person, firm, or organization for review and approval by the Engineer. Each subcontract shall be in writing and shall contain and state that all pertinent provisions and requirements of the prime contract are incorporated into the subcontract. It shall be the Contractor's responsibility to determine that all such provisions are included and such provisions shall be implied where not specifically included.

The Contractor may also be required to submit additional information concerning the prospective subcontractor or supplier, including any additional information required by the terms of this Contract, by the Department or by the FHWA, or other governmental agency, where necessary. Such information may include but may not necessarily be limited to:

A. The organization which performs the work is particularly experienced and equipped for such work.
B. Assurance by the Contractor that the Labor Standards Provisions set forth in this Contract shall apply to labor performed on all work encompassed by the Contract.
C. All Civil Rights Provisions and DBE requirements have been satisfied.
D. The Department is indemnified and saved harmless from the action of the subcontractor or supplier.
E. Disputes Resolution Clause is included in the subcontract.
F. Contractor saves harmless and indemnifies the Department for omissions in the Contractor-subcontractor agreement.

Any review performed or permission or approval granted under these Specifications shall not operate, nor be interpreted as approval of the work to be performed by the subcontractor or material supplied by a supplier, nor shall it operate to relieve the Contractor of the sole responsibility for satisfactory completion of the Contract. No contracts, subcontracts, supplier agreements, sales, transfers, leases, assignments, or any other agreements applicable to this Contract shall in any case release the Contractor of its sole responsibility and liability under the Contract and bonds.

The Department, in its discretion, may refuse to pay for all or part of the work or materials or may refuse to accept any work performed by such unapproved subcontractor or materials supplier and may refuse to consider work performed or materials supplied as part of the subcontracted work.

108.02 Notice to Proceed. Following the Contract execution, the Engineer may schedule a preconstruction meeting. Prior to the preconstruction meeting, the Contractor shall submit the progress schedule per Subsection 108.04. The Engineer will issue to the Contractor a notice to proceed which will stipulate the date on or before which the Contractor is expected to begin work. The date specified in the notice will be at least ten calendar days subsequent to the date of issuance of the notice to proceed. No work is to be started before receipt of the notice to proceed. The specified Contract time shall begin on the day the work actually starts or on the date stipulated in the notice to proceed, whichever is earlier.

108.03 Performance and Progress. The Contractor shall begin work no later than the date stipulated in the notice to proceed.

A. *Calendar Day Contracts.* Contract time will begin as specified in Subsection 108.02 and continue each and every day shown on the calendar until the substantial completion of work as determined by the Engineer. For working on Sundays and holidays, the Contractor shall submit a written request to the Engineer at least three working days prior to the Sunday or holiday for written permission to work on such Sunday or holiday. The Contractor shall provide notice to the Engineer no later than 12 PM Friday if any work is to be performed the next day so that adequate inspection can be provided by the Department.

B. *Working Day Contracts.* Contract time will begin as specified in Subsection 108.02 and continue as specified in Subsection 101.91 until substantial completion of work as determined by the Engineer. No work will be permitted on Sundays or holidays unless the Engineer determines that such work is in the best interest of the Department. Submit a written request to the Engineer at least three working days prior to the Sunday or holiday for written permission to work on such Sunday or holiday. Provide notice to the Engineer no later than 12 PM Friday if any work is to be performed the next day so that adequate inspection can be provided by the Department.

108.04 Progress Schedules. Sufficient materials, equipment, and labor shall be provided by the Contractor to guarantee the completion of the Project within the Contract time.

The Contractor shall submit a progress schedule to the Engineer for review. The Work shall not be started until the progress schedule and methods of construction operations for each phase of construction are acceptable to the Engineer and are in conformance with all applicable erosion and sediment control requirements. The progress schedule shall be used to establish the critical construction operations and to monitor the progress of the work. The progress schedule chart shall be in the form specified below, unless the Contract requires a Critical Path Method (CPM) schedule.

If Contractor elects to use a CPM schedule when it is not required in the Contract, the Contractor shall comply with the requirements of Subsection 108.04, and no additional payment will be made for the CPM schedule.

A. *Progress Schedule Chart (PSC).* The PSC prepared shall show in detail the time (working days or calendar days as specified) involved in performing construction activities for the duration of the Project. The Project shall be scheduled in such manner and sequence as to minimize the time and surface area of erodible earth material. The PSC shall be used for the coordination of work under the Contract including the activities of subcontractors, vendors, and suppliers. The Department will use the PSC to monitor the progress of the work.

The PSC shall show the interdependence of all major work activities required for the complete performance of all items of work under this Contract, including working drawing preparation, submittal, and approval; permits; fabrication and delivery activities; curing time; utility activity; etc. Also, the interdependence of work between separate project locations, if applicable, is to be shown.

The PSC shall include a description of the number of workdays per week, holidays to be taken, number of shifts per day, and number of hours per shift used for the preparation of the schedule.

B. *Preparation of Initial Schedule.* Prior to the Notice to Proceed, the Contractor shall develop the initial PSC and present three copies to the Engineer.

The construction time, as determined by the PSC shall fully use, but not exceed the specified Contract duration. It should be noted that time charges will begin no later than the time stipulated in the notice to proceed. Review and approval of the PSC will not bind the Department or constitute acceptance of any individual time period for scheduled activities.

C. *Biweekly and As-Required Look-Ahead Schedules*. The Contractor shall be required to submit to the Engineer a two-week activity schedule on each Friday for each two-week period. This activity schedule shall provide specific details related to actual construction activities the Contractor plans to have in progress during the two-week period.

When requested by the Engineer, the Contractor shall submit a revised detailed progress schedule showing the remaining work to be completed when requesting an extension of Contract time as specified in Subsection 108.07.

108.05 Traffic Requirements and Contractor′s Operations. The Contractor shall conduct work at all times in such a manner and in such sequence as will ensure the least interference with traffic. The Contractor shall give due regard to the location of detours and to the provisions for handling traffic. The Contractor shall not open up work to the prejudice or determent of work already started, and the Engineer may require the Contractor to finish a section on which the work is in progress before work is started on any additional sections.

108.06 Character of Workers and Equipment. In the construction of all public works for the State or any political subdivision thereof, or by persons contracting with the State or any political subdivision thereof, preference in employment of laborers, workers, or mechanics shall be given to bonafide legal citizens of the State who have established citizenship by residence of at least 90 days. Each public works contract for the construction of public works for the State or any political subdivision thereof shall contain a stipulation that any person, company, or corporation who violates the provisions of this Section shall pay penalty to the State Treasurer equal to the amount of compensation paid to any person in violation.

The Contractor shall employ only competent and efficient persons. Whenever, in the opinion of the Engineer, any employee is careless or incompetent, obstructs the progress of the work, acts contrary to instructions of the superintendent or foreman, or conducts oneself improperly, the Contractor shall, upon the request of the Engineer, discharge the employee from the work and shall not again employ that person on the Contract or any other contract for the Department, except with the written consent of the Engineer.

All machinery and equipment owned or controlled by the Contractor, that is proposed to be used by the Contractor on the work, shall be of sufficient size and capacity and such mechanical condition as to meet the requirements of the work and to produce a satisfactory quality of work. Equipment used

on any portion of the Project shall be such that no injury to the roadway, adjacent property or other highways results from its use.

When methods and/or equipment to be used by the Contractor in accomplishing the construction are not prescribed in the Contract, the Contractor is free to use any methods and/or equipment that it demonstrates to the satisfaction of the Engineer will accomplish the Contract work in conformity with the requirement of the Contract.

When the Contract specifies that the construction be performed by the use of certain methods and/or equipment, such methods and/or equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use a method and/or type of equipment other than those specified in the Contract, the Contractor may request authority from the Engineer to do so. The request shall be in writing and shall include a full explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing construction work in conformity with Contract requirements. If, after trial use of the substituted methods and/or equipment, the Engineer determines that the work produced does not meet the Contract requirements, the Contractor shall discontinue the use of the substitute method and/or equipment and shall complete the remaining construction with the specified methods and/or equipment.

The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made to the unit price for the Contract items involved, nor in Contract time as the result of authorizing a change in methods and/or equipment under these provisions unless it is as a credit or a VEP.

108.07 Extension of Contract Time. An extension of the Contract time may be granted by the Department under the following conditions provided documentation has been given to the Engineer. If the Contractor finds that it will be impossible to complete the work on or before the time allowed by the Contract, the Contractor shall, prior to the termination of such time, submit a written request to the Engineer for an extension of time for completion of the Contract. The Contractor shall set forth fully therein the reasons which it considers would justify the request. If requested by the Engineer, the Contractor shall submit a revised detailed progress schedule showing the remaining work to be completed on or before the requested extended completion date. If the Engineer finds that the work was delayed on account of unusual conditions beyond the control of the Contractor, or that the quantities of work done or to be done are sufficiently in excess of the estimated quantities to warrant additional time, the Engineer will grant an extension of time for completion in such amounts as appears to be reasonable and proper. Upon written notice being sent by the Engineer, the new completion time shall be incorporated into and become part of the Contract and shall be binding upon the Contractor and Surety. The Contractor shall not be entitled to any additional time as a result of any delay caused by the Contractor's failure to prosecute the work and/or the Contractor's failure to work in accordance with the progress schedule without valid reason as permitted by these Specifications.

108.08 Failure to Complete on Time. For each calendar day or work day that work remains uncompleted after the Contract time has expired or beyond the completion date established by the Contract, the sum specified in Subsection 108.09 will be deducted from any money due the Contractor. This sum shall not be considered and treated as a penalty but as liquidated damages due the Department by reason of inconvenience to the public, added cost of engineering and supervision, and other extra expenditures of public funds due to the Contractor's failure to complete the work on time. Any adjustment of the Contract time for completion of the work granted under Subsection 108.07 will be considered in the assessment of liquidated damages.

The column indicated in the chart as "Calendar Day" will also be used in the assessment of liquidated damages for contracts with a predetermined completion date.

Computations for the assessment of liquidated damages shall be made in accordance with the daily computations described in the definition of working day, when the Contract is a working day contract. On all other contracts each and every consecutive calendar day, including Saturdays, Sundays, and holidays, shall be included in the computations for the assessment of liquidated damages.

The Contractor shall become liable for liquidated damages for delays commencing from the date on which the Contract time, as adjusted by Subsection 108.07, shall expire.

If there is a delay in the delivery of critical materials, such as steel, copper, or aluminum, due to defense needs, energy crisis, etc., a time extension shall be allowed for such delays. Each case will be independently evaluated to determine if the delays were, in fact, beyond the control of the Contractor or fabricator and delayed the Project completion. Satisfactorily supported time extension requests shall be made concurrently with the delay and not after the fact.

Requests for time extensions shall be subject to review by the Engineer, and the Engineer will determine the amount of time extension allowed.

There will be no acceptance of unsupported claims of delays in delivery of material as a basis for time extensions. The Contractor is presumed to have included in its Contract price, allowance for any anticipated delays in procurement of materials, which procurement is its sole responsibility. Unless some unusual market condition such as an industrywide strike, natural disaster, or areawide shortage arises after bids are taken and prevents procurement of materials within the allowable time limitations, delays in delivery of such materials do not provide sufficient reason for suspending time charges.

Permission for the Contractor or surety to continue and finish work after the Contract time and approved extensions have elapsed shall not waive the Department's rights under the Contract.

The Department may waive such portions of the liquidated damages as may accrue after the work is substantially complete and is in a condition for safe and convenient use by the traveling public.

Payment of liquidated damages will be deducted from payments otherwise due the Contractor or be made by direct payment by the Contractor in the event the total liquidated damages due exceed said deductions.

108.09 Schedule of Liquidated Damages. The specific rates for liquidated damages are as follows:

Awarded Contract Value		***Daily Charge***	
For More Than	*To and Including*	*Work Day*	*Calendar Day*
$ 0	$ 25,000	$ 275.00	$ 195.00
25,000	50,000	300.00	210.00
50,000	100,000	395.00	270.00
100,000	500,000	710.00	500.00
500,000	1,000,000	825.00	580.00
1,000,000	2,000,000	850.00	595.00
2,000,000	5,000,000	900.00	630.00
5,000,000	10,000,000	950.00	665.00
10,000,000	15,000,000	1,500.00	1,200.00
15,000,000	20,000,000	2,500.00	2,200.00
20,000,000	25,000,000	3,500.00	3,200.00
25,000,000	30,000,000	4,500.00	4,200.00
30,000,000	35,000,000	5,500.00	5,200.00
35,000,000	over	6,500.00	6,200.00

108.10 Default of Contract. The Engineer may give notice to the Contractor and the surety, in writing, declaring the Contract to be in default under the following conditions:

A. If the Contractor fails to begin the work within the time specified in the notice to proceed.
B. If the Contractor fails to perform the work with sufficient labor, equipment, and material resources to ensure the prompt completion of the work in accordance with the approved schedule.
C. If the Contractor's work is unacceptable, or if the Contractor refuses to remove materials or perform any such work as shall be determined by the Engineer to be defective or otherwise unacceptable work.
D. If the Contractor discontinues the prosecution of the work or fails to resume the work which has been discontinued.
E. If the Contractor becomes insolvent, declares bankruptcy, commits any acts of bankruptcy or insolvency, or allows any final judgement to stand unsatisfied for a period of ten days.
F. Makes an assignment for the benefit of creditors without authorization by the Department.
G. For any other cause whatsoever, fails to carry on the work in a manner acceptable to the Department.

If the Contractor or surety, within a period of ten days after such notice, does not proceed in accordance therewith, then the Engineer will declare the Contractor to be in default on the Contract, terminate the Contractor's right to proceed with the work, and have full power and authority, without violating the Contract, to take over the prosecution of the work from the Contractor. The Department may appropriate or use the Contractor's materials at the site as may be suitable for use in the Project and may enter into an agreement with another contractor for the completion of the Contract according to the terms and provisions thereof, or use other methods as in the opinion of the Engineer will be required for the completion of the Contract.

All costs and changes incurred by the Department, as a result of the default, including the cost of completing the work under contract or remedying defective or otherwise unacceptable work, and any applicable liquidated damages or disincentives will be deducted from monies due the Contractor for completed work. If such cost exceeds the sum which would have been payable under the Contract, then the Contractor and the surety shall be liable and shall pay to the Department the balance of such costs in excess of the Contract price.

If it is determined, after termination of the Contractor's right to proceed, that the Contractor was not in default, the rights and obligations of the parties will be the same as if the termination had been issued for the convenience of the Department in accordance with Subsection 108.11. Thus, damages to which a Contractor may be entitled as a result of an improper default termination will be limited to amounts as provided for in Subsection 108.11.

108.11 Termination of Contract. The Department may, by written order to the Contractor, terminate the Contract or any portion of the Contract when such termination would be in the best interest of the Department. In the event such termination occurs without fault and for reasons beyond the control of the Contractor, all completed items as of the date of termination will be paid for at the Contract price. Payment for partially completed and eliminated work will be paid for as provided in Subsection 109.06.

Acceptable materials, obtained by the Contractor for the work, but which have not been incorporated therein, may, at the option of the Department, be purchased from the Contractor at actual cost delivered to a prescribed location, or otherwise disposed of as mutually agreed.

After receipt of notice of termination from the Department, the Contractor shall submit, within 60 days of the effective termination date, its claim for additional damages or costs not covered above or elsewhere in these Specifications. Such claim may include such cost items as reasonable idle

equipment time, mobilization efforts, uncompensated bidding and project investigation costs, overhead expenses attributable to the Project terminated, legal and accounting charges involved in claim preparation, subcontractor costs not otherwise paid for, actual idle labor costs if work is stopped in advance of the termination date, guaranteed payments for private land usage as part of original Contract, and any other cost or damage item for which the Contractor feels reimbursement should be made. The intent of negotiating this claim would be that an adjusted figure be reached with the Contractor. In no event, however, will loss of anticipated profits be considered as part of any settlement.

The Contractor agrees to make its cost records available to the extent necessary to determine the validity and amount of each item claimed.

Termination of the Contract or portion thereof shall not relieve the Contractor of its contractual responsibilities for the work completed, nor shall it relieve the surety of its obligation for and concerning any just claim arising out of the work performed.

108.12 Termination of Contractor's Responsibility. The termination of the Contractor's responsibility occurs upon the completion of the work.

SECTION 109 – MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. Work completed under the Contract will be measured by the Engineer according to the United States customary units (English units) or the modern metric system, SI (System of International Units) as designated on the Plans.

Unless stated otherwise, all material that is to be measured by weight shall be measured as follows:

A. The weight of each load shall be determined by weighing each loaded truck or other approved hauling equipment and then deducting the tare weight of the truck or hauling equipment. The tare weight shall be checked once daily, or as often as directed by the Engineer. Appropriate adjustments shall be made in the use of the tare weight as directed by the Engineer.

B. The scale platform shall be of such length and width that it will conveniently accommodate all trucks and other approved hauling equipment. The entire vehicle, including its load, must rest on the scale platform and be weighed as one unit.

C. Scales will be certified by the State sealer of weights and measures.

D. Weight tickets showing a net weight of each load of material delivered to the Project will be signed by a Department inspector.

A station when used as a definition or term of measurement will be 100 linear feet (1 km).

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures (such as manholes, utility poles, etc.) having an area of 9 square feet (1 m^2) or less. Transverse measurements for area computations will be the neat dimensions shown on the Plans.

Measure structures according to neat lines shown.

For items measured by linear foot (linear meter), such as pipe, culverts, guardrails, underdrains, etc., take measurements parallel to the base or foundation upon which such structures are placed.

The term "ton" means the short ton consisting of 2000 pounds avoirdupois (the term "metric ton" means 1000 kilograms). Weigh all material measured by weight or proportioned by weight on accurate, approved scales using competent, qualified personnel at locations designated by the Engineer. If materials are shipped by rail, the car weight may be accepted provided that only the actual weight of

materials is paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the Engineer directs, and each truck shall bear a plainly legible identification mark.

When requested by the Contractor and approved by the Engineer in writing, material specified to be measured by the cubic yard (cubic meter) may be weighed and such weights will be converted to cubic yards (cubic meters) for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

Bituminous materials will be measured by the gallon (liter).

Volumes will be measured at 60°F (16°C) or will be corrected to the volume at 60°F (16°C) using ASTM D 1250 for asphalt or ASTM D 633 for tars.

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 will be measured by the pound (kilogram).

Timber will be measured by the actual thousand feet board measure, MFBM (cubic meters) incorporated into the structure.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

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

109.02 Scope of Payment. The Contractor shall receive and accept compensation provided for in the Contract as full payment for furnishing all materials and for performing work under the Contract in a complete and acceptable manner and for all risk, loss, damage, or expense of every kind arising out of the nature of the work or the performance thereof, subject to the provisions of Subsection 107.13.

If the "Basis of Payment" clause relating to any unit price in the Contract requires that the unit price cover and be considered compensation for certain work or materials essential to the item, this same work or material will not be measured or paid for under any other pay item appearing in the Contract.

Under any Section or item included in the Contract, the Contractor shall be aware that when requirements, responsibilities, and furnishing of materials are outlined in the details and notes on the Plans and in the paragraphs preceding the "Basis of Payment" paragraph in these Specifications or Special Provisions, no interpretation shall be made that there is an exclusion from payment because reiteration is not made in the "Basis of Payment" paragraph.

Contractors receiving payments shall, within 30 days of receipt of any payment, file a statement to the Department on a form to be determined by the Department that all subcontractors furnishing labor or material have been paid the full sum due them at that stage of the Contract, except any funds withheld under the terms of the Contract as required by Chapter 8, Title 17 of the Delaware Code, Annotated Revised 1974, and as amended.

109.03 Compensation for Altered Quantities. When the accepted quantities of work vary from the quantities in the Contract schedule, the Contractor shall accept payment at the original Contract unit prices for the accepted quantities of work done. No allowance will be made for any increased cost, except as provided in Subsections 104.05, 104.06, 104.07, and 108.11.

109.04 Payment for Differing Site Conditions, Major Changes, Extra Work, and Force Account. Differing site conditions, changes, and extra work performed under Section 104 will be paid for using the following methods as appropriate:

A. Contract unit prices.

B. Unit prices agreed upon in the change order authorizing the work.

C. A lump sum amount agreed upon in the change order authorizing the work.

D. If directed by the Department, work performed on a force account basis is to be compensated in the following manner except as further provided in Subsection 105.21:

1. *Labor.* For all necessary labor and foremen in direct charge of the specific operations, whether the employer is the Contractor, subcontractor, or another, the Contractor shall receive the rate of wage (or scale) actually paid as shown in its certified payrolls for each and every hour that said labor and foremen are actually engaged in such work.

   The Contractor shall receive the actual costs paid to, or on behalf of, workers by reason of health and welfare benefits or other benefits, when such amounts are required by collective bargaining agreements or other employment contracts generally applicable to the classes of labor employed on the work.

2. *Bond, Insurance, and Tax.* For bond premiums, property damage, liability, and workers compensation insurance premiums, unemployment insurance contributions, and social security taxes on the force account work, the Contractor shall receive the actual incremental cost thereof, necessarily and directly resulting from the force account work. The Contractor shall furnish satisfactory evidence of the rate or rates paid for such bond, insurance, and tax.

3. *Materials.* The Department reserves the right to furnish such materials as it deems advisable, and the Contractor shall have no claims for costs and markup on such materials.

   Only materials furnished by the Contractor and necessarily used in the performance of the work will be paid for. The cost of such materials shall be the cost to the purchaser, whether Contractor, subcontractor, or other forces from the supplier thereof, together with transportation charges actually paid by the purchaser, except as the following are applicable:

   a. If a cash or trade discount by the actual supplier is offered or available to the purchaser, it shall be credited to the State notwithstanding the fact that such discount may not have been taken.

   b. If materials are procured by the purchaser by any method which is not a direct purchase from a direct billing by the actual supplier to such purchaser, the cost of such materials is the price paid to the actual supplier as determined by the Engineer plus the actual costs, if any, incurred in the handling of such materials.

   c. If the materials are obtained from a supply or source owned wholly or in part by the purchaser, the cost of such materials shall not exceed the price paid by the purchaser for similar materials furnished from said source on items or the current wholesale price for such materials delivered to the job site, whichever price is lower.

   d. If the cost of such materials is, in the opinion of the Engineer, excessive, then the cost of such material is deemed to be the lowest current wholesale

price at which such materials are available in the quantities concerned delivered to the Project site, less any discounts as provided in a. above.

e. If the Contractor does not furnish satisfactory evidence of the cost of such materials from the actual supplier thereof, the cost will be determined in accordance with d. above.

4. *Equipment and Plant.*

a. *Contractor-Owned Equipment and Plant.* The hourly rates for Contractor-owned equipment and plant will be determined from the applicable volume of the Rental Rate Blue Book (referred to hereafter as the "Blue Book"), published by Machinery Information Division of K-III Directory Corporation, 1735 Technology Drive, Suite 410, San Jose, CA 95110.

The Blue Book will be used in the following manner:

(1) The hourly rate will be determined by dividing the monthly rate by 176. The weekly, hourly, and daily rates will not be used.

(2) The number of hours to be paid will be the number of hours that the equipment or plant is actually used on a specific force account activity.

(3) The current revisions will be used in establishing rates. The current revision applicable to specific force account work is as of the first day of work performed on that force account work and that rate applies throughout the period the force account work is being performed.

(4) An area adjustment will be made. Equipment life adjustment will be made in accordance with the rate adjustment tables.

(5) Overtime shall be charged at the same rate indicated in (1) above.

(6) The estimated operating costs per hour will be used for each hour that the equipment or plant is in operation on the force account work. Such costs do not apply to idle time regardless of the cause of the idleness.

(7) Idle time for equipment will not be paid for, except where the equipment has been held on the Project site on a standby basis at the request of the Engineer and, but for this request, would have left the Project site. Such payment will be made at one-half the rate established in (1) and (4) above.

(8) The rates established above include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs, overhaul and maintenance of any kind, depreciation, storage, overhead, profits, insurance, and all incidentals.

(9) Operator costs are not included in this hourly rate for this equipment.

All equipment shall, in the opinion of the Engineer, be in good operating condition. Equipment used by the Contractor shall be specifically described and be of suitable size and suitable capacity required for the work to be performed. In the event the Contractor elects to use equipment of a higher rental value than that suitable for the work, payment will be made at the rate applicable to the suitable equipment. The Resident Engineer will determine the suitability of the equipment. If there

is a differential in the rate of pay of the operator of oversize or higher rate equipment, the rate paid for the operator is to be that for the suitable equipment.

In the event that a rate is not established in the Blue Book for a particular piece of equipment or plant, the Engineer will establish a rate for that piece of equipment or plant that is consistent with its cost and use in the industry.

The above provisions apply to the equipment and plant owned directly by the Contractor or by entities which are divisions, affiliates, subsidiaries, or in any other way related to the Contractor or its parent company.

b. *Rented Equipment and Plant.* In the event that the Contractor does not own a specific type of equipment and must obtain it by rental, the Contractor shall inform the Resident Engineer of the need to rent the equipment and of the rental rate for that equipment prior to using it on the work. The Contractor will be paid the actual rental rate for the equipment for the time that the equipment is actually used to accomplish the work, provided that rate is reasonable, plus the cost of moving the equipment on to and away from the job. The Contractor shall provide a copy of the paid receipt or canceled check for the rental expense incurred.

5. *Miscellaneous.* No allowance will be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.

6. *Profit.* Profit shall be computed at 5% of the following:
   a. Total material cost (bare cost not including FOB).
   b. Total direct labor cost (actual hours worked multiplied by regular hourly rate and benefits) as provided by Subsection 109.04 D.1.

7. *Overhead*. Overhead is defined to include the following:
   a. All salaries and expenses of executive officers, supervising officers, or supervising employees and all home office expenses;
   b. All clerical or stenographic employees;
   c. All charges for minor equipment, such as small tools, including shovels, picks, axes, saws, bars, sledges, lanterns, jacks, cables, pails, wrenches, and other miscellaneous supplies and services; and
   d. All drafting room accessories such as paper, tracing cloth, and blueprinting.

   Overhead costs for Force Account work shall be computed at 10% of the following:
   a. Total material cost (bare cost not including FOB).
   b. Total direct labor cost (actual hours worked multiplied by the regular hourly rate) and benefits as provided by Subsection 109.04 D.1.
   c. Total Equipment and Plant cost.
   d. Specific extraordinary overhead expenses, such as hiring of additional supervisory personnel or the use of special type of minor equipment (as defined above), which the Contractor has to purchase specifically for the Force Account, may be allowed. In such instances, the Contractor will be paid only the reasonable costs of such extraordinary overhead expenses

provided the Engineer has agreed to such costs prior to their being incurred.

8. *Subcontracting.* For administration costs in connection with approved subcontract work, the Contractor shall receive an amount equal to 5% of the total of such work completed as set forth in 1. through 4. above.

9. *Records.* The Contractor shall maintain force account records in such a manner as to provide a clear distinction between the direct costs of work paid for on a force account basis and the costs of other operations.

From the above records, the Contractor shall furnish the Engineer completed daily force account work reports for each day's work to be paid for on a force account basis. Said daily force account work reports shall be signed by the Contractor and submitted daily. The daily force account work reports shall be detailed as follows:

a. Name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman.
b. Designation, dates, daily hours, total hours, rental rate (including a copy of the Blue Book pages used), and extension for each unit of machinery and equipment.
c. Quantities of materials, prices, and extensions.
d. Transportation of materials.
e. Cost of property damage, liability, and workers compensation insurance premiums; unemployment insurance contributions; bonds; and social security tax.

Material charges shall be substantiated by valid copies of vendor's invoices. Such invoices shall be submitted with the daily force account work reports, or if not available, they shall be submitted with subsequent daily force account work reports. Should said vendor's invoices not be submitted within 60 days after the date of delivery of the material, or within 15 days after the completion, whichever occurs first, the Department reserves the right to establish the cost of such materials at the lowest current wholesale prices at which said materials are available, in the quantities concerned delivered to the location of work less any discounts provided in Subsection 109.04 D.3.a.

The Engineer will compare its records with the completed daily force account work reports furnished by the Contractor and make any necessary adjustments. When these daily force account work reports are agreed upon and signed by both parties, said reports become the basis of payment for the work performed, but do not preclude subsequent adjustment based on a later audit by the Department.

The Contractor's cost records pertaining to work paid for on a force account basis shall be open to inspection or audit by representatives of the Department as provided in Subsection 105.19 J.

109.05 Basis of Payment for Fixed Quantity Items. When indicated on the Plans or in the Special Provisions, certain items will be paid for on an estimated fixed quantity item basis. Where this occurs the method of measurement and basis of payment indicated in these Specifications for such items are deleted.

When estimated fixed quantities are indicated, the only quantities for which payment will be made are the estimated quantities as shown in the proposal at the unit prices bid.

The bidder should check the estimates and make its own appraisal of the amount of labor, equipment, or material required to complete the work in accordance with the Plans and Specifications. No allowance will be made or claims considered for any quantities used in completing the work in excess of those given in the proposal unless changes due to conditions encountered during construction become necessary and are authorized in writing by the Engineer. In such cases additions or deductions will be made to or from the proposal quantities for the actual volume or amounts charged, with payment adjusted in accordance with the bid price of the item.

If estimated fixed quantity items are deleted completely, no payment will be made.

In cases where a fixed quantity is contested by the Contractor, it shall be the responsibility of the Contractor to provide necessary measurements and computations to support a change in the quantity. If the change is verified and approved by the Engineer, payment will be adjusted in accordance with this Subsection.

In cases where it can be shown that the quantities indicated in the proposal are in error by more than 5%, additions or deductions will be made in excess of or deficient of the 5%, with payment adjusted in accordance with the bid price of the item.

109.06 Eliminated Items. Should any items contained in the Contract be found unnecessary for the completion of the work, the Engineer may, upon written order to the Contractor, eliminate the items from the Contract. The elimination of these items shall not invalidate the Contract. When the Contractor is notified of the elimination of items, the Contractor will be reimbursed for the actual work done and all actual costs incurred. Reimbursement of materials actually purchased prior to notification of the elimination of items will be paid for at the actual cost of the materials plus 15%. Such materials shall became the property of the Department. In no event will reimbursement for an eliminated item exceed the extended amount of the Contract item. Also, in no case will the Contractor be reimbursed for the loss of anticipated profit.

109.07 Partial Payment. The Engineer will once in each month make an estimate, in writing, of the total amount of work done on the Contract and the value thereof to the date of such estimate. Five percent of the value of the work done as indicated by the estimate shall be retained as security for fulfillment of the Contract until a total of 5% of the total bid price has been retained. Securities may be substituted for this retainage in accordance with Section 6919, Chapter 69, Title 29 of the Delaware Code and as amended. Payment of estimates, except final estimates, shall not exceed those shown on the proposal except those authorized by change order. No such estimates or payments shall be required to be made when in the judgment of the Engineer the work is not proceeding in accordance with the provisions of the Contract, or when in the Engineer′s judgment the total value to the work done since the last estimate amounts to less than $3,000.00. The Engineer, if it deems it expedient to do so, may cause estimates to be made more frequently than one in each month and payments thereon to be made more frequently to the Contractor.

109.08 Payment for Material. When approved by the Engineer, partial estimates may include an allowance for the value of tested and acceptable materials of a non-perishable or non-contaminative nature which have been produced or furnished in a condition ready for incorporation as a permanent part of work yet to be completed, provided the following terms and conditions are met:

A. *Request.* The request for payment allowance for properly stored materials must be in writing, accompanied by an itemized inventory statement, written consent of the surety, and documentation of prepayment for the materials.

No payment allowance will be permitted for amounts less than $25,000.00 for each material of a qualifying Contract item.

B. *Materials.* An allowance of 100% of the cost to the Contractor for materials, not to exceed 90% of the Contract item price, may be made when such material is delivered and stockpiled or stored in accordance with the requirements specified herein.

Prior to such allowance, all such material shall have been tested and found acceptable to the Engineer.

Payment shall not be allowed in excess of the quantity required for the Contract. The required quantity shall be based on the Contract bid quantities and approved revisions.

C. *Excluded Materials.* No allowance shall be made for fuels, form lumber, falsework, temporary structures, or for other materials of any kind which will not become an integral part of the finished construction.

No allowance shall be made for cement, aggregate, sand, seed, plants, fertilizer, or other perishable or contaminative items, nor for materials which, in the opinion of the Engineer, have an unacceptable shelf life, environmental, or safety restriction.

D. *Storage.* All materials shall be stored in an approved manner and in areas where damage is not likely to occur. The material stored shall be dedicated to the Project.

When it is determined impractical to store materials within the limits of the Project, the Engineer may approve the storage of materials on private property or, for structural members, in the manufacturer′s or fabricator′s yard. Requests for payment for such material stored outside the limits of the Project shall be accompanied by a release from the owner and/or tenant of such property or yard agreeing to permit the removal of the materials from the property without cost to the State.

E. *Materials Inventory.* Materials shall be available for inspection and inventory at the storage site by the Engineer or its authorized representative at all times.

F. *Materials Measurement and Payment.* The method of measurement for materials shall be in units which are easily inventoried and acceptable to the Engineer.

Payment allowance for materials shall be included in the progress estimate as a new and separate item and shall be subject to retainage provisions.

As the materials are incorporated in the Project and paid for in place, an equal percentage shall be deducted from progress estimates until 100% of the allowance has been deducted. At the conclusion of the work for which the materials are required, the cost of materials remaining in storage for which payment allowance has been made will be deducted from the progress estimate.

109.09 Retainage of Funds. Whenever liquidated damages are assessable, such damages shall be deducted from the monthly and final estimate. The payment of any current or final estimate or of any retained percentage shall in no way affect the obligation of the Contractor to repair or renew any defective parts of the construction and to be responsible for all damage due to such defects.

If at any time there is evidence of any lien or claim for which, if established, the Department might become liable, and which is chargeable to the Contractor, the Department shall have the right to retain out of any payment then due or to become due an amount sufficient to completely indemnify the Department against such lien or claim. If there should prove to be any such claim after all payments

are made, the Contractor shall refund to the Department all monies that the Department may be compelled to pay in discharging any lien made obligatory in consequence of the Contractor's neglect or default.

Upon substantial completion of the work under the Contract, the Engineer may release 60% of the amount then retained. The balance of the amount retained will be held until all reports required of the Contractor are received and final payment is authorized by the Department. The Department may, at its option, retain temporarily or permanently a smaller amount and may cause the Contractor to be paid temporarily or permanently, from time to time, such portion of the amount retained as it deems equitable.

No provision contained in these Specifications shall be construed as creating any debt, liability or obligation on the part of the State or Department to any subcontractor, supplier, or materialman.

109.10 Final Payment. The Engineer will, as soon as practicable after the completion of the Contract, make a final estimate of the work done thereunder and the value of such work, and the Department shall pay the entire sum found to be due after deducting from all previous payments all amounts to be kept and all amounts to be retained under the provisions of the Contract. All prior partial estimates and payments shall be subject to correction in the final estimates payment.

The acceptance by the Contractor of the last payment, as aforesaid, shall operate as and shall be a release to the State, the Department, the Director, and its agents from all claims of liability under the Contract, or for anything done or furnished or relating to the work under the Contract, or for any act or neglect of the State, the Department, the Director, or its agents relating to or connected with the Contract.

109.11 Source of Supply and Carrier Rates on Construction Materials. Bidders must fully inform themselves as to the source of supply of acceptable materials needed for the work and in regard to the carrier rates and transportation facilities for these materials before submitting proposals.

Inability to secure satisfactory materials from the source upon which the bid was based, or changes in carrier, or the alteration of transportation facilities for these materials during the life of the Contract, shall not constitute cause for claim for extra compensation.

109.12 Transportation Tax Exemption. All unit prices shall be based on exemption from any transportation tax for which the State is, by law, exempt on materials entering into and forming a part of the Project.

In order for the Contractors to take advantage of the exemption from payment of the tax on transportation and to have the construction materials consigned to the State, in care of itself, the Contractor shall furnish the supplier with a statement certifying that the Contractor has been authorized to claim the exemption, identifying the Contract in which the authorization was given and instructing the supplier to make the shipment involved free of tax.

109.13 Asphalt Cement Cost Adjustment. For all Sections within Division 400, payments to the Contractor will be adjusted to reflect increases or decreases in the Delaware Posted Asphalt Cement price when compared to the Project Asphalt Cement Base price, as defined in the bid proposal.

The Delaware Posted Asphalt Cement Price will be issued weekly by the Department and will be the industry posted price for Asphalt Cement, F.O.B. Philadelphia, Pennsylvania.

The Project Asphalt Cement Base price will be the anticipated Delaware Posted Asphalt Cement Price expected to be in effect at the time of receipt of bid.

All deviations of the Delaware Posted Asphalt Cement Price from the Project Asphalt Cement Base Price are eligible for cost adjustment. No minimum increase or decreases or corresponding percentages are required to qualify for cost adjustment.

Actual quantity of asphalt cement qualifying for any Asphalt Cement Cost Adjustment will be computed on the basis of weight tickets and asphalt percentage from the approved job mix formula. For Recycled Hot-Mix the asphalt percentage eligible for cost adjustment shall be only the new asphalt cement added to the mix.

There shall be no separate payment for asphalt cement. That cost shall be included in the various unit prices bid per ton (metric ton) for those bid items that contain asphalt cement.

If the Contractor exceeds the authorized allotted completion time, the price of asphalt cement on the last authorized allotted work day shall be the price used for cost adjustment during the time liquidated damages are assessed.

The Project Asphalt Cement Base Price shall be determined by the Department and shall be set forth in the Special Provisions for each project.

SECTION 110 – EROSION, SEDIMENT CONTROL, AND WATER POLLUTION

110.01 Definitions.

Clearing. The clearing of trees, brush, shrubs, downed timber, rotten wood, rubbish, and any other vegetation, except where excluded by the definition for grubbing, as well as the removal of fences and structures. See Subsection 201.01.

Disturbed Area. An area where any activity has been initiated which may result in soil erosion from water or wind or movement of sediments or pollutants into state waters or onto lands in the state, or which may result in accelerated stormwater runoff, including, but not limited to, clearing, grubbing, grading, excavating, transporting, filling, and backfilling of land.

Grubbing. Shall mean the removal from the ground of trees, stumps, roots, brush, root mat, and debris.

Phasing. Staged construction sequencing as shown on the erosion and sediment control plans and the maintenance of traffic plans.

110.02 Legal Authority. The Department is a delegated agency of the DNREC as defined in Chapter 40, Title 7 of the Delaware Code and the Delaware Sediment and Stormwater Regulations. Any project built under the Contract documents shall maintain compliance with the aforementioned law and regulations at all times throughout the life of that project. As a delegated agency, the Department may enforce compliance with the law and regulations through the Contract documents or may refer a project to the DNREC for enforcement action.

110.03 Sediment and Stormwater Permit Approval. A signature, date, and seal in the Stormwater Engineer′s block on the title sheet of the Plans indicates that the Plans were designed in conformance with the applicable State and Federal stormwater regulations and that the Sediment and Stormwater Permit is approved. All work shall be completed pursuant to the Plans.

Review and approval of the erosion, sediment control, and water pollution control plan or errors and omissions in the Plans shall not relieve the Contractor from its responsibilities for compliance with

the Delaware Sediment and Stormwater Regulations or other applicable laws or regulations and the more stringent water pollution control requirements shall apply.

110.04 Description of Work. Erosion and sediment control measures shall be applied to erodible earth material exposed by any of the Contractor's land disturbing activities on the Project. The work shall consist of the application of temporary and permanent erosion and sediment control items as provided in the Contract or ordered by the Engineer. The temporary erosion control items shall be coordinated with the permanent erosion control items specified. The items shall include, but are not limited to, the use of berms, dikes, dams, sediment basins, traps, geotextiles, stone check dams, silt fences, phased construction, special land grading methods, mats and nets, aggregates, mulches, grasses, slope drains, chemical binders, tackifiers, and other erosion and sediment control items or approved methods as designated in the Contract documents or as directed by the Engineer.

110.05 Completion of the Work. This Subsection sets forth the methods of construction operations, progress schedules, and construction phasing, staging, and sequencing for the completion of temporary or permanent erosion and sediment control work.

The Contractor shall implement the temporary and permanent erosion control items for each phase of construction as detailed in the Contract documents. Additional erosion and sediment control items may be required from time to time during the life of the Project as deemed necessary by the Engineer in order to provide continuous erosion and sediment control protection.

Before starting each phase of any land-disturbing activity, the Contractor shall make certain that all erosion and sediment control items required in that phase are installed and functional.

A. *Construction Phasing.* For Project sites in excess of 20 ac (8 ha), the construction must be phased in 20 ac (8 ha) increments. Once grading is initiated in one 20 ac (8 ha) increment, a second 20 ac (8 ha) increment may be cleared and grubbed provided the Contractor installs and maintains effective erosion and sediment control measures on both sections in such quantities and locations as deemed acceptable by the Engineer.

When balancing earthwork, such as when borrow from a cut is used as fill at a noncontiguous location distant from the cut, more than a total of 20 ac (8 ha) may be allowed to be grubbed and graded within the overall limits of the Project at any one time with prior written approval from the Engineer. In such cases, one 20 ac (8 ha) increment in cut and one 20 ac (8 ha) increment in fill may be grubbed and graded at each separate location concurrently. Examples of when this would likely occur would be on interchange construction or on a new alignment.

The Engineer may further limit the area of clearing, grubbing, stripping, and grading operations to the Contractor's capability and actual progress of keeping the finish grading, mulching, seeding, and other temporary or permanent erosion control measures current according to the approved progress schedule and construction sequence.

B. *Construction Sequence.* The Contractor shall sequence the construction to comply with the following constraints unless indicated otherwise on the Plans:

1. Implement temporary erosion and sediment control items prior to any operation which exposes soil to erosion, such as during the clearing portion and prior to the grubbing portion of each phase of construction.
2. Schedule and perform the clearing and grubbing operations so that grading operations and permanent stabilization can follow immediately thereafter. Once earthwork has begun, the operation shall be continuous from clearing and grubbing through to completion of grading and final stabilization in accordance with

Subsection 110.09 A.2. Any interruption in these operations in excess of 14 calendar days must be approved by the Engineer and shall require interim stabilization in accordance with Subsection 110.09 A.1.

3. Vegetatively stabilize bare soil areas in each phase of construction in accordance with Subsection 110.09 A.1. prior to advancing the work into the next phase of construction.
4. Vegetatively stabilize all cut and fill slopes of the highway excavation and embankment as the work progresses in height increments not to exceed 10′ (3 m) measured along the slope surface.
5. Excavate roadside ditches as early in the Project as possible to establish good drainage.
6. Vegetatively stabilize all grass ditches, swales, and medians within seven calendar days after their initial excavation.
7. Remove temporary erosion and sediment controls after final stabilization is complete in accordance with Subsection 110.09 A.2. Return land contours to original grade or as indicated on the Plans, and vegetatively stabilize any remaining bare soil areas.

110.06 Plan Changes. The Contractor shall not deviate from the Plans without prior review and approval by the Engineer and appropriate regulatory authorities. Those portions of the Plans which are normally covered by environmental permits include, but are not limited to, erosion and sediment control, stormwater management, construction sequencing, stream diversions, and site dewatering.

For plan changes initiated by the Contractor, revised construction Plans shall be submitted for review and approval by the Engineer. The revised Plans shall be prepared in accordance with current Department standards for roadway design, traffic control, erosion and sediment control, and stormwater management. Revised Plans shall also conform to all applicable Federal, State, or municipal pollution control laws, rules, or regulations. All supporting design calculations and cost analyses required by the Engineer shall accompany the submission. The number of copies required to be submitted for review shall be determined by the Engineer depending on the nature of the proposed revision.

Contractor proposed revisions to the Plans, as well as review time by the Department, will not justify a delay in the progress schedule. All costs involved in preparing plan revision documents for changes proposed by the Contractor shall be the responsibility of the Contractor.

110.07 Limits of Construction. The Contractor shall not perform any work including, but not limited to, clearing, grubbing, construction phasing, equipment storage, and material stockpiling outside the limits of construction shown on the Plans without prior approval of the Engineer.

If the Contractor should require additional lands which are not within Department rights-of-way or easements, it shall be the Contractor′s responsibility to make all arrangements with the property owners and to acquire all permits from the appropriate regulatory authorities for the use of these lands.

The Contractor shall acquire a statement signed by the property owners which releases the Department from all claims arising from the use of the property being considered. The signed statement from the property owner and copies of all permits acquired by the Contractor shall be transmitted by the Contractor to the Engineer for the Engineer′s records prior to initiating any operation on the property being considered for use.

110.08 Site Reviewer. A Site Reviewer shall be a person from the Contractor′s staff assigned to erosion and sediment control implementation and maintenance and shall be required on specific projects

as noted in the Plans. The name and DNREC certification number of each Site Reviewer so required shall be submitted to the Department at the time of bid.

110.09 Vegetative Stabilization.

A. *Interim and Final Stabilization.* An area of the work shall be considered vegetatively stabilized for erosion control if it meets the criteria in one of the following two cases:

1. *Interim Stabilization*. The seeding and mulching items, sod, or erosion and sediment control items as noted on the Plans are in place and accepted by the Engineer.
2. *Final Stabilization.* Meets the requirement for the removal of the temporary erosion controls placed during interim stabilization and complete growth of vegetation has occurred to the satisfaction of the Engineer. Complete growth of vegetation includes permanent grass reaching a height of 3″ (75 mm) over all areas seeded.

B. *Incremental Stabilization.* Side slopes, and other slopes 1:3 (vertical to horizontal) or steeper require placement of either temporary or permanent seeding and mulching as the work progresses in height increments not to exceed 10′ (3 m) measured along the slope surface.

C. *Tracking of Slopes.* During grading operations the Contractor shall track all slopes 1:3 (vertical to horizontal) or steeper to prevent gully and sheet erosion. The tracking shall be accomplished by driving cleated equipment such as a bulldozer up and down the slopes so the cleats make horizontally oriented indentations in the soil. All costs associated with tracking of slopes at regular increments shall be incidental to Section 202.

Prior to applying seeding items on slopes 1:3 (vertical to horizontal) or steeper, the Contractor shall track the slopes as described above in order to prepare a stable seedbed. All costs associated with tracking of slopes to prepare a seedbed shall be incidental to the seeding item being applied to the slope surface.

D. *Maximum Soil Exposure Times.* All erodible earth material exposed by the Contractor′s activities shall be vegetatively stabilized within the time frames specified below:

Location	***Maximum Time to Vegetatively Stabilize***
Sediment controls (berms, ditches, traps, basins, etc.)	Seven calendar days from initial construction
Areas meeting final grades	Seven calendar days from completion of grading
Areas not meeting final grades	Fourteen calendar days from ceasing work in that location

110.10 Temporarily Stockpiled Material. Erodible earth material designated on the Plans or required by the Engineer to be excavated and temporarily stockpiled for later use in the Project shall be located away from live streams and wetlands, kept within Department rights-of-way and easements, and placed only in areas deemed appropriate by the Engineer.

The Contractor shall install the erosion and sediment control items designated on the Plans or as directed by the Engineer about the base of the pile in advance of the actual stockpiling operation. Erodible earth material shall be placed in piles of neat conformations. Side slopes shall be seeded and mulched as the pile is placed in height increments of 10′ (3 m) measured along the slope surface. All remaining unstabilized surfaces shall be seeded and mulched immediately following completion of the stockpiling operation.

If the Contractor proposes to stockpile erodible earth material in areas not designated on the Plans for such use, it shall be the Contractor's responsibility to prepare and submit for approval by the Engineer erosion and sediment control plans for those proposed areas which are located within Department rights-of-way and easements. Materials shall not be stockpiled until an erosion and sediment control plan for the proposed stockpile has been approved by the Engineer.

If the Contractor proposes to stockpile erodible earth material in areas outside of Department rights-of-way and easements, it shall be the Contractor's responsibility to prepare and submit for approval a plan for the use of the proposed site to the appropriate agencies having jurisdiction. No stockpiling operation shall commence in areas outside the Department rights-of-way and easements until the Engineer has received copies of all plans approved by the appropriate regulatory agencies and received copies of statements signed by the property owners, as required under Subsection 110.07, which release the Department from any claims arising from the use of the property.

110.11 Channel and Ditch Scour Protection. Riprap or other proposed channel lining items designated on the Plans at pipe, culvert, and bridge inlets and outlets and along channel lengths shall be placed before the pipes, culverts, bridges, and channels become operational.

110.12 Sediment-Laden Runoff. Stormwater runoff from disturbed areas shall be directed to an approved sediment control measure, such as a trap or basin, prior to release to ditches, storm drain systems, streams, or surface water bodies of any type. All storm drain pipes which convey sediment-laden runoff shall discharge to a sediment trap or sediment basin prior to release from the Project limits of construction as shown on the Plans, or as directed by the Engineer.

110.13 Dewatering Operations. The Contractor shall not pump or otherwise withdraw water from below the water table at a rate exceeding 50,000 gallons (189 270 L) per day without having first obtained the necessary water allocation and well permits.

The Contractor is responsible for obtaining all permits required from the appropriate issuing authority for the withdrawal of groundwater from the Project site. Costs associated with water allocation and water well permit acquisition shall be paid by the Contractor. The Contractor shall submit copies of all permit approvals to the Engineer for the Engineer's records.

Sediment-laden dewatering discharge shall be directed to an approved sediment trapping device such as a dewatering basin, portable sediment tank, sediment trap, or sediment basin, prior to release to ditches, storm drain systems, streams, or surface water bodies of any type.

Prior to initiating a pumping operation to remove water from open excavations or temporary cofferdams, the area to be dewatered shall be allowed to rest undisturbed under quiescent conditions for a period of 12 hours in order to induce physical settling of suspended particles.

The Contractor shall attach the suction line of the pumping equipment to a flotation device, immersing the intake end no more than 6″ (150 mm) below the water surface. In this manner, water shall be "skimmed" off the surface.

Once the water level has been pumped down, further dewatering shall be accomplished in conjunction with a sump pit constructed in conformance with Department standards or as directed by the Engineer.

110.14 Clean Water Diversions. Stormwater runoff from non-disturbed areas shall be directed away from work areas using any combination of dikes, swales, and slope drains or as shown on the Plans, or as directed by the Engineer.

110.15 Stream Diversions. The Contractor shall not conduct work in a stream without having first obtained the appropriate wetland and subaqueous lands permit(s).

When work is to be conducted in the flow line of a stream, whether the stream is perennial or intermittent, the Contractor shall use any combination of dikes, swales, ditches, cofferdams, pipes, pumps, and other devices as shown on the Plans, or as directed by the Engineer to direct the stream flow around the work area.

110.16 Temporary Stream Crossings. Equipment shall not be operated in live streams without a stream diversion being installed to the satisfaction of the Engineer. Temporary bridges or other structures shall be installed if the work requires the crossing of a stream by construction equipment.

110.17 Wash Water. Water containing sediment from any construction activity on the Project such as saw cutting, milling, aggregate washing, and equipment washing and which is not regulated as a waste water under State or Federal statutes shall be discharged to a sediment trapping device and treated by filtration or settling. Sediment-laden wash water shall not be discharged directly to any stream or waterbody of any type.

110.18 Waste Water. Water containing pollutants such as raw sewage, bitumens, fuels, lubricants, paint, or other harmful materials, is strictly regulated under State and Federal statutes and as such shall not be discharged into waters of the State as defined in Chapter 60, Title 7 of the Delaware Code or into natural or manmade channels or storm drain systems leading to waters of the State.

The Contractor is responsible for obtaining all permits required from the appropriate issuing authority for the discharge of waste waters from the Project site. Costs associated with waste water permit acquisition shall be paid by the Contractor. The Contractor shall submit copies of all permit approvals to the Engineer for the Engineer′s records.

110.19 Water Pollution Violations Enforced. If a water pollution control violation exists on the Project which in the Engineer′s judgment poses a public health or safety risk, such as a fuel or chemical spill or release of raw sewage, the Engineer may refer the violation to the DNREC for immediate enforcement action. The cost of clean up shall be the sole responsibility of the Contractor if the DNREC investigation reveals the Contractor′s actions caused the violation.

110.20 Maintenance. Erosion and sediment control items shall be maintained during the construction season as well as the winter months and other times when the Project is closed down. The Contractor shall inspect the Project site immediately after each rain and repair, replace, or maintain any erosion and sediment control item promptly as needed or as directed by the Engineer. Any eroded surface shall be stabilized, and any accumulated sediment not trapped by a control measure shall be removed and disposed of in an approved stockpile area or hauled off-site. Access shall be maintained to all sediment control devices until construction phasing and stabilization allow the removal of those controls that are no longer required.

Costs associated with repairing, replacing, and maintaining the erosion and sediment control items are incidental to the initial construction of each item. Sediment removal will be paid for separately under Section 250.

110.21 Erosion and Sediment Control Reports. The Department will provide the Contractor with erosion and sediment control reports on a regular basis. The reports will itemize work required to

maintain compliance with the Contract. The Contractor shall complete the items of work listed by the completion dates indicated on the reports.

110.22 Failure to Implement and Maintain Erosion and Sediment Control Measures. Controlling erosion and sedimentation is the Contractor's responsibility under the Contract. If the Contractor fails at any time to implement and maintain the required erosion and sediment control provisions of the Contract, the Engineer will notify the Contractor, orally or in writing, to comply with the required erosion and sediment control provisions. If the Contractor fails to perform the work as directed by the Engineer, the Engineer may take the following actions in the order listed below to gain compliance with the Contract.

A. *Stop Work Order.* If the Contractor continues to fail to implement and maintain the erosion and sediment controls after oral or written direction to do so by the Engineer, or continues not to follow the approved construction phasing, sequencing, and progress schedule, the Engineer may order a "Shut-Down" of all land-disturbing activities except those necessary to bring the site into compliance with the Contract. The Engineer will establish a time frame for completion of the erosion and sediment control work.

If the unsatisfactory construction procedures and operations are not corrected promptly after the initial "Shut-Down", the Engineer may suspend the performance of other construction until all items of work on the erosion and sediment control reports are complete and accepted.

No claims for additional time or money shall be considered due to "Shut-Downs" resulting from the Contractor's failure to implement and maintain the required erosion and sediment control items or failure to follow the approved construction phasing, staging, sequencing, and progress schedule required by the Contract documents.

B. *Withhold Progress Payment.* If the Contractor fails to bring the erosion and sediment controls into compliance with the Contract documents or fails to proceed in accordance with the approved construction phasing, staging, and sequencing after oral or written direction from the Engineer to do so and after a "Shut-Down" of all land-disturbing activities, then no monthly estimate or payment will be made. No payment will be made until all items of work on the erosion and sediment control reports are complete and accepted.

C. *Deduct Cost of Work Completed By Others.* If the Contractor fails to remedy unsatisfactory conditions within the time frame established and after all land-disturbing activities have been shut down and payment has been withheld, then the Engineer may proceed with adequate forces and equipment to implement or maintain the erosion and sediment control items necessary to bring the Project into compliance with the Contract documents. The entire cost of this work for engaging an on-call contractor and administering the on-call contractor will be deducted from monies due the Contractor on the Contract.

D. *Default of Contract.* More than one "Shut-Down" for erosion and sediment control noncompliance may be considered as a failure to perform the terms of the Contract and will be grounds for finding the Contractor in default of the Contract in accordance with Subsection 108.10. If the Contractor defaults on the erosion and sediment control provisions of the Contract, the Project will be referred to the DNREC for enforcement action.

110.23 Contractor Payment. Payment will be made at the unit prices bid for the quantities of the various erosion and sediment control items provided in the Contract which are installed by the Contractor and accepted by the Engineer. Any additional work or corrections brought about by errors by the Contractor such as nonconformance with the Contract documents and the construction phasing, staging, or sequencing will be made at the Contractor's expense.

DIVISION 200 – EARTHWORK

SECTION 201 – CLEARING AND GRUBBING

201.01 Description. This work consists of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of construction unless otherwise indicated, except such objects as are designated to remain or are to be removed in accordance with other Sections of these Specifications. This work also includes the preservation from injury or defacement of all vegetation, trees, and objects designated to remain.

CONSTRUCTION METHODS.

201.02 General. The Contractor shall remove only material herein specified. If the Contractor chooses to do such work with mechanical equipment, and removes and wastes suitable embankment and topsoil material required on the Project, any suitable embankment and topsoil material removed with the cleared and grubbed material shall be replaced by the Contractor.

The Department reserves the right to require the Contractor to use a root rake if large quantities of suitable embankment and topsoil material is being wasted during the grubbing operation.

All arboriculture practices for tree care operations shall be conducted in accordance with ANSI Z133.1 as prepared by the International Society of Arboriculture.

201.03 Trees Designated to Remain. The Engineer shall designate such trees, shrubbery, and plants which are not to be removed, and the Contractor shall protect them from any damage. If any such trees, shrubbery, or plants are damaged, they shall be replaced or repaired by a certified tree surgeon. Branches of trees overhanging the roadbed shall be properly trimmed to maintain a clearance height of 20′ (6 m), unless otherwise directed. All pruning shall be performed in accordance with the International Society of Arboriculture′s Current Tree Pruning Guidelines, Publication ISBN 1-881956-07-5, and as illustrated on the Standard Construction Details.

201.04 Disposal. All materials removed by the clearing and grubbing operation shall become the property of the Contractor and shall be removed from the Project or otherwise disposed of as specified in Subsection 106.09.

201.05 Preparation of Ground Surface. Grading operations shall not be started in any area until all operations of clearing and grubbing work within the area affected have been completed. In areas where excavation is to be made, the ground shall be cleared of all living or dead trees, stumps, brush, or other objectionable material. All embedded stumps, root mats, etc., shall be removed to a depth of not less than 2′ (600 mm) below the subgrade or slope surfaces. All depressions made below the subgrade or slope surfaces by the removal of stumps or roots shall be backfilled with approved material and compacted as directed.

In areas where embankment is to be made 5′ (1.5 m) or more in depth, where depth is measured from the bottom of the fill to the subgrade, trees and stumps shall be cut off as close to the ground as is practicable, but not to exceed 6" (150 mm) above the ground surface. In the area from the toe of the embankment slope to 5′ (1.5 m) inside the embankment, all trees, stumps, roots, brush, root mat, and debris shall be removed.

In areas where embankment is to be made less than 5′ (1.5 m) in depth, all trees, stumps, roots, brush, root mat, and debris shall be removed, grubbed, or blasted from the ground, in their entirety. Root mat shall be removed to the following depths unless otherwise indicated in the Contract:

(a)	Forested areas (within tree line shown on the Plans):	2′ (600 mm)
(b)	Scrub wooded areas:	1′ (300 mm)
(c)	Field areas:	vegetation only

Clearing, grubbing, and excavation to permit installation of necessary ditches and sediment controls shall be done prior to clearing and grubbing the remainder of the Contract. Based on soil conditions encountered after completion and acceptance by the Engineer of the applicable clearing and grubbing, topsoil removal, and ditching, the Engineer may direct the Contractor to withhold all earth-moving activities for a maximum of 14 calendar days to allow for drying and solidification of the ground.

201.06 Clearing and Grubbing Limitations. The Engineer reserves the right to limit clearing and grubbing operations in order to ensure compliance with the applicable erosion and sediment control regulations.

The maximum exposed surface area of erodible soil, due to clearing and grubbing operation, shall be 20 ac (8 ha).

201.07 Clearing Outside the Limits of Construction. All trees that interfere with sight distance, either vertically or horizontally, shall be cleared from the right-of-way and easement areas. If noted in the Contract, right-of-way and easement areas shall be cleared, flush with the ground, of all trees, brush, shrubs, downed timber, rotten wood, rubbish, and other objectional debris and vegetation.

201.08 Removal of Other Obstructions. Fences and guardrail upon or within the limits of construction, shall be removed carefully by the Contractor, wholly or in part, as specified or directed, and disposed of as specified or directed, except as otherwise indicated in the Contract. Buildings and other structures shall be removed by the Department or other responsible authority unless otherwise provided. Footings, pipes, conduits, drainage inlets and grates, and similar items which are located beneath the ground surface are not to be removed under Section 201.

201.09 Method of Measurement. The quantity of clearing and grubbing will not be measured.

201.10 Basis of Payment. The quantity of clearing and grubbing will be paid for at the Contract lump sum. Price and payment will constitute full compensation for replacement of suitable material that was cleared and grubbed; for furnishing and compacting approved material to fill all depressions; for replacement or repair of damaged trees, shrubbery, or plants designated to remain; for disposal; and for all labor, equipment, tools, and incidentals required to complete the work.

All costs associated with the direction to withhold earth-moving activities will be incidental to the work.

SECTION 202 – EXCAVATION AND EMBANKMENT

202.01 Description. This work consists of the removal and final disposal of all materials taken from within the limits of construction as necessary for the preparation and construction of the roadbed, embankments, subgrades, shoulders, slopes, side ditches, approaches, intersecting roads, and private

entrances. Flexible pavement shall be removed under this Section. The removal and final disposal of materials specified under other pay items is not included in this work.

This work also consists of grading and compacting of the embankment, roadway, and shoulders; construction, shaping, and sloping of side ditches, embankment, and cut slopes; construction and maintenance of temporary edge berms, interceptor berms, and embankment slopes associated with all erosion control methods indicated in Section 261; undercutting, which is the removal of unsuitable material below the grade of a proposed subgrade or embankment foundation; salvaging and stockpiling of topsoil for re-use; backfilling of areas from which unsuitable materials have been removed; and the removal and disposal of all material not otherwise provided for, so that the Project is completed in a neat workmanlike manner.

CONSTRUCTION METHODS.

202.02 Test Rolling. Test rolling shall be performed with self-propelled, pneumatic-tired equipment, which shall be of the size, type, and weight that will reveal any soft, yielding, or spongy areas. The equipment shall be run longitudinally with less than 18" (500 mm) of unrolled area between tire strips.

If the test rolling shows the subgrade to be unstable, the Contractor shall scarify, disc, aerate, or add moisture, and recompact the subgrade to the extent necessary to achieve stability.

Acceptance of the test roll by the Engineer will be a requirement prior to placement of subsequent lifts. The test roll shall be performed with a fully loaded, ten-wheel dump truck or other equipment approved by the Engineer. The test roll shall serve to verify the stability of the lift in question, and no compaction tests will be taken until the stability of the lift is determined to be satisfactory by the Engineer.

202.03 Excavation. Excavation shall be made in accordance with these Specifications, the Plans, or as established by the Engineer. No allowance will be made for materials excavated beyond or below the lines and grades shown. All suitable material removed as excavation shall be used in the formation of embankments, shoulders, and slopes, before securing or impoting any borrow, unless specifically approved by the Engineer. No unsuitable material will be allowed in the formation of embankment. Unsuitable materials shall be deposited on slopes as directed or shall be disposed of when directed. All existing ditches and waterways, and all new or existing pipes and culverts, unless noted on the Plans to be abandoned, shall be cleaned and cleared of obstructions and shall be left in a neat and trimmed condition.

(a) *Obstructions.* The Contractor shall remove and properly dispose of pipes, drainage inlets, pole bases, conduits, and any other articles located below existing ground level.

(b) *Disposal.* All waste materials removed by the excavation operation shall become the property of the Contractor and shall be removed from the Project or otherwise disposed of as specified in Subsection 106.09.

(c) *Topsoil.* Topsoil, if present, shall be removed in its entirety from all cut sections and from fill sections where embankment heights are less than 5′ (1.5 m) when measured from bottom of fill to subgrade.

Sufficient topsoil shall be stockpiled to meet the requirements of Section 733.

For projects where excavation generates excess fill material, remaining topsoil shall be removed from the site and taken to an approved disposal area or shall be retained by the State.

For projects in which embankments are constructed, remaining topsoil shall be incorporated in the outer portions of embankment as shown in the Contract. After all

embankment needs have been met, any remaining topsoil shall be removed from the site and taken to an approved disposal area or shall be retained by the State.

Excess topsoil may be claimed by the Engineer. In such cases, the Contractor shall load State vehicles for its removal. If the State wishes to claim excess topsoil, such direction will be given to the Contractor prior to the start of earth-moving operations.

(d) *Excess Material Stockpiled for Later Use.* If ordered by the Engineer, excess material that cannot be immediately placed in fill areas shall be stockpiled at a location within the Project limits designated by the Engineer, for later use, thus requiring double handling. At the time when stockpiled excess material is to be used in fill areas or for the formation of embankments, shoulders and slopes, it shall be loaded and hauled by the Contractor and placed and compacted as specified in Subsection 202.05. The requirements of this paragraph also apply to excess materials generated from hot-mix removal, incidental concrete removal, and all construction materials which can be used for fill material.

(e) *Excess Material Generated From Other Pay Items.* If ordered by the Engineer, excess materials generated from other pay items which are suitable for embankment purposes shall be placed in fill areas. If the material being excavated can immediately be moved to fill areas for placement, it shall be placed and compacted in accordance with Subsection 202.05. If the material cannot be immediately placed in fill areas, then it shall be stockpiled, and reused at a later time according to (d) above.

(f) *Excess Material Generated by Others.* Excess material generated by others, including other Contractors or utility companies and their Contractors performing work within the Contract limits shall be separately stockpiled for later use in accordance with Subsection 202.03 (d).

202.04 Removal of Existing Pipe. All obstructions, within the limits of construction, not covered under Section 201, shall be removed as shown on the Plans, or as directed. The removal of pipe is included in this Section. All existing pipe shall be removed with reasonable care. If the removed pipe is re-usable, it will remain the property of the Department and shall be stored at a suitable location on or adjacent to the Project for transport by the Department.

Existing pipe, which is not to be removed and is no longer functional, shall be plugged with concrete block, brick, or masonry, or as otherwise directed.

202.05 Embankment. All embankments shall be formed of material meeting the requirements of Section 209, except that rock, bituminous concrete, or portland cement concrete, obtained from the excavation, may be used if placed in uniform loose layers of 24" (600 mm) or less. Any exposed rebar shall be cut and disposed of. All material which cannot be readily incorporated into a 24" (600 mm) loose layer shall be reduced in size to meet this requirement. Individual pieces of rock, bituminous concrete, or portland cement concrete shall not exceed 36" (900 mm) in any dimension. No rock, bituminous concrete, or portland cement concrete shall be placed within 5′ (1.5 m) of the top of the embankment when measured from the top surface of rock, bituminous concrete, or portland cement concrete to the bottom of the pavement structure. Embankment materials placed in pile foundation areas where piles are to be placed shall contain no rock, aggregate, broken concrete, or other material which would be retained on a 2½" (63 mm) sieve. No spongy, wet, or frozen material will be permitted in the embankment. Excessive or insufficient mixture content shall not be criteria for classifying materials as unsuitable for embankment. The Contractor shall make the necessary effort to wet or dry the mixture in order to comply with Subsection 202.05 (f).

(a) *Preparation.* Unless shown otherwise on the Plans or in the Special Provisions, where the embankment height to be constructed is less than 5′ (1.5 m), all sod, vegetation, and topsoil shall be removed from the surface upon which the embankment is to be placed, and the cleared surface shall be completely broken-up to a minimum depth of 6" (150 mm). This area shall then be recompacted. Sod not required to be removed shall be thoroughly disced before construction of embankment.

Existing treated or compacted road surfaces lying within 3′ (900 mm) of the final grade, or within the pavement structure if the subgrade is more than 3′ (900 mm) from the final grade, shall be scarified to a depth of at least 6" (150 mm), unless otherwise designated on the Plans. Scarified material shall be recompacted.

Existing paved road surfaces lying within 3′ (900 mm) of the final grade, or within the pavement structure if the subgrade is more than 3′ (900 mm) from the final grade, shall be removed, and the underlying base materials scarified to a depth of 6" (150 mm).

Existing roadway surfaces lying more than 3′ (900 mm) below the final grade, or bottom of pavement structure, shall remain in place and be treated as follows:

(1) Bituminous concrete shall be broken up to a maximum surface area of 1 ft² (0.1 m^2) and recompacted.

(2) Portland cement concrete shall be broken up to a maximum surface area of 1 yd² (0.8 m^2) with a pavement breaker or other approved equipment.

(3) Bituminous surface treated roadways lying beneath an embankment shall be scarified to a depth of 6" (150 mm) and recompacted.

(b) *Widening Existing Embankments.* Where new embankments are to be placed against existing embankments or the existing embankment is to be widened, the existing embankment shall be benched in accordance with the details shown on the Plans or as directed.

(c) *Placement.* Material shall be placed in successive layers, and each layer shall be placed in a level, uniform cross-section, not to exceed 8" (200 mm) in depth, loose measurement, unless otherwise approved by the Engineer. It shall be deposited and spread parallel to the roadway centerline, and the layers shall extend the full width of the embankment. If so required, each layer shall be disced to ensure uniform distribution of moisture and component materials. Each layer shall be properly compacted, as hereinafter specified, before starting the next layer. No embankment shall be placed on any wet, unstable, or frozen materials.

However, depending on the soil conditions encountered at proposed embankment areas, the Contractor may be directed to place the first lift of embankment to a thickness greater than 8″ (200 mm) in depth. All subsequent lifts shall be placed as specified herein.

Unless otherwise approved by the Engineer, the Contractor shall be required to test roll all lifts of soil, aggregate, or soil mixtures according to the requirements of Subsection 202.02. Any instability evidenced during the test roll shall be corrected to the satisfaction of the Engineer by discing, aerating, recompacting, removing, and replacing of material. After corrective measures have been taken, test rolls to verify the stability of the lift shall be required.

At the end of each day during which the Contractor places embankment, the Contractor shall construct edge berms, interceptor berms, and embankment slopes. Temporary slope drains shall be extended to connect to the edge and interceptor berms.

(d) *Compaction Equipment.* There shall be sufficient equipment of the proper type and weight provided to do the work of grading, leveling, and compacting promptly after depositing the material. When this equipment is inadequate for the rate of compacting, the rate of excavation or placing of embankment shall be reduced to a rate not to exceed the capacity of the grading and compacting equipment.

Compaction shall be attained by approved rollers or compactors. The use of other suitable compaction equipment may be approved for work under Section 202 provided such equipment is configured and operated so that the requirements of these Specifications are fully met.

(e) *Compaction Procedure.* Compaction or rolling shall start at the edges, progress toward the center of the embankment, and shall continue until each layer is thoroughly and uniformly compacted to the full width of the embankment and to 95% or more of the maximum density of the same soils as determined by AASHTO T 99 Method C, Modified.

The ordinary use of trucks, carryalls, scrapers, tractors, or other construction equipment may be considered as rolling, but the traffic of such hauling equipment shall be distributed over the fill in such a manner that makes use of the compaction provided by the construction equipment.

All areas of sharp depressions, trench backfills, and around culverts, bridges, and walls, inaccessible to the specified methods of compaction, shall be built in continuous horizontal layers not more than 8" (200 mm) in depth, loose measurement, and shall be thoroughly tamped and compacted to the specified density.

Properly broken rock, bituminous material, or portland cement concrete shall be compacted with a minimum of six passes of an approved roller or as otherwise directed.

(f) *Density and Moisture Control.* The determination of compliance with field compaction requirements, as specified herein, shall be in accordance with the following AASHTO test methods:

(1) AASHTO T 191, T 238, and T 239, Modified. Field density tests shall be expressed as a percentage of the maximum density made on the same soils.

(2) AASHTO T 99 Method C, Modified, for determination of maximum density and optimum moisture content.

(3) AASHTO T 224, Modified, by coarse particle correction method.

The moisture content of the soil at the time of compaction shall be within 2% of the optimum moisture content, as determined by AASHTO T 99 Method C, Modified. If the moisture content is not within 2% of optimum, the soil shall be either moistened or dried and thoroughly mixed to the proper moisture content before compaction.

No compaction or moisture tests shall be taken, unless specifically requested by the Engineer, until the stability of the lift to be tested has been approved by the Engineer.

202.06 Preparation of Subgrade. The subgrade shall be maintained in such condition that it drains. Prior to the formation of the final subgrade, or of the cutting of any section for the pavement structure in which the subbase or base is to be placed, all side ditches parallel to the centerline of the roadway shall be cut to their plan gradient and vegetatively stabilized to prevent scour and erosion. Temporary ditches permitting drainage from the cut for the pavement structure to the side ditches shall be provided at intervals as required. All facilities necessary for complete drainage of the construction area shall be provided and maintained by the Contractor. The Contractor shall provide for the control of sediment and erosion for all water drained or pumped from the subgrade in accordance with Section 110.

In no case shall vehicles be allowed to travel in a single track and form ruts in the subgrade. If any sharp irregularities are formed, the subgrade shall be scarified and recompacted.

(a) *Cut Section.* The subgrade shall be properly shaped and uniformly and thoroughly compacted, in conformity with the lines and grades shown on the Plans or as established in the field, before any subbase, base, or surfacing material is placed. The subgrade shall be free from boulders, large rocks, muck, vegetation, or other materials that would prove detrimental to the road′s stability. Depressions that develop during the rolling shall be filled with suitable material, and the subgrade shall be rolled until no depressions continue to develop.

Where excavation to the finished graded section results in a subgrade or slopes of unsuitable material, the Engineer may require the Contractor to remove the unsuitable material and backfill to the finished graded section with approved material in accordance with Section 212. The Contractor shall conduct its operations in a manner that allows the Engineer to take the necessary cross-sectional measurements before the backfill is placed.

(b) *Fill Section.* Prior to placement of any base material, the subgrade and adjacent shoulder or slope rounding earthwork shall be completed to their finished grade elevation in order to form a box to retain the base material. No base material shall be placed in a section where a box has not been created unless specifically approved by the Engineer.

202.07 Approval of Subgrades. No subbase or base materials shall be placed until the subgrade has been approved.

202.08 Haul Roads. All haul roads across State owned property or within the limits of the Contract must be proposed by the Contractor to the Engineer and approved prior to their construction. Maintenance of the haul roads includes, but is not limited to, any necessary base materials or hot-mix pavement, or both. Haul roads will not be permitted through wetland areas which fall outside the limits of the construction unless approved by the U.S. Army Corps of Engineers or the DNREC, or both, as applicable.

202.09 Dust Control. Adequate dust control must be maintained by the Contractor at all times during the earth-moving operations. Dust shall be controlled exclusively through the use of water unless otherwise indicated in the Contract documents or authorized by the Engineer.

202.10 Method of Measurement. The quantity of excavation will be measured by the cubic yard (cubic meter). The volume will be computed by the method of average end areas and will be measured by cross-sections taken at regular intervals and at breaks in grade. All excavation, except topsoil, will be measured in its original position. Topsoil will be measured in its original position or in a stockpile after excavation, at the discretion of the Engineer. Topsoil removed from fill areas may be stockpiled separately for the cross-sectioning or may be measured by cross-sectioning the area of removal before and after topsoil stripping is performed. Excess excavation generated by the Contractor that the Engineer has directed to be stockpiled for use at a later date will not be measured. Excess excavation generated by others will be measured by the cubic yard (cubic meter) in the stockpile.

Embankment will not be measured.

202.11 Basis of Payment. The quantity of excavation will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for the removal of all obstructions not covered under other Sections and the removal of all pipe within the limits of the work;

for the placement of embankments as specified under Subsection 202.05; for the disposal of all surplus material; for the preparation of subgrade and shoulders; for cleaning and clearing ditches of all obstructions; for stockpiling excess topsoil and loading excess topsoil into State vehicles; for placing and compacting material in fill areas immediately after excavating; for cross-sectioning fill material stockpiled for later usage; for test rolling all lifts of soil and correcting unstable lifts of fill including, but not limited to, furnishing and operating the loaded, ten-wheel dump truck, aerating, discing, recompacting, removing of material, and furnishing and placing replacement material; for constructing temporary ditches from the cut for the pavement structure; for utilizing excess excavation from utility company work; for constructing, maintaining, and restoring haul roads throughout the limits of the Contract; for dewatering; for controlling dust; and for all labor, equipment, tools, and incidentals required to complete the work. All excavation not included under the other Sections will be paid for under Section 202. Undercutting of unsuitable material, as defined in Section 212, will be paid for at the rate of 150% of the unit price per cubic yard (cubic meter) for Section 202 unless Section 212 is a bid item in the Contract. Test holes or test pits will be paid for as shown on the Plans, in the Special Provisions, or as directed.

Cost for stockpiling and double handling excess material as outlined in Subsection 202.03 (d) and (e) shall be incidental to Section 202. Measurement will be made only once, that being at the time of initial excavation.

Material generated and stockpiled by others as outlined in Subsection 202.03 (f) will be paid for at the Contract unit price per cubic yard (cubic meter) when it is excavated from the stockpile for use on the Project.

Embankment will not be paid for directly. It will be considered a necessary part of the work paid for as Excavation, Excavation for Structures, or Borrow, as applicable. The construction of edge berms and interceptor berms will be considered incidental to the construction of embankments or erosion control devices, as applicable.

Payment for excavating and stockpiling topsoil will be made only once, at the time of its initial excavation. Any rehandling, disposal, transporting, or other related costs will be paid under Section 733.

If topsoil is stockpiled for sectioning, the piles must be kept separate from those piles generated for cut areas. Failure to properly separate these piles will void payment for topsoil removed in fill areas.

No separate payment will be made for the construction, maintenance, and final restoration of haul roads except for bridges across wetlands as identified in the Special Provisions. No separate payment will be made for materials used for the maintenance of haul roads.

SECTION 203 – CHANNEL EXCAVATION

203.01 Description. This work consists of widening and deepening existing stream channels and waterways, reconstructing channel and stream configurations and locations, shaping and finishing channel and stream beds and banks, and backfilling of old channels and streams. This work also consists of the disposal or the approved utilization of the excavated material.

203.02 Construction Methods. Disposal areas shall be either designated by the Department or secured by the Contractor as directed. Work shall be completed in conformance with Subsections 110.15 and 110.16. Excess excavated material suitable for use in embankment or fill areas shall be utilized in accordance with Subsection 202.03 (d). Unsuitable excavated material shall be disposed of as specified in Subsection 106.09.

203.03 Method of Measurement. The quantity of channel excavation will be measured by comparison of original and final cross-sections. The volume will be computed on a cubic yard (cubic meter) basis, by the average end area method between the limits shown on the Plans. Measurement will not include material removed outside the payment limits, unless such work is authorized by the Engineer.

203.04 Basis of Payment. The quantity of channel excavation will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for excavating; for hauling, depositing, and grading of excavated materials; for shaping and finishing of channel and stream beds and banks; for backfilling of old channels and streams; for disposing of excess and unsuitable materials; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 204 – MUCK EXCAVATION

204.01 Description. This work consists of the removal and disposal of mixtures of soil and organic matter, commonly called muck. This work also consists of backfilling the area where muck is excavated.

204.02 Construction Methods. Excavation and backfilling shall be carried progressively across the area being excavated. Work shall be coordinated so the open trench between excavation and backfill areas does not exceed the working range of excavation equipment. The length of open trench completely excavated to acceptable foundation material shall be at least 20′ (6 m) at all times when backfill is being placed. Excavation shall be made to ensure the slopes remain stable until backfill has been satisfactorily placed. Any alternative procedures for excavation and backfilling must be approved in writing.

The depth to which excavation shall be carried will be determined by the Engineer as excavation proceeds. Variations from the estimated depths on the Plans are expected.

Excavation shall be accomplished by dragline or an approved alternate method. Equipment shall operate on the unexcavated soil and shall not operate on the surface of backfill unless approved. The water level in the excavation shall not be lowered by pumping unless approved. The Contractor shall conduct its operations in a manner that will allow the Engineer to determine that all unsuitable material has been removed. Muck excavation shall be conducted and protected in a manner which will prevent the entry of undesirable material into the excavated area. The Contractor is required to provide access and measuring devices to permit the Department to inspect the work and take measurements or soundings for the purpose of determining quantities for payment. The Contractor shall not place fill in an area where muck has been excavated, until the Engineer has given authorization to proceed. The Engineer will determine when additional muck excavation is required.

The Contractor shall secure approved disposal areas. No disposal shall be made within 100′ (30 m) of the right-of-way. Materials placed in disposal areas shall be graded to obtain a smooth, free draining surface. The Engineer will determine when the finished condition is proper and complete.

Excavated muck shall be considered unsuitable material. It shall be the Contractor′s responsibility to remove all unsuitable material.

204.03 Method of Measurement. The quantity of muck excavation will be measured in cubic yards (cubic meters). The volume will be measured to the limits shown on the Plans, or as directed, computed by the method of average end areas. Areas will be based on cross-sections taken of the original ground prior to muck excavation and cross-sections taken after unsuitable materials have been excavated. Allowance will not be made for excavation beyond the lines, grades, and typical cross-sections shown on the Plans established by the Engineer.

The excavation and removal of slides within the excavation will not be measured.

204.04 Basis of Payment. The quantity of muck excavation will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for excavating and satisfactorily disposing of muck, backfilling of material, and removing and disposing of obstructions and encumbrances not otherwise provided for; for securing disposal areas; for constructing necessary haul roads; for maintaining the work in a finished condition until acceptance; for furnishing water transportation for the inspection; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 205 – ROCK EXCAVATION FOR ROADWAY

205.01 Description. This work consists of bedrock and ledgerock removal for roadway that cannot be accomplished without either blasting or using rippers. This work also consists of the use or disposal of such excavated material and backfilling the excavation with suitable material.

CONSTRUCTION METHODS.

205.02 Rock Classification. All boulders and other detached stones, having a volume of 1/2 yd^3 (0.30 m^3) or more, shall be considered as rock. The classification "Rock Excavation" shall not apply to soft disintegrated rock, bituminous pavements, gravel, broken stone, or concrete pavements. These and other materials are classified as normal excavation and are included under Subsection 202.03.

205.03 Excavation and Backfilling. Rock excavation shall be made in conformity with the lines, grades, and cross-sections shown on the Plans, or as directed.

Excavated rock shall be used in forming embankments wherever the depth of the fill is sufficient to properly contain the rock in accordance with Section 202. All material from rock excavation within the limits of construction, excavated under this Section, shall be used in the formation of embankments and shoulders before using any borrow, unless otherwise approved by the Engineer. Unless otherwise specified, material classified as rock shall be excavated, within the limits of the roadbed, to a minimum depth of 6" (150 mm) but not more than 12" (300 mm) below the subgrade.

The excavation, regardless of the depth, shall be backfilled with approved material and compacted to the specifications designated on the Plans, the Special Provisions, or by the Engineer. Undrained pockets left in the surface of the rock shall be drained prior to backfilling.

All unsuitable and excess material shall be disposed of as specified in Subsection 106.09, or as directed.

205.04 Blasting. Prior to any blasting, the Department will call a blasting conference at which the Contractor shall submit for approval its blasting methods, schedule, and the required protection it will use to ensure the utmost safety during blasting operations. The Contractor shall be responsible for all damage due either directly or indirectly from the blasting operations.

When rock that is encountered in cuts requires drilling and blasting, all necessary precautions shall be exercised to preserve the rock in the finished slope in a natural undamaged condition. The surfaces shall remain reasonably straight and clean. Excessive blasting or "over shooting" will not be tolerated. Any material outside the limits shown on the Plans which becomes shattered or loosened shall be removed and replaced with approved backfill material. When the results of the blasting do not yield

a natural undamaged condition, the Contractor shall adjust its operations to obtain the required slope conditions called for on the Plans. The method of drilling and blasting shall be modified by procedures such as drilling blast holes at the inclination of the finished slope, employing delayed blasting techniques, changing the spacing of blast holes, or reducing the quantity of explosive.

When the presplitting method of excavation is specified, the excavation shall be performed in a manner that will produce a uniform plane of rupture in the rock, and will ensure that the resulting backslope face will be unaffected by subsequent blasting and excavation operations. The Contractor shall presplit the rock along rock slopes at locations, lines, and inclinations shown on the Plans, or as directed. A 100′ (30 m) test section shall be provided to establish the diameter and spacing of the drill holes and the proper blasting charge to be used in the presplitting operation. The spacing of the drill holes shall not exceed 3′ (900 mm), unless approved. Drill holes shall extend to plan grade, or shall extend in lifts of not more than 25′ (7.5 m), whichever is less. If drilled in benches, an offset will be permitted to accommodate the head of the drill. Each individual offset shall not exceed 18" (450 mm). Presplitting shall extend a minimum of 20′ (6 m) ahead of the limits of fragmentation blasting, unless otherwise directed. If the presplitting is determined to be unsatisfactory, adjustments shall be made in the spacing, diameter, and loading of the presplit holes using another 100′ (30 m) test section.

The Contractor shall schedule its operations so that all rock excavation within a distance of 100′ (30 m) from bridges or other large structures is completed to the required slope lines and depths before any structure work is started.

All loose and unstable material, breakage, and slices, even if located beyond the payment lines indicated on the Plans, shall be removed as directed, as the excavation for each vertical stage (lift) progresses.

205.05 Method of Measurement. The quantity of rock excavation for roadway will be measured in cubic yards (cubic meters). The volume of rock excavation will be measured to the limits of excavation shown on the Plans or as adjusted by the Engineer, computed by the method of average end areas. Areas shall be based on cross-sections taken before and after rock excavation. When it is impractical to measure rocks or boulders by the cross-section method, three-dimensional measurement using a pre-approved method of calculation may be used. Rock excavated from depths in excess of 12" (300 mm) below the subgrade will not be measured.

The material used for backfilling the excavated areas will be measured under the appropriate Section, within the limits established by that Section. In areas where rock was excavated to depths in excess of 12" (300 mm) below the subgrade, backfill material placed between 12" (300 mm) below the subgrade and the bottom of the excavation will not be measured.

205.06 Basis of Payment. The quantity of rock excavation for roadway will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for drilling, blasting, and presplitting; for excavating, removing, backfilling, and compacting materials within the area between the subgrade as shown on the Plans or adjusted by the Engineer and 12" (300 mm) below the subgrade; for disposing of surplus material; for draining undrained pockets in the surface of the rock; for removing shattered or loosened material and replacing it with approved backfill material; and for all labor, equipment, tools, and incidentals required to complete the work.

The material used for backfilling excavated areas will be paid for under the appropriate Section for the materials used, as long as the work is within the area between the subgrade as shown on the Plans or adjusted by the Engineer and 12" (300 mm) below the subgrade.

No payment will be made for rock excavated from depths in excess of 12" (300 mm) below the subgrade. No payment will be made for backfilling areas from the bottom of the excavation to 12" (300 mm) below the subgrade.

SECTION 206 – ROCK EXCAVATION AND BACKFILLING FOR STRUCTURES AND TRENCHES

206.01 Description. This work consists of bedrock and ledgerock removal for structures and trenches that cannot be accomplished without either blasting or using rippers. This work also consists of the use or disposal of such excavated material and backfilling the excavation with suitable material.

CONSTRUCTION METHODS.

206.02 Definitions. If rock is encountered while performing the work required under Subsection 207.02, 207.03, or 208.03, it shall be excavated as indicated in this Section, and the excavated space shall be backfilled in accordance with the requirements of either Subsection 207.05 or 208.04. All boulders or other detached stones, having a volume of 1/3 yd^3 (0.30 m^3) or more shall be classified according to Subsection 205.02.

The classification "Rock Excavation" shall not apply to soft disintegrated rock. This material is classified as normal excavation and is included under Section 207 and Section 208.

206.03 Excavation and Backfilling. Rock excavation shall be made in conformity with the lines, grades, and cross-sections shown on the Plans, or as directed by the Engineer. The Engineer may, during the period of construction, order changes in dimensions or elevations of footings as required to secure a satisfactory foundation.

Excavated rock shall be used in forming embankments wherever the depth of the fill is sufficient to properly contain the rock in accordance with Section 202. The Contractor may be permitted to use excavated rock for purposes other than embankments.

Any blasting shall conform to the requirements of Subsection 205.04. Any loose or fractured rock shall be removed as directed by the Engineer. Any material more than 12" (300 mm) below the bottom elevation of trenches and structures or more than 6" (150 mm) below the bottom elevation of gutters that becomes shattered or loosened shall be removed.

All unsuitable and excess material shall be disposed of as specified in Subsection 106.09, or as directed.

The excavation, regardless of the depth, shall be backfilled with approved material and compacted to the specifications designated on the Plans, the Special Provisions, or by the Engineer. Undrained pockets left in the surface of the rock shall be drained prior to backfilling.

206.04 Method of Measurement. The quantity of rock excavation and backfill for structures and trenches will be measured in cubic yards (cubic meters). The volume of rock excavation for trenches, gutters, and structures will be measured by the method of average end areas. Areas shall be based on cross-sections taken before and after rock excavation. The end areas of rock excavations will be measured as follows:

(a) The pipe trenches will be measured to a width not to exceed 12" (300 mm) on each side of the pipe and to a depth limit not to exceed 12" (300 mm) lower than the bottom of the

earth cushion for bedding in rock, as shown on the Plans, or as established by the Engineer.

(b) The gutters, if designated for separate payment, will be measured to a width not to exceed 18" (450 mm) on each side of the gutter and to a depth limit not to exceed 6" (150 mm) below the bottom surface of the gutter as shown on the Plans, or as established by the Engineer.

(c) The headwalls, culverts, bridges, and other structures will be measured to a width of 18" (450 mm) outside the neat lines of the structure and to a depth limit not to exceed 12" (300 mm) lower than the bottom elevation of the structure as shown on the Plans, or as established by the Engineer.

When it is impractical to measure rocks or boulders by the cross-section method, three-dimensional measurement using a pre-approved method of calculation may be used. Rock excavated from depths in excess the depth limits indicated in (a), (b), and (c) above will not be measured.

The material used for backfilling the excavated areas will be measured under the appropriate Section, within the limits established by that Section. In areas where rock was excavated to depths in excess of the depth limits indicated in (a), (b), and (c) above, backfill material placed between the bottom of the excavation and the depth limits will not be measured.

206.05 Basis of Payment. The quantity of rock excavation and backfilling for structures and trenches will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for drilling, blasting, and presplitting; for excavating, removing, backfilling, and compacting materials within the depth limits indicated in Subsection 206.04 (a), (b), and (c); for disposing of surplus material; for draining undrained pockets in the surface of the rock; for removing shattered or loosened material and replacing it with approved backfill material; and for all labor, equipment, tools, and incidentals required to complete the work.

The material used for backfilling excavated areas will be paid for under the appropriate Section of the materials used as long as the work is within the limits established by that Section.

No payment will be made for rock excavated from depths in excess of the depth limits indicated in Subsection 206.04 (a), (b), and (c). No payment will be made for backfilling areas from the bottom of the excavation to the depth limits indicated in Subsection 206.04 (a), (b), and (c).

All rock excavation performed for structures and trenches required for work in Subsections 207.03 and 208.03 will be paid for at the Contract unit price per cubic yard (cubic meter) under this Section.

SECTION 207 – EXCAVATION AND BACKFILLING FOR STRUCTURES

207.01 Description. This work consists of the excavation, removal, and replacement or disposal of all materials necessary for the construction of box and pipe culverts, pipe headwalls, bridge structures, bridge approach slabs, and other structures. This work also consists of placing and compacting backfill material; furnishing and placing of shoring, sheeting, bracing, and cofferdams; and dewatering of these areas, unless otherwise specified.

CONSTRUCTION METHODS.

207.02 Foundation Pits. Foundation pits shall be excavated to the depths shown on the Plans, or to such depth as required to ensure the stability of the structure to be erected, or as directed by the

Engineer.

207.03 Excavation. Excavation shall be sufficient in volume to place the full widths, thicknesses, and lengths of footings. Undercutting of edges, ends, corners, and other surfaces will not be permitted. If a sump area is required to keep the excavation dry during construction, it shall be outside the footing line.

All suitable materials removed during excavation shall be used, as far as practicable, in the formation of roadway embankments, or as structure backfill if it meets the requirements of Subsection 207.05. No excavated material shall be wasted without permission. Boulders, logs, structure remnants, or other obstructions shall be considered unsuitable materials. All unsuitable and excess material shall be disposed of as specified in Subsection 106.09, or as directed.

When the excavation is completed, the Engineer will make an inspection of the footing area. No concrete shall be placed until the depth and character of the foundation material are approved.

207.04 Cofferdams. All sheeting and bracing shall be carried to sufficient depth to obtain, as nearly as possible, a watertight cofferdam. The cofferdam shall have ample clearance to allow inspection of the forms for the finished structure and to provide sump areas. The forms for concrete shall not be braced against the cofferdam, unless approved.

Cofferdams shall be constructed to protect new concrete against damage from flooding. Cofferdams shall be dewatered in a manner that prevents the loss of concrete materials.

Unless otherwise approved, cofferdams and cribs, including all sheeting and bracing, shall be removed by the Contractor after the completion of the substructure. No timber shall remain in finished concrete structures. Care shall be taken to avoid disturbing or damaging the finished structure during removal operations.

The Contractor shall submit detailed layout, working drawings, and calculations sealed by a Professional Engineer registered in Delaware, showing the proposed method of cofferdam construction. These drawings shall be approved before cofferdam construction begins. Approval of the Contractor's drawings will not relieve the Contractor of any responsibility for the adequacy and safety of the cofferdam construction.

207.05 Backfilling. All backfilling of structures shall conform to the requirements of Subsection 202.05 (c), (d), and (e). Unless otherwise specified, all backfilling around and over structures shall be performed with material conforming to the requirements of Subsection 209.04, Borrow Type C. Backfill material shall be compacted to 95% or more of the maximum density according to the requirements of Subsection 202.05 (f). When backfilling next to bridges, culverts, or other structures, no heavy mechanical compacting equipment will be permitted over the structure until a minimum of 18" (450 mm) of cover has been placed.

Backfill adjacent to rigid frames, arches, timber structures, and other similar structures shall be brought up simultaneously at each abutment, so that no unbalanced stresses are introduced.

207.06 Method of Measurement. The quantity of excavation and backfilling for structures, excluding rock excavation, will be measured in cubic yards (cubic meters) based on field measurements. The volume will be computed by taking the difference in elevation between the existing ground surface, or the bottom of roadway excavation, or the bottom of channel excavation, whichever is lower, and the surface of the completed structure excavation at plan grade or at an approved revised plan grade.

Volume measurements will include, between the upper and lower limits defined above, the volume contained inside vertical planes located 18" (450 mm) outside of the neat line perimeter of the

vertical faces of the footing or structural unit for which the excavation is made. Borrow Type C backfill material placed outside the 18" (450 mm) vertical planes just described will not be measured. For inclined footings or unusual foundation conditions, the method of measurement will be as described in the Contract.

The Contractor shall notify the Engineer sufficiently in advance of beginning excavation for structures, so that cross-section measurements of the existing undisturbed ground may be taken. Any material removed by the Contractor before these measurements have been taken will not be measured.

207.07 Basis of Payment. The quantity of excavation and backfilling for structures will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for excavating suitable and unsuitable material; for hauling, storing, and final disposal of excavated material; for placing and compacting backfill; for placing sheeting and shoring; for constructing cribs and cofferdams; for dewatering; and for all labor, equipment, tools, and incidentals required to complete the work.

If directed to leave cofferdam bracing and sheeting in place, the actual cost of the materials left in place will be paid.

Borrow material for backfill will be paid for under Section 210.

No payment will be made for Borrow Type C backfill material placed outside vertical planes located 18" (450 mm) outside the neat line perimeter of the vertical faces of the footing or structural unit.

Additional structure excavation, directed by the Engineer to establish the foundation below the elevation indicated on the Plans, will be paid for at the Contract unit price per cubic yard (cubic meter) plus an additional percentage corresponding to the total depth lowered, as indicated in the following table:

TABLE 207-A

Depth Lowered		Additional Percent
More Than	Not Over	
0.0′ (0.0m)	5.0′ (1.5m)	25.0
5.0′ (1.5m)	8.0′ (2.5m)	60.0
8.0′ (2.5m)	10.0′ (3.0m)	100.0

The Contract unit price plus the additional percentage shown in Table 207-A shall be accepted by the Contractor as full compensation as defined in this Subsection for excavating to depths below those shown on the Plans.

SECTION 208 – EXCAVATION AND BACKFILLING FOR PIPE TRENCHES

208.01 Description. This work consists of the excavation, removal, and replacement or disposal of all materials necessary for the placement of pipes.

This work also consists of placing and compacting backfill for pipe trenches.

CONSTRUCTION METHODS.

208.02 Test Holes and Test Pits. All test holes and test pits shall be excavated under this Section. They shall be dug with extreme care, using hand excavation methods where necessary.

208.03 Excavation. Unsuitable foundation material shall be removed from below the bottom of trench elevation shown on the Plans, or as directed.

When a pipe is to be placed either partially or completely in a fill, the embankment shall be compacted to an elevation of 12" (300 mm) plus the outside diameter of the pipe above the design invert of the pipe for a minimum of two pipe diameters on each side of the centerline of the pipe. The trench shall then be excavated, as specified in this Subsection.

When rock, hardpan, or other unyielding material is encountered, the trench shall be excavated as shown on the Plans and in accordance with Subsection 206.03.

208.04 Backfilling. All backfilling of pipe trenches shall conform to the requirements of Subsection 202.05 (c), except proof rolling will not be required.

For pipe trenches or utility trenches below the roadway or shoulders, trenches shall be backfilled with material conforming to the requirements of Subsection 209.04, Borrow Type C. If the existing material meets these requirements, it shall be used for pipe or utility backfill. For these areas, backfill material shall be compacted to 95% or more of maximum density according to the requirements of Subsection 202.05 (f). For pipe trenches or utility trenches at locations other than below the roadway and shoulders, trenches shall be backfilled with material conforming to the requirements of Subsection 209.04, Borrow Type C, to a height of 12" (300 mm) above the top of the pipe or utility. The remaining depth of these pipe or utility trenches shall be backfilled with existing material. For these areas, backfill material shall be compacted to 90% or more of the maximum density according to the requirements of Subsection 202.05 (f).

Material for backfilling utility trenches shall be furnished by the Contractor. Materials shall be stockpiled at location(s) mutually agreed upon by the Contractor, the utility, and the Engineer.

The operation of backfilling utility trenches shall be performed by the utility organizations involved and shall conform to the requirements of Section 202.05 (c).

Utility companies will be required to remove all excess excavation material from the Project, unless the Engineer directs it to be utilized by the Contractor in the Project.

208.05 Method of Measurement. The quantity of excavation and backfilling for pipe trenches will be measured as the volume of excavation included between a line from the bottom of plan excavation to the bottom of the pipe at the time of pipe placement, and a normal horizontal measurement of outside pipe dimension plus 12" (300 mm) each side, unless otherwise designated on the Plans, but exclusive of rock excavation, which will be paid for under Section 206. No allowance will be made for excavation or backfill outside the limits established above. The limits of trench excavation shall extend to the exterior wall of drainage inlets and manholes. When the trench intercepts a "normal" structure, such as a headwall, culvert, etc. (where payment for structure excavation is applicable), the trench payment limit will terminate at the point where structure excavation begins [normally 18" (450 mm) outside the structure]. For pipe placement in a fill area, the trench payment limit will extend to only 12" (300 mm) above the pipe.

208.06 Basis of Payment. The quantity of excavation and backfilling for pipe trenches will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full

compensation for excavating suitable and unsuitable material from the trench within the limits specified; for hauling, storing, and final disposal of excavated material; for placing and compacting backfill; for placing sheeting and shoring; for constructing cribs; for dewatering; and all labor, equipment, tools, and incidentals required to complete the work.

Additional trench excavation, directed by the Engineer to establish the foundation below the elevation indicated on the Plans, will be paid for on the basis of the Contract unit price per cubic yard (cubic meter) plus an additional percentage corresponding to the total depth lowered, as indicated in Table 207-A. The Contract unit price plus the additional percentage shown in Table 207-A shall be accepted by the Contractor as full compensation as defined in this Subsection for excavating to depths below those designated on the Plans.

Rock excavation will be paid for under Section 206.

Borrow for backfill will be paid for under Section 210.

SECTION 209 – BORROW

209.01 Description. This work consists of furnishing and placing additional material from approved borrow areas or other approved sources when suitable material available within the right-of-way is not sufficient in quantity for construction purposes. This work also includes all clearing, grubbing, or stripping required to prepare the borrow area for cross-sectioning and excavating.

MATERIALS.

209.02 General Requirements. The uses, classifications, characteristics, and definitions of terms for borrow materials shall be in accordance with the requirements of AASHTO M 57, Modified; M 145, Modified; and M 146 and M 147, Modified.

Unless otherwise directed, all materials having the following properties shall be excluded from use:

(a) Material with a maximum dry weight less than 90lb/ft³ (1440 kg/m³).

(b) Material with a liquid limit greater than 50.

(c) Material containing frozen material, rubbish, boulders in excess of 6" (150 mm) in any direction, or organic matter such as leaves, roots, grass, or sewage.

209.03 Materials Testing. The method of testing materials shall be in accordance with the requirements of AASHTO T 88, Modified; T 89, Modified; T 90, Modified; and T 99 Method C, Modified.

209.04 Borrow Types. The following types of borrow are subject to the requirements of this Section.

(a) *Borrow Type A.* This material shall have between 95 and 100% inclusive, by dry weight, passing a 2½" (63 mm) sieve and a maximum of 35%, by dry weight, passing a No. 200 (75 µm) sieve.

(b) *Borrow Type B (Special Fill).* This material shall have 100%, by dry weight, passing a 3″ (75 mm) sieve and a maximum of 10%, by dry weight, passing a No. 200 (75 µm) sieve.

(c) *Borrow Type C (Backfill).* This material shall have between 85 and 100% inclusive, by dry weight, passing a 1" (25.0 mm) sieve and a maximum of 25%, by dry weight, passing a No. 200 (75 µm) sieve.

(d) *Borrow Type D (Cement Stabilization).* This material shall have 100%, by dry weight, passing a 3" (75 mm) sieve and between 8 and 30% inclusive, by dry weight, passing a No. 200 (75 µm) sieve.

(e) *Borrow Type E (Asphalt Stabilization).* This material shall have 100%, by dry weight, passing a 3" (75 mm) sieve and between 6 and 20% inclusive, by dry weight, passing a No. 200 (75 µm) sieve. This material shall be non-plastic.

(f) *Borrow Type F (Common Borrow).* This material shall meet the general requirements as specified in Subsection 209.02.

(g) *Borrow Type G (Select Borrow).* This material shall meet any of the grading requirements listed in the following table:

Table 209-A
Type G* (Select Borrow)

Sieve Designation U.S. Customary	Sieve Designation Metric	Dry Weight Percent Passing Square Mesh Sieves					
		Grading I	*Grading II*	*Grading III*	*Grading IV*	*Grading V*	*Grading VI*
2″	50 mm	100	100	95 - 100	95 - 100	95 - 100	95 - 100
1″	25.0 mm	---	75 - 95	85 - 100	85 - 100	85 - 100	85 - 100
3/8″	9.5 mm	30 - 65	40 - 75	50 - 85	60 - 100	---	---
No. 4	4.75 mm	25 - 55	30 - 60	35 - 65	50 - 85	55 - 100	70 - 100
No. 10	2.0 mm	15 - 40	20 - 45	25 - 50	40 - 70	40 - 100	55 - 100
No. 40	425 µm	8 - 20	15 - 30	15 - 30	25 - 45	20 - 50	30 - 70
No. 200	75 µm	2 - 8	5 - 20	5 - 15	5 - 20	6 - 20	8 - 25

* The fraction passing a No. 200 (75 µm) sieve shall not be greater than two-thirds of the fraction passing a No.40 (425 µm) sieve. The fraction passing a No. 40 (425 µm) sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6, when tested according to AASHTO T 89, Modified, and AASHTO T 90, Modified.

CONSTRUCTION METHODS.

209.05 Borrow Sources. The Contractor shall notify the Department's Materials and Research Section at least ten working days in advance of material being removed from any borrow source so that samples may be obtained and tested prior to use. The limits of approved material within the borrow source and the method of excavation shall be approved by the Department's Materials and Research Section. The ground surface shall be cleared and grubbed in the manner described under Section 201 and shall be stripped of all unsuitable material, as determined by the Engineer, before the excavation of any borrow. No borrow for the Contract shall be excavated within 100′ (30 m) of the right-of-way lines except with written permission from the Engineer.

The Contractor shall secure any borrow source that is tested, approved, and cross-sectioned for excavation by means of physical control. The method of control shall be based on conditions at the source, but may consist of complete or partial fencing, earth berms, guardrails, or other physical barriers. A gate, chain, cable, or other acceptable device shall be installed across the entrance to the source and secured by padlock. The key to the padlock will be retained by the Department, once the security method is approved.

The Contractor shall submit a physical control plan to the Engineer after the borrow source has been tested and approved, and the overburden removed. The physical control plan must be implemented and approved before the source is cross-sectioned. After excavation is completed, all borrow areas shall be trimmed and left in a neat condition to permit accurate measurement. Where practicable, water shall not collect or stand therein.

209.06 Source Testing. The Department will assist the Contractor in determining the quality and quantity of material from sources it may proposes to use. The Department will perform soil analysis tests on one test boring for each 500 yd^3 (400 m^3) of borrow.

209.07 Placing and Compacting. All borrow under this Section shall be placed and compacted in accordance with the requirements of Subsection 202.05. Placing of Type B hydraulic fill must be approved by the Engineer.

209.08 Utility Backfill. For utility trenches within the roadway, trenches shall be backfilled with material conforming to the requirements of Subsection 209.04, Borrow Type C. If the existing material meets these requirements, it shall be used for utility backfill. For these areas, backfill material shall be compacted to 95% or more of the maximum density according to the requirements of Subsection 202.05 (f). For utility trenches outside the roadway, trenches shall be backfilled with material conforming to the requirements of Subsection 209.04, Borrow Type C, to a height of 12" (300 mm) above the top of the utility, unless directed otherwise. The remaining depth of these utility trenches shall be backfilled with existing material, unless otherwise directed. For these areas, backfill material shall be compacted to 90% or more of the maximum density according to the requirements of Subsection 202.05 (f).

Material for backfilling utility trenches shall be furnished by the Contractor. Materials shall be stockpiled at location(s) mutually agreed upon by the Contractor, the utility, and the Engineer.

The operation of backfilling utility trenches shall be performed by the utility organizations involved and shall conform to the requirements of Subsection 202.05 (c) and (d), except proof rolling will not be required.

Utility companies will be required to remove all excess excavation material from the Project, unless the Engineer directs it to be utilized by the Contractor in the Project.

209.09 Method of Measurement. The quantity of borrow material will be measured in cubic yards (cubic meters) of approved and acceptable borrow material. The volume will be measured at the source, in its original position by cross-sections and computed by the method of average end areas, exclusive of the volume of overburden or stripping.

When requested by the Contractor and approved by the Department in writing, borrow material, which is specified to be measured in cubic yards (cubic meters), may alternatively be weighed and the weight converted to cubic yards (cubic meters). Factors for conversion from weight measurement to volumetric measurement will be determined by the Engineer and shall be agreed to by the Contractor, before the method is used.

Where the Engineer determines it to be impracticable to obtain weight-volume conversion factors for the borrow types specified, 3200 lbs of borrow will be considered equivalent to 1 yd^3 (1900 kg of borrow will be considered equivalent to 1 m^3).

Unless stated otherwise, all borrow material that is to be measured by weight shall be calculated as specified in Subsection 109.01.

209.10 Basis of Payment. The quantity of borrow will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for clearing, grubbing, stripping, securing the borrow source, excavating, hauling, placing, and compacting the borrow material and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 210 – FURNISHING BORROW FOR PIPE TRENCH, UTILITY TRENCH, AND STRUCTURE BACKFILLING

210.01 Description. This work consists of furnishing borrow for use as backfill in pipe and utility trenches, and structure excavations.

210.02 Materials. Material shall conform to the requirements of Subsection 209.04.

210.03 Method of Measurement. The quantity of borrow will be measured in cubic yards (cubic meters) in accordance with the requirements of Subsection 209.09.

210.04 Basis of Payment. The quantity of borrow will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for clearing, grubbing, stripping, excavating, and hauling material to locations as directed by the Engineer and for all labor, equipment, tools, materials, and incidentals required to complete the work. Payment for borrow furnished for work under Sections 207 and 208 will in no case exceed 1.3 times the volume determined in accordance with Subsection 207.06 or 208.05 less the volume of the structures or pipes.

SECTION 211 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS

211.01 Description. This work consists of removal, wholly or in part, and satisfactory disposal of all buildings, foundations, fences, structures, and other obstructions which are not designated or permitted to remain within the right-of-way. Not included are items which are to be removed and disposed of under other Sections of these Specifications. This work also includes the salvaging of designated materials and backfilling of resulting cavities.

211.02 Construction Methods. The Contractor shall raze, remove, and dispose of all buildings, foundations, structures, fences, and other obstructions, any portions of which are in the right-of-way, except utilities and those other structures and obstructions for which other provisions have been made.

Bridges, culverts, and other drainage structures shall not be removed until satisfactory arrangements have been made to accommodate traffic and the delivery of construction materials.

Blasting and other operations, which may damage new construction, shall be completed prior to placing the new work.

Steel and wooden bridges specified for salvage shall be carefully dismantled without unnecessary damage. Steel members shall be match-marked, unless such match marking is waived by the Engineer. All other designated salvable material shall be removed in sections or pieces which may be readily transported. All suitable material shall be stored and protected by the Contractor at specified places within the limits of construction, or as directed.

Portions of existing structures that lie within the limits of a new structure shall be removed, as necessary, to accommodate the new construction.

Unless otherwise directed, structures in streams shall be removed down to the natural stream bottom. Portions of structures outside of the stream shall be removed down to 12" (300 mm) below natural ground surface.

Basement and cavities left by structure removal shall be backfilled in accordance with Section 202 to the level of the surrounding ground.

Excess or waste material shall be disposed of as specified in Subsection 106.09.

Unless waived by the Engineer, all concrete removed, which is suitable for riprap, shall be stockpiled, as directed, for use by the Department.

All work performed under this Section must be completed before cross-sections are taken in accordance with Subsection 207.06.

211.03 Method of Measurement. When the Contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the quantity of structures and obstructions removed will not be measured. When the Contract stipulates that payment will be made for the removal of specified items on a unit basis, the quantity of structures and obstructions removed will be measured as the actual number of specified items removed.

Paid removal limits will be limited to vertical and horizontal planes 24" (600 mm) outside the neat lines of the existing footing. Areas excavated beyond these limits shall be backfilled with Type C material. Borrow and backfilling operations will not be measured.

211.04 Basis of Payment. When the Contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the quantity of structures and obstructions removed will be paid for at the Contract lump sum price. When the Contract stipulates that payment will be made for the removal of specified items on a unit basis, the quantity of structures and obstructions removed will be paid for at the Contract unit price for each specified item removed. Price and payment will constitute full compensation for removing and disposing of structures and obstructions in accordance with the Contract, including excavation incidental to their removal; for backfilling basement and cavities; for salvaging, storing, and protecting materials in the right-of-way; and for furnishing all labor, equipment, tools, and incidentals required to complete the work.

SECTION 212 – UNDERCUT EXCAVATION

212.01 Description. This work consists of excavation to correct unstable subgrades and embankment foundations and the disposal of such excavated material.

212.02 Materials. All material removed in the work of undercut excavation will be classified unsuitable and shall be disposed of, unless otherwise directed.

CONSTRUCTION METHODS.

212.03 Equipment. Equipment utilized in undercutting and backfilling operations shall be capable of removing and replacing the material within the area established by the Engineer. Equipment that will displace the underlying or adjacent material will not be permitted.

212.04 Preparation. When unstable subgrade or foundation conditions are encountered, all normal construction preparation procedures shall be performed to correct the unstable situation before

undercutting will be considered. After performing these normal preparation procedures, the Contractor shall allow sufficient time to elapse to accurately judge the success of the preparation effort. These normal construction preparation procedures shall include, but are not limited to, cutting channels and ditches in order to lower the water table, grading to prevent excessive surface water from entering the subgrade or foundation materials, performing all reasonable efforts to correct the moisture content to within specifications, and using properly sized equipment in such a way that does not overload the subgrade or foundations. Interpretation of "normal", "sufficient", and "reasonable", shall be made by the Engineer.

In lieu of following the above established preparation requirements, or following the required construction methods, or waiting over a reasonable time for the environmental conditions to improve, the Contractor may elect to replace the subgrade or foundation material as a means of correcting instability.

212.05 Undercutting. When the Engineer determines that undercutting is required, the Engineer will direct the Contractor to remove the material from within defined areas to defined depths. Prior to backfilling, additional depths of undercutting below the original defined depth may be required in some areas as directed by the Engineer.

Upon acceptance of the undercut excavation, the area shall be backfilled and compacted in accordance with Section 202, or as directed. The Contractor shall conduct undercut operations in a manner that will allow the Engineer to take necessary measurements, before any backfill is placed. No backfill material shall be placed in water unless approved.

Any area remaining unstable after backfilling shall be reworked in accordance with this Section. When such rework is required, the Contractor shall salvage and reuse as much of the previously placed backfill as possible. If the Engineer determines that an unstable subgrade or embankment foundation exists, the unstable condition within the affected limits shall be satisfactorily corrected.

212.06 Performance Requirements. The correction of an unstable condition shall result in a firm, unyielding foundation.

212.07 Method of Measurement. The quantity of undercut excavation will be measured in cubic yards (cubic meters) computed by the average end area method. When directed by the Engineer, the correction of an unstable subgrade or embankment foundation caused by in-place material not meeting the organic, gradation, density, or liquid limit requirement of Borrow Type F as described in Section 209 shall qualify for measurement as undercut excavation. The correction of instability, as directed, not remedied by normal construction procedures nor by improved environmental conditions, both given reasonable time to establish their effect, shall qualify for measurement as undercut excavation. Undercut areas that are re-excavated as directed by the Engineer and are not necessary as a result of the Contractor′s methods of operation, will also be measured. The replacement of subgrade or foundation material, when elected by the Contractor in lieu of following normal construction preparation procedures described in Subsection 212.04, will not qualify for measurement as undercut excavation.

212.08 Basis of Payment. The quantity of undercut excavation will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for performing all preparation excavation; for correcting unstable subgrade or embankment foundation caused by the Contractor′s methods, as determined by the Engineer; and for furnishing all labor, tools, equipment, and incidentals required to complete the work. However, the unit price bid for Undercut Excavation, as defined herein, shall not exceed 150% of the unit price bid per cubic yard (cubic meter) for the item

Excavation and Embankment, where such item is a bid item. Prior to award, the Department shall delete from the Contract bid price for this item any portion which exceeds the limit set forth in this paragraph.

The material used for backfilling undercut areas will be paid under applicable Sections.

No compensation will be made for the replacement of subgrade or foundation material, when elected by the Contractor in lieu of following the normal construction preparation procedures described in Subsection 212.04.

SECTIONS 213 through 249 – RESERVED

SECTION 250 – SEDIMENT REMOVAL

250.01 Description. This work consists of the excavation, hauling, and disposal of accumulated sediment from temporary sediment control items, such as sediment traps, sediment basins, silt fences, stone check dams, dewatering basins, dikes, swales, and diversions.

250.02 Construction Methods. Sediment shall be removed using any method of hand tools or mechanized equipment deemed appropriate by the Contractor and acceptable to the Engineer at each location or as required by the Contract documents.

250.03 Method of Measurement. The quantity of sediment removal will be measured in cubic yards (cubic meters) in place using averaged dimensions. Length, width, and depth dimensions will be taken at several locations of the accumulated sediment. The average measurement of each dimension will be used to compute the in place volume.

250.04 Basis of Payment. The quantity of sediment removal will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for excavating, hauling, and disposing of accumulated sediment and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 251 – SILT FENCE

251.01 Description. This work consists of furnishing, constructing, maintaining, and ultimately removing, and installing silt filter fences or reinforced silt fences as a temporary measure to control sedimentation within the limits of construction. Silt fences shall be constructed as shown on Standard Construction Detail, Silt Fence, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

251.02 General. All materials shall be approved prior to use by the Department's Materials and Research Section.

251.03 Posts. Posts shall be constructed of oak timber or steel. Posts shall be a minimum of 42" (1050 mm) long and at least 18" (450 mm) longer than the height of the silt fence.

(a) *Oak Timber Posts.* Oak timber posts shall be straight and have a minimum nominal cross-section of 2 by 2" (50 by 50 mm).

(b) *Steel Posts.* Steel posts shall be 2½" (65 mm) diameter Schedule 40 pipe or be standard steel "T" or "U" section of 1.30 lb/ft (1.98 kg/m) minimum.

251.04 Fasteners. Fasteners shall be either 5/8" (16 mm) long brass or copper staples, or 17 gage (1.37 mm) galvanized or aluminized steel tie wires long enough to securely attach the fabric to the posts.

251.05 Wire Mesh. Wire mesh shall be galvanized welded wire reinforcement 6 by 6-W 1.4 by W 1.4 (152 by 152 - MW9 by MW9).

251.06 Seed. Seed shall conform to the requirements of Section 734.

251.07 Mulch. Mulch shall conform to the requirements of Section 735.

251.08 Geotextile. Geotextile shall conform to the requirements of Section 827. It shall be a minimum of 36" (900 mm) wide.

251.09 Prefabricated Silt Fence. The Contractor shall have an option to use prefabricated silt fence provided it has been constructed with the materials specified in this Section and approved by the Engineer.

CONSTRUCTION METHODS.

251.10 Construction of Silt Fence. The Contractor shall excavate the trench along the upstream side of the post line as shown on Standard Construction Detail, Silt Fence. Posts shall be installed on the downstream edge of the trench, along the established fence line.

The geotextile shall be fastened to the upstream side of the posts. The geotextile roll ends shall be overlapped a minimum of 6" (150 mm) at post locations.

The geotextile shall be embedded in the excavated trench. The trench shall be backfilled and compacted over the geotextile to prevent water from flowing under the geotextile.

The silt fence shall not be constructed across a ditch, or swale, or area of concentrated flow. On slopes, the terminal ends of silt fence shall be turned upslope a sufficient distance to eliminate flow around the ends of the silt fence.

All geotextile damaged prior to installation, during installation, or during the life of the Contract shall be repaired or replaced to the satisfaction of the Engineer.

251.11 Construction of Reinforced Silt Fence. The Contractor shall construct the reinforced silt fence according to Subsection 251.10. The wire mesh shall be fastened to the posts so that the wire mesh is between the geotextile and the posts. The geotextile shall be fastened to the wire mesh at the required spacing.

251.12 Maintenance of Silt Fence. Throughout the Project construction period, the silt fence shall be maintained by removing trapped sediment. The Contractor shall clean the geotextile of trapped sediment by tapping the geotextile when dry. No trash shall be allowed to accumulate to the height of the fence. Any geotextile that does not function due to clogging or deterioration shall be replaced.

251.13 Sediment Removal. After every heavy rainfall, the Contractor shall check for excessive buildups of sediment which must be removed so that the silt fence can continue to function as intended. Accumulated sediment shall be removed by the Contractor when it reaches 50% of the height of the silt fence.

251.14 Removal of Silt Fence. The silt fence shall be removed when the Engineer determines that it is no longer required. The silt fence and all materials incidental to the silt fence construction shall be removed. All areas affected by the construction of the silt fence shall be restored to the original or plan contours and stabilized with seed and mulch.

251.15 Method of Measurement. The quantity of silt fence will be measured as the actual number of linear feet (linear meters) of silt fence placed and accepted. Reinforced silt fence will be measured using the same method for silt fence.

The quantity of sediment removal will be measured according to Section 250.

251.16 Basis of Payment. The quantity of silt fence and reinforced silt fence will be paid for at the Contract unit price per linear foot (linear meter) for each type of fence. Price and payment will constitute full compensation for furnishing all materials; for excavating and backfilling associated with the construction of the silt fence; for maintaining the silt fence during the Project construction period; for removing the silt fence with all related hardware after completion of the Project; for restoring the site; for seeding and mulching; and for all labor, equipment, tools and incidentals required to complete the work.

The quantity of sediment removal will be paid for according to Section 250.

No payment will be made for any replacement of or repairs to the silt fence or reinforced silt fence damaged prior to installation, during installation, or during the life of the Contract. No payment will be made for the replacement of the silt fence or reinforced silt fence due to clogging or deterioration.

SECTION 252 – INLET SEDIMENT CONTROL

252.01 Description. This work consists of furnishing, constructing, maintaining, and ultimately removing sediment control around drainage inlets and curb inlets as a temporary measure to control sedimentation within the limits of construction. Inlet sediment control shall be constructed as shown on Standard Construction Details, Drainage Inlet Sediment Control and Curb Inlet Sediment Control, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

252.02 Lumber. Lumber shall be construction grade two-by-four measuring 1½ x 3½" (38 by 89 mm) and free from warps, checks, splits, and decay.

252.03 Wire Mesh. Wire mesh shall be steel or galvanized welded wire reinforcement with openings ½ x ½" (13 by 13 mm) and wire diameter of 19 gage (1.04 mm).

252.04 Seed. Seed shall conform to the requirements of Section 734.

252.05 Mulch. Mulch shall conform to the requirements of Section 735.

252.06 Stone. Stone shall be Delaware No. 3 conforming to the requirements of Section 813.

252.07 Geotextile. Geotextile shall conform to the requirements of Section 827.

252.08 Prefabricated Sediment Control. The Contractor shall have an option to use prefabricated sediment control devices provided each has been constructed with the materials specified in this Section and approved by the Engineer. Approval will be based on satisfactory performance at field test locations chosen by the Engineer.

CONSTRUCTION METHODS.

252.09 Construction of Drainage Inlet Sediment Control. The Contractor shall excavate completely around the walls of the inlet to the required depth. The corner posts shall be driven to the required depth below the excavated depth. The two-by-four frame shall be assembled and completed using overlapped joints. The lumber frame shall be set at a top elevation that ensures that water ponded by the inlet sediment control will not create a flooding or safety hazard.

Wire mesh shall be stretched tightly around the lumber frame and fastened securely. The geotextile shall be stretched tightly over the wire mesh and shall be fastened securely to the lumber frame at the required depth. The ends of the geotextile must meet at the posts, be overlapped and folded, and then fastened to the posts. After the geotextile is fastened to the posts, the Contractor shall backfill the previously excavated trench according to Subsection 207.05.

If the inlet is not in a low point, the Contractor shall construct a sediment control earth dike in the ditch line, downstream from the inlet, as shown on Standard Construction Detail, Drainage Inlet Sediment Control. The earth dike shall conform to the requirements of Section 260.

252.10 Construction of Curb Inlet Sediment Control. The Contractor shall assemble the two-by-four weir frame using overlapped joints. The weir frame shall be securely nailed to the vertical spacers as shown on Standard Construction Detail, Curb Inlet Sediment Control.

The Contractor shall place the assembly over the grate and against the inlet throat making sure that the end vertical spacers are at least 12" (300 mm) beyond each end of the throat opening and the grate. The two-by-four anchors shall be nailed to the top of the frame at the spacer locations. The anchors shall extend across the curb and be held in place by sandbags or alternate weights.

The Contractor shall lay a continuous piece of wire mesh over the grate, against the weir frame, and extending at least 12" (300 mm) from both ends of the weir frame. The wire mesh shall be formed to the concrete gutter and against the face of the curb at both ends of the inlet.

The Contractor shall place a piece of geotextile, of the same dimension as the wire mesh, over the wire mesh and securely attach it to the weir frame. The geotextile shall be formed to the wire mesh at both sides of the inlet. Clean stone shall be placed over the geotextile and the wire mesh to prevent water from entering the inlet from under or around the geotextile.

252.11 Maintenance of Inlet Sediment Control. Throughout the Project construction period, the inlet sediment controls shall be maintained and remain functional. Maintenance shall include cleaning the geotextile of trapped sediment by tapping the geotextile when it is dry. After every rainfall, the Contractor shall inspect the inlet sediment control. The geotextile and, if applicable, the stones shall be

replaced when 50% of the voids are clogged. Any geotextile that does not function due to clogging or deterioration shall be replaced.

252.12 Sediment Removal. The Contractor shall remove all accumulated sediment from around the drainage inlet sediment control when the sediment has reached 6" (150 mm) from the top of the geotextile. When the sediment has reached 50% of the height of the curb, the Contractor shall remove all accumulated sediment from around the curb inlet sediment control.

252.13 Removal of Inlet Sediment Control. The inlet sediment control shall be removed when the Engineer determines that it is no longer required. The inlet sediment control and all materials incidental to inlet sediment control construction shall be removed and all areas affected by the inlet sediment control shall be restored. Unpaved areas shall be restored to the original or plan contours and, if applicable, stabilized with seed and mulch.

252.14 Method of Measurement. The quantity of drainage inlet sediment controls will be measured as the actual number of drainage inlets for which sediment control is placed and accepted. The quantity of curb inlet sediment controls will be measured as the actual number of curb inlets for which sediment control is placed and accepted.

The quantity of sediment removal will be measured according to Section 250.

252.15 Basis of Payment. The quantity of drainage inlet sediment controls will be paid for at the Contract unit price for each. The quantity of curb inlet sediment controls will be paid for at the Contract unit price for each. Price and payment will constitute full compensation for furnishing and installing all required materials, including lumber, wire mesh, geotextile, and stone; for excavating and backfilling; for maintaining the inlet sediment controls, including replacing the geotextile and stone; for removing the sediment controls and all incidental materials; for restoring the site; for seeding and mulching; and for all labor, tools, equipment, and incidentals required to complete the work.

The quantity of sediment removal will be paid for according to Section 250.

SECTION 253 – RESERVED

SECTION 254 – STONE CHECK DAM

254.01 Description. This work consists of constructing, maintaining, and ultimately removing small stone check dams across a swale, channel, or any type of ditch as a temporary measure to reduce the velocity of concentrated flows, thereby reducing erosion of the swale, channel, or ditch. Stone check dams shall be constructed as shown on Standard Construction Detail, Stone Check Dam, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

254.02 Riprap. Riprap shall be R-4 conforming to the requirements of Section 712 with the exception that geotextile will not be required to be placed under the riprap.

254.03 Seed. Seed shall conform to the requirements of Section 734.

254.04 Mulch. Mulch shall conform to the requirements of Section 735.

CONSTRUCTION METHODS.

254.05 Construction of Stone Check Dam. The stone check dam shall be constructed in reasonably straight sections of the swale or channel. The Contractor shall place the riprap so that it completely covers the width of the channel. The top of the stone check dam shall be constructed so that the center is lower than the outer edges, forming a spillway across which the water can flow as shown on Standard Construction Detail, Stone Check Dam.

254.06 Maintenance of Stone Check Dam. After each rainfall, the Contractor shall inspect the stone check dam for sediment accumulation or washout. The Contractor shall replace the riprap whenever washout, construction traffic damage, or silt accumulation among the riprap occurs and whenever the stone check dam ceases to function as intended.

254.07 Sediment Removal. Sediment shall be removed from behind the check dams when it has accumulated to one-half of the original height of the stone check dam at the spillway.

254.08 Removal of Stone Check Dam. Temporary stone check dams shall be removed only when directed by the Engineer. If stone check dams are used in grass-lined swales or channels which are mowed, the Contractor shall ensure that all riprap is removed when the stone check dam is removed. In temporary swales and channels, check dams should be removed and the ditch filled in when it is no longer needed. In permanent swales or channels, check dams may be removed when a permanent non-erodible lining can be installed. In the case of grass-lined ditches, check dams may be removed when the grass has matured sufficiently to protect the swale or channel. The area beneath the check dams should be seeded and mulched immediately after the check dams are removed.

254.09 Method of Measurement. The quantity of stone check dams will be measured as the actual number of tons (metric tons) of riprap placed and accepted.

The quantity of sediment removal will be measured according to Section 250.

254.10 Basis of Payment. The quantity of stone check dams will be paid for at the Contract unit price per ton (metric ton). Price and payment will constitute full compensation for furnishing and placing all material; for maintaining the stone check dam; for removing stone check dams; for restoring the site; for seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of sediment removal will be paid for according to Section 250.

No payment will be made for any replacement of riprap during the Project construction period.

SECTION 255 – SEDIMENT TRAP

255.01 Description. This work consists of constructing, maintaining, and ultimately removing sediment traps as a temporary measure to intercept sediment-laden runoff and to retain the sediment. Sediment traps shall be constructed as shown on Standard Construction Detail, Sediment Trap, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

255.02 Seed. Seed shall conform to the requirements of Section 734.

255.03. Mulch. Mulch shall conform to the requirements of Section 735.

CONSTRUCTION METHODS.

255.04 Construction of Sediment Trap. The Contractor shall construct sediment traps by excavating to the dimensions and elevations indicated on the Plans and Standard Construction Detail, Sediment Trap. Upon completion of the initial excavation for the trap, the side slopes shall be stabilized with seed and straw mulch or by using a method approved by the Engineer. The Engineer will approve the utilization and disposal of all excavated materials.

If any sediment trap conflicts with the placement of permanent drainage pipes or ditch lines, the Contractor shall first excavate the sediment trap to the dimensions and elevations shown on the Plans. Then, when the sediment trap is no longer needed, the proposed pipes and/or ditches shall be placed.

Sediment traps shall not be excavated in excess of 4′ (1.2 m) deep. Sediment traps having proposed bottom elevations greater than 4′ (1.2 m) lower than the original grade shall be excavated in stages concurrent with the roadway excavation.

255.05 Maintenance of Sediment Trap. Throughout the phases of construction that require erosion and sediment control, the Contractor shall maintain the sediment trap to the original dimensions and function of the sediment trap. Immediately after every rainfall, the Contractor shall inspect the sediment trap and make repairs as needed.

255.06 Sediment Removal. When sediment has accumulated to one-half the design depth of the trap, the sediment shall be removed and the trap restored to its plan dimensions and elevations. The Contractor shall clearly mark the cleanout elevation on a stake driven into the ground at the bottom of the trap. Sediment removed from the trap shall be disposed of in a manner suitable to the Engineer.

255.07 Removal of Sediment Trap. After all areas draining to the trap are permanently stabilized and the Engineer has approved its removal, the sediment trap shall be backfilled and the area restored to the original or plan contours and stabilized with seed and mulch.

255.08 Method of Measurement. The quantity of sediment traps will be measured as the actual number of cubic yards (cubic meters) of material excavated to construct the sediment traps. The volume of excavated material will be computed from the actual dimensions and elevations of the sediment traps constructed as shown on the Plans.

The quantity of sediment removal will be measured according to Section 250.

255.09 Basis of Payment. The quantity of sediment traps will be paid for at the Contract unit price per cubic yard (cubic meter) of excavated material. Price and payment will constitute full compensation for excavating and backfilling; for removing the sediment traps; for restoring the site; for seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work. Sediment trap outlet devices will be paid for separately under the appropriate item for the type of outlet device required.

The quantity of sediment removal will be paid for according to Section 250.

SECTION 256 – RISER PIPE ASSEMBLY FOR SEDIMENT TRAP

256.01 Description. This work consists of constructing, maintaining, and ultimately removing sediment trap outlets using outfall pipes, riser pipes, and trash hoods as shown on Standard Construction Detail, Riser Pipe Assembly For Sediment Trap, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

256.02 Wire Mesh. Wire mesh shall be steel or galvanized welded wire reinforcement with openings ¼ by ¼" (6 by 6 mm) and wire diameter of 23 gage (655 µm).

256.03 Metal Base Plate. Metal base plate shall have a minimum thickness of ¼" (6 mm). The length and width of the plate shall be equal to the diameter of the riser pipe plus 24" (600 mm).

256.04 Trash Hood. Trash hood shall conform to the trash hood detail as shown on Standard Construction Detail, Riser Pipe Assembly for Sediment Trap Outlet.

256.05 Pipe. Pipe shall be constructed of corrugated metal for both the perforated riser pipe and the non-perforated outfall pipe and shall conform to the requirements of Section 614.

256.06 Riprap. Riprap shall be R-4 conforming to the requirements of Section 712.

256.07 Stone. Stone shall be Delaware No. 57 conforming to the requirements of Section 813.

256.08 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

256.09 Construction of the Riser Pipe Assembly. The Contractor shall install the riser pipe assembly for sediment trap in reasonably close conformity with the lines and grades shown on the Plans. The subgrade shall be smooth and firm. The Contractor shall remove any protruding objects and fill any voids in the subgrade that may affect proper placement of the assembly. The outfall pipe shall be bedded according to Section 614.

A pipe stub shall be welded to the riser pipe to make up the riser pipe assembly. The riser pipe assembly shall be welded to the base plate. All welds shall be continuous to form watertight connections and shall be performed according to the requirements of Section 605. The outfall pipe shall be attached to the riser pipe assembly pipe stub using a banded, gasketed connection which shall be made watertight. The riser pipe shall be wrapped first with the wire mesh and then with the geotextile. The geotextile shall extend a minimum of 6" (150 mm) above the highest perforation and 6" (150 mm) below the lowest perforation. Where the ends of the geotextile come together, the ends shall be overlapped and folded. The wire mesh and the geotextile shall be securely fastened to the riser pipe at the top, center, and bottom of the cloth by bands secured around the riser pipe. The top of the riser pipe shall not be covered with geotextile.

As shown on Standard Construction Detail, Riser Pipe Assembly for Sediment Trap, the Contractor shall place stone around the riser pipe assembly and a 10′ (3 m) long section of riprap at the

end of the outfall pipe. The width of the riprap section shall be a minimum of 1.5 times the diameter of the outfall pipe or 24″ (600 mm), whichever is greater. The riprap shall be placed to a minimum depth of 14" (360 mm).

256.10 Maintenance of Riser Pipe Assembly. Throughout the Project construction period, the Contractor shall maintain the assembly by replacing any clogged geotextile and cleaning any clogged pipe and stone.

256.11 Removal of Riser Pipe Assembly. At the end of the Project construction period or when directed by the Engineer, the Contractor shall remove the riser pipe assembly and all materials incidental to the construction of the riser pipe assembly. All areas affected by the construction of the riser pipe assembly shall be restored to the original or plan contours and stabilized with seed and mulch.

256.12 Method of Measurement. The quantity of riser pipe assembly for sediment trap will be measured as the actual number of each placed and accepted.

256.13 Basis of Payment. The quantity of riser pipe assembly for sediment trap will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing and placing all materials; for excavating and backfilling around the riser pipe assembly; for welding; for maintaining the riser pipe assembly, including replacing clogged geotextile; for cleaning clogged pipe and stone; for removing the riser pipe assembly; for restoring the site; for seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of clearing and grubbing required for the riser pipe assembly for sediment trap construction will be paid for according to Section 201.

SECTION 257 – RIPRAP DITCH

257.01 Description. This work consists of constructing and maintaining trapezoidal riprap ditches with supporting toe walls to convey concentrated flow without damage from erosion and where grassed ditches would be inadequate due to a high flow velocity. Riprap ditches shall be constructed as shown on Standard Construction Detail, Riprap Ditch, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

257.02 Pins. Pins shall be steel, 18" (450 mm) long, 3/16" (4.7 mm) in diameter, and have a head or steel washer that is 1½" (38 mm) in diameter.

257.03 Riprap. Riprap shall be the type indicated on the Plans and shall conform to the requirements of Section 712.

257.04 Seed. Seed shall conform to the requirements of Section 734.

257.05 Mulch. Mulch shall conform to the requirements of Section 735.

257.06 Stone. Stone for bedding shall be Delaware No. 57 conforming to the requirements of Section 813.

257.07 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

257.08 Construction of Riprap Ditch. The Contractor shall excavate the riprap ditch according to the dimensions shown on the Plans. All debris shall be removed from the ditch. The ditch sides and bottom shall be smooth so that the geotextile rests flush with the ditch at all points of contact. The width of the geotextile shall be sufficient to cover the total width of the ditch and completely line the toe walls without any longitudinal joints. The geotextile shall be placed flat, loose, and without wrinkles against all surfaces. The geotextile shall be secured in place with pins as shown on the Standard Construction Details.

After placement of the geotextile and pins on the ditch banks, stone bedding, if required, and riprap in the ditch, the Contractor shall backfill, grade, compact, and restore the ditch banks and any other area affected by the construction of the riprap ditch to the original or plan contours. The restored areas shall be stabilized with seed and mulch.

The Contractor shall not perform any grading of the ditch after placement of the riprap.

257.09 Maintenance of Riprap Ditch. Throughout the Project construction period, the Contractor shall maintain the original dimensions and function of the riprap ditch.

257.10 Method of Measurement. The quantity of riprap ditch will be measured as the actual number of cubic yards (cubic meters) of riprap ditch excavated and accepted. The quantity of riprap will be measured as the actual number of tons (metric tons) placed and accepted. The quantity of stone will be measured as the actual number of tons (metric tons) placed and accepted.

257.11 Basis of Payment. The quantity of riprap ditch will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for furnishing and placing all material, except for riprap and, if required, stone bedding; for excavating the riprap ditch; for restoring the ditch banks and any area affected by the construction of the riprap ditch, including backfilling, compacting, grading, seeding, and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of riprap will be paid for according to Section 712. The quantity of stone bedding will be paid for according to instructions in the Special Provisions.

SECTION 258 – TEMPORARY SWALE

258.01 Description. This work consists of constructing, maintaining, and ultimately removing six temporary swales Types A-1, A-2, A-3, B-1, B-2, and B-3 as a temporary measure to prevent clean runoff from entering disturbed areas by intercepting and diverting the runoff to a stabilized outlet or to intercept sediment-laden runoff and divert it to a sediment trapping device. The types of temporary swales shall be constructed as shown on Standard Construction Detail, Temporary Swale, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

258.02 Seed. Seed shall conform to the requirements of Section 734.

258.03 Mulch. Mulch shall be straw and conform to the requirements of Section 735.

258.04 Erosion Control Blanket. Erosion control blanket shall conform to the requirements of Subsection 735.02 (c).

CONSTRUCTION METHODS.

258.05 Construction of Temporary Swale. The Contractor shall construct the temporary swale based upon the type of swale indicated on the Plans. The temporary swale shall be graded to drain. With approval from the Engineer, the location of the temporary swale may be adjusted to meet field conditions and use the most suitable outlet.

The Contractor shall remove and dispose of all brush, stumps, obstructions, and other materials that interfere with the functioning of the swale. The Engineer will approve the removal of any trees that interfere with the functioning of the swale. The swale shall be free of bank projections or other irregularities which may impede the normal flow within the swale. The Contractor shall backfill any depressions or voids in the swale. Backfilled areas shall be compacted with earth moving equipment or tamps.

The Contractor shall place all previously excavated material in areas approved by the Engineer and where the material does not interfere with the functioning of the swale or downstream traps.

258.06 Stabilization of Temporary Swale. Within seven days of the start of construction on the temporary swale, the Contractor shall stabilize all areas affected by the temporary swale with seed and straw mulch. If the operation of the temporary swale is required immediately as a clean water diversion, the Contractor shall stabilize the swale prior to the temporary swale becoming operational using a geotextile liner in accordance with Standard Construction Detail, Geotextile-Lined Channel Diversion.

The Contractor shall place erosion control blankets as shown on Standard Construction Detail, Erosion Control Blanket, and according to Section 735.

258.07 Temporary Swale Drainage. The temporary swale shall have uninterrupted, positive drainage to an outlet. The outlet shall function with a minimum of erosion and reduce runoff velocity prior to discharge.

Diverted runoff from an undisturbed area shall outlet directly into an undisturbed stabilized area at non-erosive velocity. Diverted runoff from a disturbed area shall outlet into a sediment trapping device.

258.08 Maintenance of Temporary Swale. Throughout the Project construction period, the Contractor shall maintain the temporary swale to the original dimensions and function of the temporary swale.

258.09 Sediment Removal. After each rainfall, the Contractor shall check for excessive buildups of sediment which must be removed so that the temporary swale continues to function as intended. The Contractor shall remove all accumulated sediment when it reaches 50% of the height of the swale or when the accumulated sediment impedes drainage of the temporary swale, whichever comes first.

258.10 Removal of Temporary Swale. The temporary swale shall be removed at the end of the construction period or when directed by the Engineer. The Contractor shall not remove a temporary swale which collects runoff from disturbed areas until the disturbed areas are stabilized. The temporary swale and all materials incidental to the temporary swale construction shall be removed. All areas affected by the construction of the temporary swale shall be restored to the original or plan contours and stabilized with seed and mulch.

258.11 Method of Measurement. The quantity of temporary swale Type A-1 will be measured as the actual number of linear feet (linear meters) of temporary swale excavated and accepted. Temporary swale Types A-2, A-3, B-1, B-2, and B-3 will be measured using the same method for measuring temporary swale Type A-1.

The quantity of sediment removal will be measured according to Section 250.

258.12 Basis of Payment. The quantity of temporary swale Types A-1, A-2, A-3, B-1, B-2, and B-3 will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for furnishing and placing all materials; for maintaining the temporary swale; for removing all materials incidental to the temporary swale; for excavating and backfilling; for restoring the site; for seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of clearing and grubbing required for the temporary swale construction will be paid for according to Section 201. The quantity of sediment removal will be paid for according to Section 250.

SECTION 259 – PERIMETER DIKE/SWALE

259.01 Description. This work consists of constructing, maintaining, and ultimately removing perimeter dike/swales Types A-1, A-2, and A-3 as a temporary measure to prevent clean runoff from entering disturbed areas by intercepting and diverting it to a stabilized outlet or to intercept sediment-laden runoff and divert it to a sediment trapping device. The types of perimeter dike/swales shall be constructed as shown on Standard Construction Detail, Perimeter Dike/Swale, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

259.02 Riprap. Riprap shall be R-4 conforming to the requirements of Section 712.

259.03 Seed. Seed shall conform to the requirements of Section 734.

259.04 Mulch. Mulch shall be straw conforming to the requirements of Section 735.

259.05 Erosion Control Blanket. Erosion control blanket shall conform to the requirements of Subsection 735.02 (c).

259.06 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

259.07 Construction of Perimeter Dike/Swale. The length of the perimeter dike/swale shall be as indicated on the Plans. With approval from the Engineer, the location of the perimeter dike/swale may be adjusted to meet field conditions and use the most suitable outlet. The swale shall be shaped to the line, grade, and cross-section indicated on the Plans and Standard Construction Detail, Perimeter Dike/Swale. The Contractor shall construct the dike from the material excavated during the construction of the swale.

259.08 Stabilization of Perimeter Dike/Swale. Within seven days of the start of construction on the perimeter dike/swale, the Contractor shall stabilize the dike and all areas affected by the construction of the perimeter dike/swale with seed and mulch.

If riprap is required for swale stabilization, the Contractor shall place a minimum of 14" (350 mm) of riprap over the geotextile. If erosion control blanket is required for swale stabilization, the Contractor shall place the erosion control blanket as shown on Standard Construction Detail, Erosion Control Blanket, and according to Section 735.

259.09 Perimeter Dike/Swale Drainage. The perimeter dike/swale shall have uninterrupted, positive drainage to an outlet. The outlet shall function with a minimum of erosion.

Diverted runoff from an undisturbed area shall outlet directly into an undisturbed stabilized area at non-erosive velocity. Diverted runoff from a disturbed area shall outlet into a sediment trapping device.

259.10 Maintenance of Perimeter Dike/Swale. Throughout the Project construction period, the Contractor shall maintain the perimeter dike/swale to the original dimensions and function of the swale and of the dike.

259.11 Sediment Removal. After each rainfall, the Contractor shall check for excessive buildup of sediment that must be removed so that the perimeter dike/swale continues to function as intended. The Contractor shall remove all accumulated sediment when it reaches 50% of the height of the swale.

259.12 Removal of Perimeter Dike/Swale. The perimeter dike/swale and all materials incidental to the perimeter dike/swale construction shall be removed at the end of the construction period or when directed by the Engineer. All areas affected by the construction of the perimeter dike/swale shall be restored to the original or plan contours and stabilized with seed and mulch.

259.13 Method of Measurement. The quantity of perimeter dike/swale Type A-1 will be measured as the actual number of linear feet (linear meters)of perimeter dike/swale constructed and accepted. Perimeter dike/swale Types A-2 and A-3 will be measured using the same method for measuring perimeter dike/swale Type A-1.

The quantity of sediment removal will be measured according to Section 250.

259.14 Basis of Payment. The quantity of perimeter dike/swale Types A-1, A-2, and A-3 will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for furnishing all materials; for excavating and placing the materials; for maintaining the perimeter dike/swale; for removing the perimeter dike/swale and all incidental materials; for restoring

the area; for seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of sediment removal will be paid for according to Section 250.

SECTION 260 – EARTH DIKE

260.01 Description. This work consists of constructing, maintaining, and ultimately removing temporary earth dikes Types A-1, A-2, A-3, B-1, B-2, and B-3 of compacted soil as a temporary measure to prevent clean runoff from entering disturbed areas by intercepting and diverting it to a stabilized outlet or to intercept sediment-laden runoff and divert it to a sediment trapping device. The types of earth dikes shall be constructed as shown on Standard Construction Detail, Earth Dike, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

260.02 General. The Engineer may approve the substitution of any material required in the construction of the earth dike.

260.03 Borrow. Borrow shall be Type F conforming to the requirements of Section 209.

260.04 Riprap. Riprap shall be R-4 conforming to the requirements of Section 712.

260.05 Seed. Seed shall conform to the requirements of Section 734.

260.06 Mulch. Mulch shall be straw conforming to the requirements of Section 735.

260.07 Erosion Control Blanket. Erosion control blanket shall conform to the requirements of Subsection 735.02 (c).

260.08 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

260.09 Construction of Earth Dike. With approval from the Engineer, the location of the earth dike may be adjusted to ensure a stabilized outfall. The earth dike shall be compacted by earth-moving equipment or tamps. The Contractor shall perform any excavation required to provide the required flow width at the flow depth.

260.10 Stabilization of Earth Dike. Within seven days of the start of construction on the earth dike or prior to the earth dike becoming operational as a clean water diversion dike or a sediment control dike, whichever is sooner, the Contractor shall stabilize the earth dike. The side of the earth dike that does not accommodate water flow shall be stabilized with seed and straw mulch. The side of the earth dike that accommodates the water flow shall be stabilized as shown on Standard Construction Detail, Earth Dike.

If the required stabilization is riprap, the Contractor shall place the riprap over geotextile at the thickness required for the specified size riprap as shown on Standard Construction Detail, Riprap Ditch.

If the required stabilization is erosion control blanket, the Contractor shall place the erosion control blanket as shown on Standard Construction Detail, Erosion Control Blanket Applications, and according to Section 735.

260.11 Earth Dike Drainage. The earth dike shall have positive drainage to an outlet. The outlet shall function with a minimum of erosion.

Diverted runoff from an undisturbed area shall outlet into an undisturbed stabilized area at non-erosive velocity. Diverted runoff from a disturbed area shall outlet into a sediment trapping device.

260.12 Maintenance of Earth Dike. Throughout the Project construction period, the Contractor shall maintain the earth dike to the original dimensions and function of the channel and the dike.

260.13 Sediment Removal. After each rainfall, the Contractor shall check for excessive buildups of sediment which must be removed so that the earth dike can continue to function as intended. The Contractor shall remove all accumulated sediment when it reaches 50% of the height of the earth dike.

260.14 Removal of Earth Dike. The earth dike shall be removed at the end of the construction period or when directed by the Engineer. The earth dike and all materials incidental to the earth dike construction shall be removed, and all areas affected by the earth dike shall be restored to the original or plan contours and stabilized with seed and mulch.

260.15 Method of Measurement. The quantity of earth dike Type A-1 will be measured as the actual number of linear feet (linear meters) of earth dike placed and accepted. Earth dike Types A-2, A-3, B-1, B-2, and B-3 will be measured using the same method for measuring earth dike Type A-1.

The quantity of sediment removal will be measured according to Section 250.

260.16 Basis of Payment. The quantity of earth dike Types A-1, A-2, A-3, B-1, B-2, and B-3 will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for furnishing all materials; for excavating, placing and compacting the embankment material; for maintaining the earth dike; for removing the earth dike and all incidental materials; for restoring the site; for seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of sediment removal will be paid for according to Section 250.

SECTION 261 – TEMPORARY SLOPE DRAIN

261.01 Description. This work consists of furnishing, installing, maintaining, and ultimately removing pipe slope drains to convey surface runoff down slopes without causing erosion. Temporary slope drains shall be constructed according to Standard Construction Detail, Temporary Slope Drain, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

261.02 Pipe. Pipe shall be flexible corrugated polyethylene pipe conforming to AASHTO M 294, Type C, unless otherwise indicated on the Plans.

261.03 Plywood. Plywood shall be 48 by 48" (1200 by 1200 mm) and have a nominal thickness of ½" (13 mm) with marine treatment conforming to AWPA Standard C9.

261.04 Lumber. Lumber shall be construction grade two-by-four made from southern yellow pine or Douglas fir treated with chromated copper arsenate (CCA) solution applied at a retention rate of 0.4 lb/ft³ (6.4 kg/m³) and certified for ground contact. The two-by-four shall measure 1½ by 3½" (38 by 89 mm).

261.05 Borrow Excavation. Material for construction and maintenance of embankment slopes, interceptor berms, and edge berms shall be approved materials obtained from the Project excavation or, if required, borrow material conforming to Section 209.

261.06 Riprap. Riprap shall conform to the requirements of Section 712.

261.07 Seed. Seed shall conform to the requirements of Section 734.

261.08 Mulch. Mulch shall conform to the requirements of Section 735.

261.09 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

261.10 Construction of the Temporary Slope Drain. Excavation, grading, shaping and preparation of embankment slopes, edge berms, and interceptor berms shall be as indicated on the Plans, Standard Construction Detail, Temporary Slope Drain, and Section 202.

The Contractor shall install the appropriate size pipe according to the following table:

Table 621-A

Pipe Diameter	*Maximum Drainage Area*
12" (300 mm)	0.5 ac (0.2 ha)
18" (450 mm)	1.5 ac (0.6 ha)
21" (525 mm)	2.5 ac (1.0 ha)
24" (600 mm)	3.5 ac (1.4 ha)
30" (750 mm)	5.0 ac (2.0 ha)

Construction methods for flexible pipe drains shall conform to Section 614. The slope drains shall have the flexibility and potential for length change to adjust to the interim elevations. Slope drains shall be fastened to the slope by a method approved by the Engineer. The Contractor shall construct and install a plywood anti-seep collar as shown on Standard Construction Detail, Temporary Slope Drain. The temporary slope drain shall discharge into the back of sediment traps, into sediment basins, or into ditches discharging into sediment traps or basins. When a temporary slope drain outlets into a sediment trap or basin, the temporary slope drain shall discharge at the riser crest or weir elevation.

Construction methods for riprap aprons shall conform to the requirements of Section 712. A riprap apron, with geotextile, shall be installed below the pipe outlet. The riprap apron shall be a minimum of 32 ft² (3 m²).

If directed by the Engineer, the Contractor shall adjust the elevations of and reconstruct the slope drains so that the slope drains remain functional as the embankment elevation rises.

261.11 Maintenance of the Temporary Slope Drain. Maintenance of embankment slopes, edge berms, and interceptor berms shall conform to the requirements of Section 202.

The drain system shall be inspected for clogging and rips or breaks and shall be cleaned and repaired as required to remain functional.

261.12 Removal of the Temporary Slope Drain. When the Engineer determines that the temporary slope drain is no longer required, the Contractor shall remove the temporary slope drain and all materials incidental to the construction of the temporary slope drain. All areas affected by the construction of the temporary slope drain shall be restored to the original or plan contours, and stabilized with seed and mulch.

261.13 Method of Measurement. The quantity of temporary slope drain will be measured as the actual number of linear feet (linear meters) of temporary slope drain pipe, measured from end to end of pipe, installed and accepted.

The quantity of edge berm constructed will be measured according to Section 202.

261.14 Basis of Payment. The quantity of temporary slope drain will be paid for at the Contract unit price per linear foot (linear meter) of temporary slope drain pipe. Price and payment will constitute full compensation for furnishing and installing all materials, including pipe, anti-seep collars, riprap, geotextile, seed, mulch, and, if required, borrow excavation; for readjusting or relocating drains; for removing the temporary slope drain; for restoring the site; for seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

If the Contractor is required to add a piece of slope drain pipe to an existing temporary slope drain, the additional piece of slope drain pipe will be paid for separately and on the same basis as that for the existing temporary slope drain. The Contractor shall submit a unit price cost breakdown for this work when more than one size of pipe is used.

The quantity of edge berm will be paid for according to Section 202.

SECTION 262 – STILLING WELL

262.01 Description. This work consists of constructing, maintaining, and ultimately removing stilling wells as a temporary measure to pump clean water around a disturbed construction area to a stabilized outfall. Stilling wells shall be constructed as shown on Standard Construction Detail, Stilling Well, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

262.02 Riprap. Riprap shall be R-4 conforming to the requirements of Section 712.

262.03 Seed. Seed shall conform to the requirements of Section 734.

262.04 Mulch. Mulch shall conform to the requirements of Section 735.

262.05 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

262.06 Construction of Stilling Well. The Contractor shall excavate to the dimensions shown on the Plans or as directed by the Engineer. The Contractor shall remove all debris from the excavated area.

The Contractor shall line all surfaces of the stilling well with the geotextile prior to placing the riprap. The geotextile and riprap shall be placed as indicated on the Plans, Standard Construction Detail, Stilling Well, and Section 712.

262.07 Maintenance of Stilling Well. Throughout the Project construction period, the Contractor shall maintain the stilling well to the original dimensions and function of the stilling well. The Contractor shall remove and dispose of all trash and debris that enters the stilling well and interferes with the functioning of the stilling well.

262.08 Removal of Stilling Well. The stilling well shall be removed when the Engineer determines that it is no longer required. All materials incidental to the construction of the stilling well shall be removed, and all areas affected by the stilling well shall be restored to the original or plan contours and stabilized as required.

262.09 Method of Measurement. The quantity of stilling wells will be measured as the actual number of cubic yards (cubic meters) of stilling well excavated and accepted. The quantity of riprap will be measured according to Section 712.

262.10 Basis of Payment. The quantity of stilling well will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for furnishing all materials; for excavating; for maintaining the stilling well; for removing all stilling well materials; for restoring the site, including backfilling, seeding, and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of riprap will be paid for according to Section 712.

SECTION 263 – SUMP PIT

263.01 Description. This work consists of constructing, maintaining, and ultimately removing sump pits for the purpose of trapping and filtering excess water from excavations prior to pumping the water to a suitable discharge area. Sump pits shall be constructed as shown on Standard Construction Detail, Sump Pit, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

263.02 Pipe. Pipes shall be perforated corrugated aluminum with a perforated cap on the bottom conforming to the requirements of Section 615.

263.03 Stone. Stone shall be Delaware No. 57 conforming to the requirements of Section 813.

263.04 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

263.05 Excavation for Sump Pit. The Contractor shall excavate the sump pit according to the dimensions on Standard Construction Detail, Sump Pit, and at the location shown on the Plans.

263.06 Construction of Sump Pit. The Contractor shall place the layer of stone in the bottom of the sump pit as shown on Standard Construction Detail, Sump Pit. The stationary pipe with bottom cap shall be placed on top of the bottom layer of stone. The removable pipe shall be placed inside of the stationary pipe as shown on Standard Construction Detail, Sump Pit. Both pipes shall extend to the same height and be a minimum of 24" (600 mm) above the lip of the sump pit. The Contractor shall backfill the sump pit with stone. The stone shall be sloped up to meet the height of the pipes.

263.07 Maintenance of Sump Pit. When clogged with sediment, the Contractor shall replace the geotextile and, if applicable, the wire mesh on the removable pipe and bottom cap.

263.08 Removal of Sump Pit. When permitted by the Engineer, the Contractor shall remove the sump pit and all materials incidental to the construction of the sump pit. All areas affected by the sump pit shall be restored to the original or plan contours.

263.09 Method of Measurement. The quantity of sump pits will be measured as the actual number of each constructed and accepted.

263.10 Basis of Payment. The quantity of sump pits will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing and placing all materials, including perforated metal pipes with bottom caps, stone, geotextile, and wire mesh; for excavating the sump pit; for maintaining the sump pit, including replacing all clogged geotextile and wire mesh; for removing the sump pit and all incidental materials; for restoring the sump pit area; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 264 – DEWATERING BASIN

264.01 Description. This work consists of constructing, maintaining, and ultimately removing dewatering basins as shown on Standard Construction Detail, Dewatering Basin, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

264.02 Borrow. Borrow for fill material for the berm shall be clean mineral soil free of roots, woody vegetation, stones greater than 4" (100 mm) in diameter, or other objectionable materials. Sandy or gravely soils classified as GW, GP, SW, and SP under the Unified Soil Classification System shall not be used in the embankment.

264.03 Geotextile. Geotextile shall conform to the requirements of Section 827.

264.04 Riprap. Riprap shall be R-4 conforming to the requirements of Section 712.

264.05 Seed. Seed shall conform to the requirements of Section 734.

264.06 Mulch. Mulch shall conform to the requirements of Section 735.

CONSTRUCTION METHODS.

264.07 Construction of the Dewatering Basin. The area under the berm shall be cleared, grubbed, and stripped of topsoil. In order to facilitate clean out and restoration, the pool area will be cleared of all brush, trees, and other objectionable materials.

The fill material for the berm and the area on which the fill material for the berm is to be placed shall have sufficient moisture so that it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction. The fill material shall be placed in 12" (300 mm) thick lifts over the entire length of the fill. Compaction shall be obtained by tamping the berm with the flat side of the backhoe bucket used to excavate the dewatering basin.

264.08 Vegetative Treatment. The berm top and side slopes shall be stabilized immediately after construction with seed and mulch.

264.09 Maintenance of the Dewatering Basin. Throughout the Project construction period, the Contractor shall maintain the dewatering basin to its original dimensions and function.

264.10 Sediment Removal. The Contractor shall remove all accumulated sediment when the basin is filled to one-half of its original basin.

264.11 Removal of Dewatering Basin. The dewatering basin shall be removed at the end of the construction period or when directed by the Engineer. The dewatering basin and all materials incidental to its construction shall be removed. All areas affected by the construction, use, and removal of the dewatering basin shall be restored to the original or plan contours and stabilized with seed and mulch.

264.12 Method of Measurement. The quantity of dewatering basins will be measured as the actual number of dewatering basins constructed and accepted. The quantity of sediment removal will be measured according to Section 250.

264.13 Basis of Payment. The quantity of dewatering basins will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for excavating; for furnishing and placing all materials, including the berm; for maintaining the dewatering basin; for removing the dewatering basin and all incidental materials; for restoring the area; for seeding and mulching and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of sediment removal will be paid for according to Section 250.

SECTION 265 – GEOTEXTILE LINED CHANNEL DIVERSION

265.01 Description. This work consists of constructing, maintaining, and ultimately removing a geotextile lined channel diversion as a temporary drainage way to allow the Contractor to work in the existing channel by redirecting the water flow of the existing channel around the intended work area. Geotextile lined channel diversion shall be constructed as shown on Standard Construction Detail,

Geotextile-Lined Channel Diversion, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

265.02 Fasteners. Fasteners shall be steel pins, 3/16" (4.7 mm) in diameter, and a minimum of 18" (450 mm) long. Washers shall be steel and 1½" (38 mm) in diameter.

265.03 Seed. Seed shall conform to the requirements of Section 734.

265.04 Mulch. Mulch shall conform to the requirements of Section 735.

265.05 Stone. Stone shall be Delaware No. 3 conforming to the requirements of Section 813.

265.06 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

265.07 Construction of Geotextile Lined Channel Diversion. The Contractor shall have all required materials on site prior to starting construction on the geotextile lined channel diversion. The process of excavation shall be a continuous and uninterrupted operation. The cross-section of the diversion channel shall replicate the cross-section of the natural channel, unless otherwise specified. The Contractor shall begin excavation for the geotextile lined channel diversion at the downstream end of the proposed channel and proceed upstream. Excavation, including the downstream and upstream connection to the natural channel, shall be constructed under dry conditions. Sandbags shall be used to contain the stream. The Contractor shall excavate 24 by 24" (600 by 600 mm) trenches at the points of tie-in to the existing channel and at 12" (300 mm) beyond the top of the bank of the diversion channel for keying-in the geotextile as shown on Standard Construction Detail, Geotextile-Lined Channel Diversion.

All excavated materials shall be stockpiled outside of the floodplain. The Contractor shall temporarily stabilize the stockpiles according to the Engineer′s directions to prevent reentry of any of the previously excavated materials into the natural channel. All disturbance resulting from construction of the geotextile lined channel diversion shall be contained by appropriate sediment control measures as indicated on the Plans or as determined by the Engineer.

All debris shall be removed and the channel diversion surfaces made smooth so that the geotextile will rest flush with the channel at all points of contact. The geotextile shall be placed such that one piece will line the entire channel. If the diversion channel is larger than the geotextile, the geotextile shall be placed with longitudinal overlapping. The Contractor shall be required to use sewn longitudinal overlaps. The Contractor shall overlap the upstream sections over the downstream sections. The geotextile sections shall be secured with pins and washers as shown on Standard Construction Detail, Geotextile-Lined Channel Diversion.

The Contractor shall key-in and anchor the geotextile along the entire length of the diversion channel by completely lining the trenches with the geotextile. After the geotextile is in place in the trenches, the Contractor shall carefully place the stone into the trench from a zero drop height.

The Contractor shall construct berms or swales to prevent sediment from surrounding areas of disturbance from entering the geotextile lined channel diversion. The Contractor shall stabilize the points of tie-in between the geotextile lined channel diversion and the natural channel according to the Plans.

265.08 Maintenance of Geotextile Lined Channel Diversion. Throughout the Project construction period, the Contractor shall maintain the geotextile lined channel diversion to the original dimensions and function of the geotextile lined channel diversion.

265.09 Removal of Geotextile Lined Channel Diversion. When directed by the Engineer and when all construction is completed in and around the existing stream, the Contractor shall redirect the stream back through the natural stream bed and remove the geotextile lined channel diversion. All materials incidental to the construction of the geotextile lined channel diversion shall be removed and the area shall be backfilled according to Subsection 207.05. The Contractor shall restore the area of the geotextile lined channel diversion to the original or plan contours and shall stabilize the area with seed and mulch.

265.10 Method of Measurement. The quantity of geotextile lined channel diversion will be measured as the actual number of cubic yards (cubic meters) excavated for the geotextile lined channel diversion and accepted.

265.11 Basis of Payment. The quantity of geotextile lined channel diversion will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for excavating; for furnishing and placing all material, including geotextile, stone, washers, pins, seed, and mulch; for maintaining the geotextile lined channel diversion during the Project construction period; for removing the geotextile lined channel diversion and all incidental materials; for restoring the site; for seeding and mulching; and for all labor, equipment, tools and incidentals required to complete the work.

SECTION 266 – SANDBAG DIKES/SANDBAG DIVERSIONS

266.01 Description. This work consists of constructing, maintaining, and ultimately removing sandbag dikes and sandbag diversions for the purpose of erosion control when construction activities such as bank stabilization or bridge construction take place within a stream channel. Sandbag dikes and sandbag diversions shall be constructed as shown on Standard Construction Details, Sandbag Diversion and Sandbag Dike, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

266.02 Sand. Sand shall conform to the requirements of Section 804.

266.03 Sheeting. Sheeting shall consist of polyethylene, or other material approved by the Department′s Materials and Research Section, 6 mils (150 μm) thick, impervious, and resistant to puncture and tearing.

266.04 Pipe. Pipe shall be flexible with watertight bands and of the size and material indicated on the Plans.

266.05 Seed. Seed shall conform to the requirements of Section 734.

266.06 Mulch. Mulch shall conform to the requirements of Section 735.

266.07 Prefabricated Sandbags. Sandbags shall be of jute, woven polyester, or polypropylene mesh resistant to ultra-violet radiation, and of sufficient strength to contain the sand without failure or leakage. The size of the sack shall be approximately 16 by 25" (400 by 625 mm) measured inside the seam when the sack is laid flat and each sack will be filled with 1 ft^3 (0.03 m^3) of unwashed sand.

CONSTRUCTION METHODS.

266.08 Construction of Sandbag Dike. The Contractor shall construct the sandbag dike as shown on Standard Construction Detail, Sandbag Dike. If excavation is required by the Plans, all excavated materials shall be disposed of in an approved disposal area outside of the 100 year floodplain. The Contractor shall begin placing the sandbags at the upstream location and continue downstream. When it is necessary to overlap the sheeting, the upstream portion shall cover the downstream potion, and the overlap shall be a minimum of 24" (600 mm).

266.09 Construction of Sandbag Diversion. The Contractor shall construct the sandbag diversion as shown on Standard Construction Detail, Sandbag Diversion. Placement of the sandbags shall begin at the upstream location and continue downstream. When it is necessary to overlap the sheeting, the upstream portion shall cover the downstream potion, and the overlap shall be a minimum of 24" (600 mm).

266.10 Maintenance of Sandbag Dike and Sandbag Diversion. The Contractor shall maintain the original dimensions of the accepted sandbag dikes and sandbag diversions.

266.11 Removal of Sandbag Dike and Sandbag Diversion. The sandbag dikes and sandbag diversions shall remain in place until all disturbed areas are stabilized and the Engineer approves their removal. All sandbags and all materials incidental to the construction of the sandbag dike or sandbag diversion shall be removed and the area restored to the original or plan contours and stabilized with seed and mulch.

266.12 Method of Measurement. The quantity of sandbag dikes will be measured as the actual number of cubic yards (cubic meters) of sandbags placed and accepted. The quantity of sandbag diversions will be measured as the actual number of cubic yards (cubic meters) of sandbags placed and accepted. All measurements will be based on one sandbag being 1 ft^3 (0.03 m^3).

The quantity of pipe will be measured as the actual number of linear feet (linear meters) of pipe placed and accepted.

266.13 Basis of Payment. The quantity of sandbag dikes will be paid for at the Contract unit price per cubic yard (cubic meter). The quantity of sandbag diversions will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for furnishing and placing all materials, excluding the pipe; for constructing the sandbags; for maintaining the sandbag dikes and sandbag diversions; for removing and disposing of the sandbag dikes and sandbag diversions and all incidental materials; for restoring the area; for seeding and mulching; and for all labor, tools, equipment, and incidentals required to complete the work.

The quantity of pipe will be paid for according to the appropriate Section for the pipe installed.

SECTION 267 – RESERVED

SECTION 268 – STABILIZED CONSTRUCTION ENTRANCE

268.01 Description. This work consists of constructing, maintaining, and ultimately removing stabilized pads of aggregate on a filter cloth base at each entrance to and exit from a construction site so that construction vehicles and equipment do not track mud off-site. The stabilized construction entrance shall be constructed according to Standard Construction Detail, Stabilized Construction Entrance, at the locations shown on the Plans, and as directed by the Engineer.

MATERIALS.

268.02 Pipe. Pipe shall be as specified in the Plans.

268.03 Seed. Seed shall conform to the requirements of Section 734.

268.04 Mulch. Mulch shall conform to the requirements of Section 735.

268.05 Stone. Stone shall be Delaware No. 3 conforming to the requirements of Section 813.

268.06 Geotextile. Geotextile shall conform to the requirements of Section 827.

CONSTRUCTION METHODS.

268.07 Construction of Stabilized Construction Entrance. Any addition, deletion, or change in location of a stabilized construction entrance shall be approved in advance by the Engineer.

The entrance pipe, if required, shall be placed in Class C bedding and graded to drain. The pipe shall be installed prior to the placement of the geotextile or stone. The stabilized construction entrance location shall be excavated to the required dimensions and the subgrade compacted. The geotextile shall be placed on the compacted subgrade and the stone placed on top to the required depth.

It is intended that the entire width at points where ingress and egress occur shall be stabilized as described above. The Engineer may direct the Contractor to widen the entrance as required to prevent the entrance location from becoming a source of sediment.

268.08 Maintenance of Stabilized Construction Entrance. The Contractor shall leave all paved surfaces adjoining the Project limits free of accumulated sediment at the end of each workday. The Contractor may utilize any means and methods available to remove sediment provided the cleaning operation itself does not violate water or air pollution laws of the State.

After heavy use and after each rain, the Contractor shall inspect the stabilized construction entrance to ensure proper functioning. When the voids in the stone pad are filled, the Contractor shall rake the surface to reestablish the voids in the stone pad. If sedimentation of the entrance is severe, and the raking is unsuccessful in restoring void space, the Contractor shall replace the top 2" (50 mm) of the stone with 2" (50 mm) of clean Delaware No. 3 stone.

If the Contractor chooses to clean construction vehicle wheels to remove sediment prior to entering public rights-of-way, the cleaning shall be done in aggregate stabilized areas that drain into approved sediment trapping devices. All sediment shall be prevented from entering storm drains, ditches, or watercourses.

268.09 Removal of Stabilized Construction Entrance. When no longer needed for access to the Project and when directed by the Engineer, the stabilized construction entrance and all materials incidental to the construction of the stabilized construction entrance shall be removed. All areas affected by the stabilized construction entrance shall be restored to the original or plan contours. If required by the Engineer, the restored areas shall be stabilized with seed and mulch.

268.10 Method of Measurement. The quantity of stabilized construction entrances will be measured as the actual number of tons (metric tons) of stone placed and accepted. The quantity of stone used for topdressing will be measured as the actual number of tons (metric tons) of stone placed and accepted. The quantity of drainage pipe, if used, will be measured as the actual number of linear feet (linear meters) of pipe placed and accepted.

268.11 Basis of Payment. The quantity of stabilized construction entrances, including topdressing, will be paid for at the Contract unit price per ton (metric ton) of stone. The quantity of stone used for topdressing will be paid for separately from the quantity of stabilized construction entrances but at the same price per ton (metric ton) of stone. Price and payment will constitute full compensation for furnishing and placing all material, including the geotextile; for maintaining the stabilized construction entrance during the Project construction period, excluding topdressing; for removing the stabilized construction entrance after completion of the Project; for restoring the site, including any required seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of drainage pipe will be paid for separately.

SECTION 269 – TURBIDITY CURTAIN

269.01 Description. This work consists of furnishing, constructing, installing, maintaining, and ultimately removing a turbidity curtain from a body of water to minimize the drift of suspended sediment in the water body during construction of the Project. Construction of the turbidity curtains shall be as shown on Standard Construction Detail, Turbidity Curtain, at the locations shown on the Plans, and as directed by the manufacturer and the Engineer.

269.02 General. Prior to the installation of the turbidity curtain and its accessories, the Contractor shall submit the manufacturer′s drawings and technical specifications to the Engineer for approval.

MATERIALS.

269.03 Curtain. The curtain shall be a synthetic material coated with suitable elastomeric or polymeric compound and have a high resistance to weathering, hydrocarbons, fresh and salt water, and temperature extremes. The material shall have a tensile strength of not less than 200 lb (890 N) when measured lengthwise or crosswise. Seams, if required, shall be either vulcanized welded or sewn and shall develop the full strength of the material.

269.04 Flotation Units. Flotation units shall be flexible, buoyant units contained in a flotation sleeve or collar attached to the turbidity curtain. Buoyancy provided by the flotation units shall be sufficient to support the required width of the turbidity curtain and maintain a freeboard of at least 3" (75 mm) above the water surface level.

269.05 Load Lines. Load lines shall be fabricated into the top and bottom of the turbidity curtain. The top load line shall consist of woven webbing or vinyl sheathed steel cable and shall have a minimum breaking strength of 10,000 lb (44.6 kN). The bottom loadline shall consist of a ¼" (6 mm) galvanized steel chain incorporated into the bottom hem of the turbidity curtain to act as ballast. The load lines shall have suitable devices which develop the full breaking strength for connecting to load lines in adjacent sections.

269.06 Stakes. Stakes shall be constructed of oak timber or steel. Posts shall be a minimum of 6.5′ (2 m) long and at least 18" (450 mm) longer that the height of the turbidity curtain.

(a) *Oak Timber Posts.* Oak timber posts shall be straight and have a minimum nominal cross-section of 2 by 4" (50 by 100 mm).

(b) *Steel Posts.* Steel posts shall be 2½" (65 mm) diameter Schedule 40 pipe or be standard steel "T" or "U" section of 1.30 lb/ft (1.98 kg/m) minimum.

269.07 Fasteners. Fasteners shall be either 5/8" (16 mm) long brass or copper staples, or 17 gage (1.37 mm) galvanized or aluminized steel tie wires long enough to securely attach the fabric to the posts.

269.08 Anchors. Anchors shall be standard marine type boat anchors. The Contractor shall use Danforth type anchors for sandy bottoms, or kedge or mushroom type anchors for mud bottoms. The size, weight, and overall number of the anchors shall be sufficient to hold the turbidity curtain in its intended location. Alternate anchoring methods such as heavy concrete weights or driven pilings may be used if approved, prior to use, by the Engineer.

269.09 Rope. Rope shall be polypropelene, 5/8" (16 mm) diameter, with a minimum breaking strength of 800 lb (3.6 kN).

CONSTRUCTION METHODS.

269.10 General. When assembling and installing a turbidity curtain, the Contractor shall follow all the directions of the turbidity curtain manufacturer.

The turbidity curtain shall not be installed perpendicular to the direction of streamflow, such as across a river. The turbidity curtain shall be installed parallel to the flow of water only, such as along a river bank. All construction activities which generate any sediment or turbidity into the waterway shall be contained within the turbidity curtain.

Unless otherwise directed by the Engineer, the Contractor shall begin installation at high tide from a shoreline anchorage and work along with the current in a downstream direction.

The turbidity curtain shall form a continuous vertical and horizontal barrier to suspended sediment. The bottom of the turbidity curtain shall rest in contact with the bottom of the waterway for the entire length of the turbidity curtain. The top of the turbidity curtain shall extend above the water surface with at least a 3" (75 mm) freeboard for all stages of water levels.

269.11 Installation of Floating Turbidity Curtain. The turbidity curtain shall be floated into position, attached to the anchor lines, and then unfurled. The Contractor shall securely attach curtain panel ends together using rope lashings. The top lashing shall be securely tied to the anchor line. The Contractor shall place the anchors such that the turbidity curtain remains in the Plan location and none of the flotation devices are pulled under the water surface. If directed by the Engineer, the Contractor shall supply and place additional anchorage.

269.12 Installation of Staked Turbidity Curtain. Stakes shall be installed along the turbidity curtain alignment as shown on the Plans. The stakes shall be driven into the ground to the depth and spacing as shown on Standard Construction Detail, Turbidity Curtain.

The curtain shall be securely fastened to the side of the stakes facing the work area generating the sediment and turbidity. At curtain panel ends, the two panels shall be overlapped a minimum of 6" (150 mm) and rolled and fastened together around a common stake to ensure a sediment-tight seam.

269.13 Maintenance of Turbidity Curtain. Throughout the Project construction period, the Contractor shall maintain the turbidity curtain so that no sediment caused by the Project enters the waterway beyond the turbidity curtain.

All turbidity curtain damaged prior to installation, during installation, or during the life of the Contract shall be repaired or replaced to the satisfaction of the Engineer.

269.14 Removal of Turbidity Curtain. The turbidity curtain shall remain in place until the Project is complete and the turbidity has settled to no more than what existed prior to the start of construction. When directed by the Engineer, the turbidity curtain shall be furled in place, then released from its anchors and towed out of the water. The turbidity curtain and all materials incidental to the construction of the turbidity curtain shall be removed in such a manner as to minimize turbidity to adjacent waters. The turbidity curtain and related components shall become the property of the Contractor and shall be removed from the Project.

269.15 Method of Measurement. The quantity of floating and staked turbidity curtain will be measured, from edge to edge of the turbidity curtain along the support cable, as the actual number of linear feet (linear meters) of turbidity curtain placed and accepted.

269.16 Basis of Payment. The quantity of floating turbidity curtain and staked turbidity curtain will be paid for at the Contract unit price per linear foot (linear meter) for each type of curtain. Price and payment will constitute full compensation for furnishing, assembling, installing, maintaining, and removing the turbidity curtain and all materials incidental to the construction and installation of the turbidity curtain, and for all labor, tools, equipment, and incidentals required to complete the work.

SECTION 270 – PORTABLE SEDIMENT TANK

270.01 Description. This work consists of constructing, installing, maintaining, and ultimately removing portable sediment tanks to trap and retain sediment prior to pumping water back to the watercourse. Construction of the portable sediment tanks shall be as shown on Standard Construction Detail, Portable Sediment Tank, or an approved alternate design, at the locations shown on the Plans, and as directed by the Engineer.

270.02. Alternate Design. If the storage volume is adequate and approval is obtained from the Stormwater Engineer, the Contractor may use an alternate der sign for the portable sediment tank.

270.03 Submittal. Prior to the actual use of the portable sediment tank, the Contractor shall submit the hydraulic design of the portable sediment tank to the Engineer for approval.

MATERIALS.

270.04 Materials for Standard Construction Detail, Portable Sediment Tank. The materials that follow are specific to the portable sediment tank design shown on Standard Construction Detail, Portable Sediment Tank.

(a) *Wire Mesh.* Wire mesh shall be steel or galvanized welded wire reinforcement with openings ¼ by ¼" (6 by 6 mm) and wire diameter of 23 gage (655 µm).

(b) *Pipe.* Pipes shall be corrugated metal, either steel or aluminum, conforming to the requirements of Section 614 or 615, respectively.

(c) *Fasteners.* Eye bolts conforming to the requirements of ASTM F 541, Type 1 or Type 2, and shall be of sufficient strength to lift the portable sediment tank filled with sediment to a depth of 24" (600 mm).

(d) *Metal Plate.* Metal plate shall conform to the same material requirements as the pipe.

(e) *Geotextile.* Geotextile shall conform to the requirements of Section 827.

270.05 Materials for an Alternate Design. The Contractor shall submit a detailed list of materials to the Engineer. All materials shall not contribute to any contamination of the outflow. The materials list shall be submitted with the hydraulic design submittal required in Subsection 270.03.

270.06 Seed. Seed shall conform to the requirements of Section 734.

270.07 Mulch. Mulch shall conform to the requirements of Section 735.

CONSTRUCTION METHODS.

270.08 General. With approval from the Engineer, the Contractor may install the portable sediment tank at a different location than is shown on the Plans. The portable sediment tank shall be located for ease of clean-out and disposal of the trapped sediment and to minimize the interference with the construction activities and pedestrian traffic.

270.09 Construction of Portable Sediment Tank According to Standard Construction Detail, Portable Sediment Tank. All welds shall be watertight. The Contractor shall line the inside of the perforated pipe with a layer of wire mesh first, and then with a layer of geotextile. The wire mesh and geotextile shall be securely fastened to the pipe.

270.10 Construction of Portable Sediment Tank According to an Alternate Design. The Contractor shall submit a detailed sketch of the alternate design with notes describing the planned construction methods. The detailed sketch shall be submitted with the hydraulic design submittal in Subsection 270.03.

270.11 Maintenance of Portable Sediment Tank. The Contractor shall make any required repairs to the portable sediment tank to ensure that the portable sediment tank functions as intended.

270.12 Sediment Removal. The Contractor shall remove the sediment when it accumulates to a depth of 24" (600 mm) in a tank designed according to Standard Construction Detail, Portable Sediment Tank, and when it accumulates to one-third of the portable sediment tank height for an alternate design. All

sediment collected in the portable sediment tank shall be disposed of in an approved disposal area or as approved by the Engineer.

270.13 Removal of Portable Sediment Tank. The portable sediment tank and all materials incidental to the construction of the portable sediment tank shall be removed and all areas affected by the portable sediment tank shall be restored to the original or plan contours and stabilized with seed and mulch.

270.14 Method of Measurement. The quantity of portable sediment tanks will be measured as the actual number of each portable sediment tank placed and accepted. Sediment removal will be measured according to Section 250.

270.15 Basis of Payment. The quantity of portable sediment tanks will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing, fabricating, and installing the portable sediment tank; for maintaining the portable sediment tank; relocating within project limits; for disposing of the portable sediment tank and all incidental materials; for restoring the portable sediment tank area; for seeding and mulching; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of sediment removal will be paid for according to Section 250.

SECTION 271 – STORMWATER MANAGEMENT POND

271.01 Description. This work consists of constructing the foundation, dam, reservoir, and emergency spillway for a stormwater management pond at the location shown on the Plans and as directed by the Engineer.

271.02 Materials. Borrow for stormwater management pond construction shall conform to the requirements of Subsection 274.02. The types of soil required are as follows:

Foundation Cutoff	Clay Borrow, Type 1
Dam	Clay Borrow, Type 2

CONSTRUCTION METHODS.

271.03 Excavation. The Contractor shall excavate for the stormwater management pond in reasonably close conformity with the lines and grades shown on the Plans or as directed by the Engineer. All suitable material removed as excavation shall be used in constructing the dam foundation and embankment before securing or hauling any borrow, or unless directed by the Engineer. Materials determined by the Engineer to be unsuitable for use in the dam foundation and embankment shall be deposited on slopes as directed by the Engineer or removed from the Project site and disposed.

If rock excavation, as defined in Section 205, is necessary for construction of the stormwater management pond, it shall be paid for in accordance with Section 205. The classification "Rock Excavation" shall not apply to soft disintegrated rock. This material is classified as normal excavation and is included in Section 271.

271.04 Dam Foundation and Reservoir Preparation. The dam foundation and reservoir shall be cleared of trees, logs, stumps, roots, brush, boulders, sod, topsoil and rubbish. All surfaces under the foundation shall be graded to remove irregularities and shall be scarified parallel to the axis of the fill

to loosen the soil a minimum of 2" (50 mm) in depth. The moisture content of the loosened material shall be controlled as specified in Subsection 271.06.

The foundation area shall be kept free of standing water during placement of the material for the dam by approved dewatering methods. Exposed rock surfaces under the foundation shall be cleaned of all loosened earth material.

Test pits and other cavities shall be filled with compacted soil conforming to Section 210.

Topsoil shall be stockpiled and used in the completed embankment and other areas as directed by the Engineer.

271.05 Foundation Cutoff Trench. The foundation cutoff trench shall be located under the dam centerline or as shown on the Plans. The foundation cutoff trench shall be keyed into the original ground extending down to a relatively impervious layer and up the abutment slope to at least the ten-year pool elevation. The foundation cutoff trench shall be excavated prior to placing the dam embankment. The cutoff trench shall extend a minimum of 4′ (1.22 m) below the original ground surface or as indicated on the Plans. The trench shall have a minimum 4′ (1.22 m) bottom width or be wide enough to accommodate the equipment used for excavation, backfill, and compaction. The side slopes of the cutoff trench shall be no steeper than 1:1.

271.06 Dam Foundation and Embankment Placement and Compaction. Fill shall not be placed until the required foundation preparation has been completed and the foundation excavation has been inspected and approved by the Engineer. Fill shall not be placed on frozen surfaces nor shall frozen materials be used in the fill.

If the surface of any layer becomes too hard, smooth or dry for proper bond with the next layer, it shall be scarified parallel to the axis of the dam to a depth of not less than 2" (50 mm) and brought to the optimum moisture content before the next layer is placed.

Fill material shall contain the optimum moisture to obtain the required density. If the material is too wet, it shall be allowed to dry or be removed. If the material is too dry, water shall be added and mixed with the soil until the optimum moisture content is met.

Fill material shall be placed beginning at the lowest area of the foundation and shall be brought up in 8" (200 mm) to 12" (300 mm) thick continuous, horizontal layers over the entire length of the fill. Compaction shall be obtained by approved rollers or compactors. Compaction or rolling shall start at the edges and progress towards the center of the embankment. Compaction shall continue until each layer of the full width is thoroughly and uniformly compacted to at least 90% of the laboratory maximum density on the same soil.

271.07 Method of Measurement. The quantity of stormwater management ponds will be measured as the actual number of cubic yards (cubic meters) of material excavated to construct stormwater management ponds. The volume will be computed by the method of average end areas and will be measured by cross-sections taken at regular intervals and at breaks in grade. All excavation, except topsoil, will be measured in its original position. Topsoil will be measured in its original position or in a stockpile excavation, at the discretion of the Engineer. Topsoil removed from fill areas may be stockpiled separately for the cross-sectioning or may be measured by cross-sectioning the area of removal before and after topsoil stripping is performed. No measurement will be made for materials excavated beyond or below the lines and grades shown on the Plans.

271.08 Basis of Payment. The quantity of stormwater management ponds will be paid for at the Contract unit price per cubic yard (cubic meter) of excavation. Price and payment will constitute full

compensation for clearing, grubbing, and disposing of all obstructions, including all pipes within the limits of the work, not covered under any other Section; for excavating the foundation cutoff trench; for placing and compacting the foundation; for grading and compacting the dam; for excavating, grading, and shaping the reservoir and emergency spillway; for removing and disposing of all unsuitable material; for backfilling all areas from which unsuitable materials have been removed; for salvaging and stock piling topsoil for re-use; for removing and disposing of all material not otherwise provided for so that the stormwater management pond is completed in a neat and clean manner; for dewatering; and for all labor, equipment, tools, and incidentals required to complete the work.

The removal and final disposal of materials specified under other pay items is not included in this work.

SECTION 272 – POND OUTLET STRUCTURE, CONCRETE

272.01 Description. This work consists of furnishing, fabricating, and constructing a pond outlet structure at the locations shown on the Plans and as directed by the Engineer.

MATERIALS.

272.02 Borrow. Borrow for backfill material shall be Clay Borrow, Type 2 and shall conform to the requirements of Subsection 274.02.

272.03 Concrete. Concrete used in risers may be precast or cast-in-place. Concrete used in anti-seep collars shall be cast-in-place only. Concrete used in risers and anti-seep collars shall be Class A conforming to the requirements of Section 812

272.04 Reinforcing Steel. Reinforcing steel shall be Grade 60 (Grade 400) and conform to the requirements of Section 603.

272.05 Grout. Grout shall be non-shrink conforming to the requirements of ASTM C 1107.

272.06 Pipe. Reinforced concrete pipe used for the principal spillway shall conform to Section 612.

272.07 Gaskets. Gaskets for reinforced concrete pipe shall conform to Subsection 612.03.

272.08 Steps. Steps shall be molded plastic with a reinforcing bar core, and shall conform to the requirements of AASHTO M 31/M 31M, ASTM A 478, and ASTM D 4101.

CONSTRUCTION METHODS.

272.09 Excavation. The Contractor shall excavate to the required depth. The foundation upon which the structure is to be placed shall be compacted to a firm and level surface.

272.10 Outlet Structure.

(a) *Riser*. Concrete risers shall be poured in place or pre-cast. If the concrete risers are pre-cast, the Contractor shall design the lifting lugs, and all hardware required to transport and install the structure. The top slab shall not be used to lift the riser structure. Any space between pipes and

the walls of the pre-cast riser shall be filled with grout. The largest dimension of the opening in the riser of connection of the outfall pipe shall be no greater than the outfall pipe diameter plus 4" (100 mm).

(b) *Anti-Seep Collars.* The subgrade soil shall be excavated to the dimensions of the bottom half of the collars. Concrete forming the bottom half of the anti-seep collars shall be poured into the excavation using the adjacent soil as the form. Concrete formwork shall be used to form the top half of the anti-seep collars.

(c) *Principal Spillway Outfall Pipe.* The principal spillway pipe shall have Class A pipe bedding. Shims used to establish grade and alignment of the pipe shall be made of concrete. Lumber or bricks shall not be used for shims. Care shall be exercised during backfill to prevent any pipe movement from its horizontal and vertical alignment.

When the principal spillway outfall pipe is to be placed partially or completely in fill, the fill embankment shall be constructed 24" (600 mm) above the proposed top of pipe. A trench shall then be excavated to the required grade with side slopes no steeper than 1:1.

The Contractor shall place bell and spigot pipes with the bell end upstream. The pipe trench shall be kept free of standing water during pipe placement and backfilling using an approved dewatering method.

272.11 Backfill. The backfill material next to pipes and other structures shall be placed to the required elevation in 4" (100 mm) horizontal loose-thickness lifts at the same rate on all sides to prevent damage from unequal loading. Each lift shall be compacted by a manually directed power tamper under and around the pipe and other structures to 90% or more of maximum dry density. Compaction next to cast-in-place concrete structures will not begin until the concrete has reached enough strength to support the load.

A minimum depth of 24" (600 mm) of hand compacted backfill shall be placed over the pipe before crossing it with construction equipment.

272.12 Method of Measurement. The quantity of pond outlet structure, concrete will be measured as the actual number of each pond outlet structure, concrete installed and accepted.

272.13 Basis of Payment. The quantity of pond outlet structure, concrete will be paid for at the Contract unit price for each pond outlet structure, concrete. Price and payment will constitute full compensation for excavating; for dewatering; for all ground preparation; for furnishing and placing all materials, reinforcing steel, concrete, concrete pipes, gaskets, grout, pipe bedding, steps, backfill, and all other materials required for pond outlet structure, concrete; for welding; and for all labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 273 – TEMPORARY SEDIMENT BASIN OUTLET STRUCTURE, CORRUGATED METAL

273.01 Description. This work consists of furnishing, fabricating, and constructing a corrugated metal sediment-basin outlet structure at the locations shown on the Plans and as directed by the Engineer. The structure will include riser pipe, principal spillway pipe, trash racks, outlet drains, sediment filters and any anti-seep collar as shown on the Plans.

MATERIALS.

273.02 Borrow. Borrow for backfill shall be Clay Borrow, Type 1 and conform to the requirements of Subsection 274.02.

273.03 Concrete. Concrete shall be Class C and conform to the requirements of Section 812.

273.04 Geotextile. Geotextile shall conform to the requirements of Section 827.

273.05 Stone. Stone shall be Delaware No. 57 and conform to the requirements of Section 813.

273.06 Corrugated Metal. Corrugated metal pipe, anti-seep collars, base metal, and fabrication of all pipes and assemblies shall conform to the requirements of Section 614. Minimum steel plate corrugations shall be 2 2/3 by ½" (68 by 13 mm). Minimum thickness of corrugated metal shall be 15 gage (1.83 mm) except that base plates shall have a minimum thickness of ¼" (6 mm).

273.07 Seed. Seed shall conform to the requirements of Section 734.

273.08 Mulch. Mulch shall conform to the requirements of Section 735.

CONSTRUCTION METHODS.

273.09 Excavation. The Contractor shall excavate for the sediment basin outlet structure in reasonably close conformity with the lines and grades shown on the Plans. The subgrade upon which the structure is to be placed shall be compacted to a firm and even surface. The Contractor shall remove any protruding objects and fill any voids in the subgrade that may affect proper placement of the outlet structure.

273.10 Outlet Structure. The outlet pipe shall be bedded according to Section 612. Installation of the anti-seep collar, the metal base plate, stone, and the geotextile shall be in accordance with the details shown on the Plans. The anti-seep collar and base plate shall be welded to the pipe and riser. Where the ends of the geotextile come together, the ends shall be overlapped, folded, and stapled to prevent bypass. The geotextile shall be securely fastened to the pipe at the top and bottom of the geotextile.

The concrete base of the riser shall be constructed according to the requirements of Section 602. Reinforcement of the concrete base is not required. Unless otherwise ordered by the Engineer, curing requirements may be reduced to three days.

Connections of the riser pipe to the outlet pipe shall be made watertight by welding the full circumference of the joint. All connections between pipe sections shall be made using approved watertight band assemblies. Welding shall be performed according to the requirements of Section 605.

273.11 Backfill. The backfill conforming to Subsection 273.02 shall be placed to the required elevation in 4" (100 mm) horizontal loose-thickness lifts at the same rate on all sides to prevent damage from unequal loading. Each lift shall be compacted by a manually directed power tamper under and around the pipe and other structures to 90% or more of maximum dry density.

A minimum depth of 24" (600 mm) of hand compacted backfill shall be placed over the pipe before crossing it with construction equipment.

273.12 Maintenance. Throughout the Project construction period, the Contractor shall maintain the sediment basin outlet structure by replacing all clogged geotextile and cleaning all clogged pipes and stones.

273.13 Removal of the Outlet Structure. At the end of the Project construction period or when directed by the Engineer, the Contractor shall remove the outlet structure and all materials incidental to the construction of the sediment basin outlet structure. All areas affected by the construction of the outlet structure shall be restored to the natural or plan contours and stabilized with seed and mulch.

273.14 Method of Measurement. The quantity of corrugated metal sediment basin outlet structures, will be measured as the actual number of each corrugated metal sediment basin outlet structure installed and accepted.

273.15 Basis of Payment. The quantity of corrugated metal sediment basin outlet structures will be paid for at the Contract unit price for each sediment basin outlet structure, corrugated metal. Price and payment will constitute full compensation for excavating; for dewatering; for all ground preparation; for furnishing and placing all materials including stones, concrete, corrugated metal pipes, connections, and bedding, trash racks, anti-seep collars, backfill, and all other materials required for the corrugated metal sediment basin outlet structure; for restoring the site; for seeding and mulching; for disposing of excess materials; and for all labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 274 – CLAY BORROW, STORMWATER MANAGEMENT POND

274.01 Description. This work consists of furnishing and placing additional material from approved borrow areas when suitable material available within the right-of-way is not sufficient in quantity to construct the foundation cutoff, the pond embankment, and other pond features. This work also includes all clearing, grubbing, or stripping required to prepare the borrow area for cross-sectioning and excavating.

274.02 Materials. Borrow for stormwater management pond construction shall conform to the following criteria:

(a) *Clay Borrow, Type 1.* Clay borrow, Type 1 shall conform to the Unified Soil Classification System designation GC, SC, CL or CH and shall be free of rubbish; organic matter such as leaves, roots, grass, or sewage; and stones larger than 6" (150 mm) and other objectionable material.

(b) *Clay Borrow, Type 2.* Clay borrow, Type 2 shall conform to the Unified Soil Classification System designation GC, SC, or CL and shall be free of rubbish; organic matter such as leaves, roots, grass, or sewage; and stones larger than 6" (150 mm) and other objectionable material.

CONSTRUCTION METHODS.

274.03 Borrow Sources. Prior to removing material from a borrow source, the Contractor shall comply with the requirements of Subsection 209.05.

274.04 Borrow Source Testing. The Department will assist the Contractor in verifying a source as detailed in Subsection 209.06.

274.05 Placement and Compaction. Clay borrow shall be placed and compacted in accordance with the requirements of Subsection 271.06 and as directed by the Engineer.

274.06 Method of Measurement. The quantity of clay borrow for stormwater management ponds will be measured in accordance with Subsection 209.09.

274.07 Basis of Payment. The quantity of clay borrow, stormwater management pond will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for clearing, grubbing, stripping, excavating, hauling, placing, and compacting the borrow material and for all labor, equipment, tools, and incidentals required to complete the work.

DIVISION 300 – BASES

SECTION 301 – SELECT BORROW BASE COURSE

301.01 Description. This work consists of furnishing, placing, and compacting select borrow material on a prepared subgrade.

301.02 Materials. The material used for the select borrow base course shall conform to the requirements of Subsection 209.04, Borrow Type G.

Source of material for the select borrow base course shall conform to the requirements of Subsection 209.05.

Source testing shall conform to the requirements of Subsection 209.06.

CONSTRUCTION METHODS.

301.03 Equipment. The Contractor shall provide equipment of the proper type and weight to do the grading, leveling, and compacting work as specified. Compaction shall be uniformly attained by approved rollers or compactors.

301.04 Preparation of Subgrade. The subgrade shall be properly shaped. It shall also be uniformly and thoroughly compacted in conformance with the lines and grades as shown on the Plans or as established by the Engineer, before any base course material is placed. These operations shall be performed in accordance with Subsection 202.06.

The subgrade shall be maintained as established in Subsection 202.06. Test rolling shall be performed as established in Subsection 202.02.

No base course material shall be placed until the subgrade has been approved by the Engineer.

301.05 Placement of Select Borrow Base Course. Select borrow base course material shall be placed in successive layers. Each layer shall be placed in a level, uniform cross-section not to exceed 8" (200 mm) in depth, loose measurement, unless otherwise approved by the Engineer. The material shall be deposited and promptly spread parallel to the centerline. Each layer shall extend the full plan width.

If a layer does not contain a uniform distribution of moisture and component materials, it shall be disced or processed in a manner to ensure homogeneity. Each layer shall be properly compacted, as specified, before starting the next layer.

Compaction or rolling shall start at the edges and progress toward the center and shall continue until each layer is thoroughly and uniformly compacted to the full width.

In no case shall vehicles be allowed to travel in a single track or form ruts in the base course. If any sharp irregularities are formed, the base course shall be scarified to a depth of 6" (150 mm) and recompacted.

301.06 Performance Requirements. Compaction shall continue until each layer is thoroughly and uniformly compacted to 100% or more of the laboratory maximum density on representative material.

The moisture content of the select borrow base course material at the time of compaction shall be within 2% of the optimum. The material shall either be moistened or dried, as needed, and thoroughly mixed before compaction.

Field compaction shall comply with the requirements of the following AASHTO test methods as modified by the Department:

(a) AASHTO T 99 Method C, Moisture-Density Relationship.
(b) AASHTO T 191, Density By Sand Cone.
(c) AASHTO T 224, Coarse Particle Correction.
(d) AASHTO T 238, Density By Nuclear Methods.
(e) AASHTO T 239, Moisture Content by Nuclear Methods.
(f) AASHTO T 272 Method C, Moisture-Density Family of Curves.

The finished surface of the select borrow base course shall not vary from that required on the Plans by more than ½" (13 mm) when tested with a 10′ (3.048 m) straightedge applied to the surface parallel to the centerline of the pavement, and when tested with a template cut to the cross-section of the pavement.

A straightedge meeting the approval of the Engineer shall be supplied by the Contractor at each placement operation. The straightedge shall be constructed of rigid materials that resist warping and bending.

301.07 Method of Measurement. The quantity of select borrow base course will be measured as the number of cubic yards (cubic meters) of Borrow Type G placed and accepted. Borrow will be measured in its original position by cross-sections and computed by the method of average end areas. The number of cubic yards (cubic meters) of borrow measured, as stated above, will not include any overburden or stripping.

When requested by the Contractor and approved by the Engineer in writing, material specified to be measured by the cubic yard (cubic meter) may be weighed and such weights will be converted to cubic yards (cubic meters) for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such method of measurement of pay quantities is used. Where the Engineer has determined it impractical to obtain a weight-volume conversion factor, 3,200 lb/yd³ (1900 kg/m³) shall be used as the conversion factor. The weight will be determined according to Subsection 109.01.

301.08 Basis of Payment. The quantity of select borrow base course will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for all clearing, grubbing, or grading required to prepare the materials source for cross-sectioning; for excavating; for furnishing, hauling, placing, discing if required, and compacting all materials; and for all equipment, tools, labor, and incidentals required to complete the work.

SECTION 302 – GRADED AGGREGATE BASE COURSE

302.01 Description. This work consists of furnishing, placing, and compacting graded aggregate base course materials on a prepared subgrade or base.

302.02 Materials. The material used to construct graded aggregate base course shall conform to the requirements of Section 813 and Section 821, Type B.

CONSTRUCTION METHODS.

302.03 Subgrade Preparation. The subgrade shall be properly constructed in accordance with Subsection 202.06.

No base course material shall be placed until the subgrade has been approved by the Engineer.

302.04 Placement.

(a) *Equipment.* The aggregate materials shall be spread uniformly by an approved spreading machine or box in such a manner that no segregation occurs. A conventional motor grader will not be approved for placement of graded aggregate on mainline roadway sections.

Where it is not possible to use a spreading machine or box in patching or other tight areas, other approved methods can be used only in such manner that no segregation occurs. Water shall be uniformly applied with an approved sprinkling device. Compaction shall be uniformly attained by approved rollers or compactors. No graded aggregate shall be placed until approved equipment is on the Project site and is operational.

(b) *Spreading and Compacting.* Graded aggregate material conforming to the requirements of Section 821 shall be placed in successive layers. Each layer shall be placed in a level, uniform cross-section not to exceed 8" (200 mm) in depth, loose measurement, unless otherwise approved by the Engineer. The material shall be deposited and spread parallel to the centerline, and the layer shall extend to the full width as shown on the Plans. The material shall be handled so that no segregation of fine or coarse particles occurs. No more than 1,000′ (300 m) of material, as measured along the roadway centerline, shall be spread in advance of compaction operations.

Each layer shall be properly compacted as specified, before starting the next layer. Water shall be added before the material is compacted. The water shall be applied in a manner that results in a uniform and adequate moisture content.

Compaction or rolling shall be performed parallel to the roadway centerline starting at the edges and progressing toward the center. It shall continue until each layer is thoroughly and uniformly compacted to the full width as shown on the Plans.

After compacting, all voids in the surface of each layer shall be filled with aggregate meeting the requirements of Section 813, Delaware No. 10. Water shall be applied to the surface and compaction continued. Additional Delaware No. 10 aggregate placement, water application, and compaction shall continue until the layer of base material is well bonded and firm, as determined by the Engineer.

In no case shall vehicles be allowed to travel in a single track or to form ruts in the base course. If any sharp irregularities are formed in the subgrade or base course material, the affected area shall be scarified to a depth of 6" (150 mm) and compacted to conform to the requirements of Section 202 or this Section.

(c) *Performance.* The moisture content of the base course material at the time of compaction shall be within 2% of the optimum moisture content. If the moisture content is not within 2% of optimum, the material shall either be moistened or dried, as needed, and thoroughly mixed before compaction.

Compaction of graded aggregate Type A shall continue until each layer is thoroughly and uniformly compacted into a firm and unyielding surface, to the satisfaction of the Engineer. Compaction of graded aggregate Type B shall continue until each layer is thoroughly and uniformly compacted to 98% or more of the laboratory maximum density obtained on a sample of the same material. If the material is too coarse to use the test methods listed below, compaction shall continue until there is no movement of the material under the compaction equipment.

The determination of compliance with performance requirements as specified in this Subsection shall be in accordance with the following test methods, as modified by the Department:

(1) AASHTO T 99 Method C, Moisture-Density Relationship.

(2) AASHTO T 191, Density By Sand Cone.

(3) AASHTO T 224, Coarse Particle Correction.
(4) AASHTO T 238, Density By Nuclear Methods.
(5) AASHTO T 239, Moisture Content By Nuclear Methods.
(6) AASHTO T 272 Method C, Moisture-Density Family Of Curves.

The finished surface of the graded aggregate base course shall not vary from that required on the Plans by more than ½" (13 mm) when tested with a 10′ (3.048 m) straightedge applied to the surface parallel to the centerline of the pavement and when tested with a template cut to the cross-section of the pavement. The actual thickness of the graded aggregate base course shall not be more than ½" (13 mm) less than the thickness shown on the Plans; however, the actual thickness may be greater than that shown on the Plans. Those portions of completed graded aggregate base course not meeting these performance requirements shall be completely removed and replaced with proper material placed in accordance with this Section.

A straightedge meeting the approval of the Engineer shall be supplied by the Contractor at each placement operation. The straightedge shall be constructed of rigid materials that resist warping and bending.

302.05 Method of Measurement. The quantity of graded aggregate base course will be measured by the cubic yard (cubic meter). The volume of cubic yards (cubic meters) will be measured as the number of square yards (square meters) of surface area of graded aggregate base course, placed and accepted, multiplied by the depth shown on the Plans If the depth of the graded aggregate base course placed and accepted is greater than the depth shown on the Plans, the plan depth will be used to measure the quantity for payment.

If the limits of measurement for pay quantities for graded aggregate base course are designated on the Plans, the quantity of graded aggregate base course measured for payment will be the number of square yards (square meters) of surface area multiplied by the depth, placed within the payment lines and grades shown on the Plans. If the limits are not designated on the Plans, or have been changed by the Engineer, in-place dimensions of the accepted graded aggregate base course will be established. The computation of quantity will be made from cross-sections taken after the completion of work under this Section.

As an alternate method of measurement, graded aggregate base course will be measured by the ton (metric ton) if so required by the Contract. The weight will be determined according to Subsection 109.01. On jobs paying by the ton (metric ton), the Engineer reserves the right to template areas for payment, through use of a conversion factor supplied by the Department, whenever the Contractor exceeds the limits of base course placement shown on the Plans.

Materials placed beyond the designated lines and grades as shown on the Plans or beyond the limits established by the Engineer will not be measured for payment.

There will be no separate measurement made for the Delaware No. 10 aggregate used for filling voids or for the water applied as required in Subsection 302.04.

302.06 Basis of Payment. The quantity of graded aggregate base course will be paid for at the Contract unit price per cubic yard (cubic meter) or by the number of tons (metric tons) installed, as required by the Contract for this material. Price and payment will constitute full compensation for preparing, furnishing, placing, and compacting the materials, and for furnishing all labor, equipment, tools, and incidentals required to complete the work.

No payment will be made for materials placed beyond the designated lines and grades as shown on the Plans or beyond the limits established by the Engineer.

SECTION 303 – RESERVED

SECTION 304 – ASPHALT STABILIZED BASE COURSE

304.01 Description. This work consists of scarifying, stabilizing with asphalt, compacting, and shaping the base course.

304.02 Materials.

(a) *Asphalt.* Asphalt for stabilization shall be a high-float, medium-setting emulsion conforming to the requirements of Section 809. Other types of mixing grade emulsions may be submitted for laboratory evaluation and approval.

Prior to approval of any emulsion type or source of supply, the Contractor shall submit to the Department's Materials and Research Section a 1 gal (4 L) emulsion sample for laboratory analysis and mixing evaluation. A laboratory analysis report prepared by the supplier shall accompany the sample.

Laboratory evaluation shall include a determination of mixing qualities of the emulsion and water with silicious sandy soils representative of the soil types found within the Project location and conforming to Subsection 209.04, Borrow Type E. Fast breaking emulsion yielding globules of unmixed asphalt or emulsions which fail to thoroughly and homogeneously blend throughout the emulsion-water-soil mixture will be judged unsatisfactory for use. The moisture content of the soil-emulsion mixed in the laboratory shall range from 5 to 9% with optimum moisture and maximum density determined in accordance with AASHTO T 180 Method A, Modified. Molded soil-emulsion specimens will also be evaluated by air curing, water immersion, absorption, and compression testing.

All testing will be performed at the Department's Materials and Research Laboratory. Upon completion of all laboratory testing and review of the data, the decision of the Department as to emulsion acceptability will be final. Approval of the material will also be contingent on satisfactory performance under field mixing conditions.

(b) *Water.* Water to be used in the stabilizing process shall conform to the requirements of Section 803.

(c) *Soils.* All materials to be stabilized shall consist of local soils or borrow soils or a mixture of both. These materials shall be free from roots and leaves and any other types of organic matter. Local soils to be stabilized shall be granular in nature and approved prior to use. All borrow shall conform to the requirements of Subsection 209.04, Borrow Type E.

304.03 Equipment. The type, condition, and quantity of equipment furnished shall meet the qualifications necessary for the proper execution of the work within the specified working time. Equipment shall bear the manufacturer's name plate, on which shall be stamped the model number. All equipment shall be maintained in good condition and be subject to approval prior to and during its use in connection with the Project. Compaction equipment shall also conform to the requirements of Subsection 202.05 (d).

304.04 Construction Methods. Before any stabilization is started, the roadway shall be widened and graded. Ditches and slopes shall be cut, borrow shall be placed, and the entire section shall be formed in accordance with the typical sections shown on the Plans. Where applicable, the requirements of Section 202 shall apply.

After the prepared roadway has been approved and prior to the addition of asphalt, the base course shall be scarified to the full depth that will give, when mixed with asphalt, a compacted base having a thickness as shown on the Plans and within the specified tolerances. The scarified base course shall then be mixed, and water shall be added or aeration shall take place until the moisture content of the soil to be stabilized is between 90 and 110% of the optimum mixing moisture as determined by the Department. Mixing shall continue until clay lumps and other cohesive materials present are broken up and distributed evenly. The mixing operation shall be considered complete when the moisture content of the material to be stabilized is uniform and between 90 and 110% of the optimum mixing moisture and the soil lumps have been pulverized.

After the base course has been mixed as described in this Subsection, asphalt shall be applied at a temperature between 140 and 170 °F (60 and 77 °C). The quantity of asphalt shall range from 14 to 20 gal/yd³ (70 to 100 L/m³) of compacted thickness of base shown on the Plans, depending on the properties of the soil. The number of gallons per cubic yard (liters per cubic meter) to be applied will be determined by the Department.

No asphalt shall be applied unless the mixing operation can be completed within two and one-half daylight hours following the application of the asphalt. Asphalt shall not be applied to a new section on any succeeding day until those portions which have been mixed previously are aerated and compacted to the specified requirements. If field conditions render the requirements of the preceding sentence impracticable, such as inclement weather, then the Engineer will have the option of waiving the requirements.

Immediately following the application of asphalt, the base course shall be thoroughly mixed with self-propelled mixers. There must be at least two self-propelled mixers of the multiple pass type or one of the single pass type used in this phase of the stabilization operation. During the mixing operation, care shall be taken to avoid cutting below the prepared soil layer and incorporating additional raw soil into the mix. The mixing operation shall be considered complete when the asphalt and soil have been thoroughly mixed to a uniform color free from fat spots, streaks, balls, and uncoated particles throughout the full length, width, and depth of the section.

Following the mixing of the asphalt and soil, a period of aeration shall take place until the moisture content of the mixture is between 75 and 100% of the optimum moisture content as determined by AASHTO T 180 Method A, Modified. Compaction shall then begin, starting at the edges and progressing toward the center of the base course. This compaction shall continue until the base course is shaped and rolled until approved. The thickness of the stabilized base and the surface of the base course will then be tested and shall conform to the tolerances as specified:

(a) *Thickness.* The thickness of the soil asphalt mixture shall be within ½" (13 mm) of the plan thickness and shall be determined from the average of a set of measurements taken through holes made through the finished soil asphalt mixture at intervals not to exceed 500′ (150 m) per lane. A set of measurements consists of three holes spaced 5′ (1.5 m) apart in a triangular pattern with the thickness measured to the nearest ¼" (6 mm). Measurements will be made immediately following the finishing operation.

If the average thickness shown by a set of measurements is not within the tolerances specified, additional sets of measurements shall be made at 25′ (7.5 m) intervals forward and backward until at least two consecutive sets of measurements in each direction are within the tolerance specified. Areas represented by averages exceeding the tolerances specified may be required to be reconstructed.

(b) *Surface.* The surface smoothness of the asphalt stabilized base course mixture during and after the compaction and finishing operations shall be tested with a 10′ (3.048 m)

straightedge furnished by the Contractor. The straightedge shall be laid parallel to the centerline. Any irregularities greater than ±½" (±13 mm) shall be satisfactorily corrected.

The base course shall then be opened to traffic, before sealing, for a period of time necessary to cure the stabilized mixture. This curing period shall not be more than 14 days unless otherwise approved. The stabilized base course shall be considered satisfactory for surfacing when the stabilized mixture has attained the following:

(a) a minimum density of 120 lb/ft³ (1925 kg/m³) or a minimum of 95% of the maximum dry density as determined by AASHTO T 180 Method A, Modified;

(b) a moisture content that does not exceed 65% of the optimum moisture content as determined by AASHTO T 180 Method A, Modified; and

(c) base course that is properly shaped and has no soft, wet, or unstable areas.

No stabilization shall start on any project or portion thereof before April 1 of each year. All stabilization shall stop by September 30 of each year.

304.05 Method of Measurement. The quantity of asphalt stabilized base course will be measured as the number of miles (kilometers) measured along the centerline of the completed and accepted roadway. Seal material and asphalt for stabilization will be measured according to Subsection 404.16.

304.06 Basis of Payment. The quantity of asphalt stabilized base course will be paid for at the Contract unit price per mile (kilometer). Price and payment will constitute full compensation for all mixing, shaping, removing, and disposing of excess and unsuitable materials and for all labor, equipment, tools, and incidentals required to complete the work. Seal coat material and asphalt for stabilization will be paid for separately.

SECTION 305 – GRADED AGGREGATE FOR TEMPORARY ROADWAY MATERIAL (TRM)

305.01 Description. This work consists of furnishing and placing graded aggregate as temporary roadway material (TRM) for the maintenance and repair of the roadway, for pipe and utility crossings, for driveways and entrances, for temporary ramps up to curbs, and for other areas as directed by the Engineer. TRM under this Section shall not be used for constructing detour roads or other temporary roadways; however, it can be used for their maintenance.

305.02 Materials. Graded aggregate for TRM shall conform to the requirements of Section 821, Type B.

305.03 Construction Methods. Repair of the existing pavement and the placement of TRM shall be done as approved or directed by the Engineer. The work shall be coordinated with all other work and operations necessary to maintain traffic.

305.04 Method of Measurement. The quantity of graded aggregate for TRM will be measured as the actual number of tons (metric tons) of graded aggregate placed and accepted. The weight will be determined according to Subsection 109.01.

305.05 Basis of Payment. The quantity of graded aggregate for TRM will be paid for at the Contract unit price per ton (metric ton). Price and payment will constitute full compensation for furnishing,

preparing, hauling, placing and compacting all materials; for disposal of temporary roadway material; and for all labor, equipment, tools and incidentals required to complete the work.

DIVISION 400 – BITUMINOUS PAVEMENTS

SECTION 401 – HOT-MIX, HOT-LAID BITUMINOUS CONCRETE PAVEMENT

401.01 Description. This work consists of constructing hot-mix, hot-laid bituminous concrete bases and surface courses on either a prepared foundation or an existing surface course.

401.02 Materials. Materials for hot-mix, hot-laid bituminous concrete shall conform to Section 823. Tack coat shall conform to Section 811. Sand for protection of traffic shall conform to Section 804.

401.03 Delivery of Mixture. The mixture shall be delivered at the spreader with a temperature loss not greater than 20 °F (11 °C) from the temperature measured at the plant by the Engineer's representative.

A minimum of 100 tons (90 metric tons) of hot-mix bituminous concrete per hour shall be delivered to the Project site unless otherwise directed.

EQUIPMENT.

401.04 Hauling Equipment. Trucks used for hauling bituminous concrete shall have tight, clean, smooth metal beds which have been thinly coated with an emulsified oil, soap solution, or other approved release agent to prevent adherence of the bituminous mixture to the bed of the truck. Each truck shall have a securely fastened cover of canvas or other suitable waterproof material that covers the bed from front to back and over the sides. The front of the tarp shall be securely fastened to the body or protected by an air foil. The cover shall have at least three straps to a side and two straps on the back to prevent the cover from ballooning up, to protect the mixture from the weather, and to prevent heat loss. In addition, from September 30 through March 31, the truck bed shall be insulated on the front, sides, and back with plywood or other suitable material. Trucks with heated bodies may be used if the heat is uniformly distributed along the entire area of both side walls. The front and back, unless they are uniformly heated along the entire area, shall be insulated with plywood or other suitable material. All covers used and trucks with heated bodies are subject to the approval of the Engineer. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed by sunset unless approval for nighttime paving has been granted by the Engineer.

401.05 Pavers. Bituminous pavers shall be self-contained units, provided with an activated screed or strike-off assembly, heated, and capable of spreading and finishing asphaltic concrete in lane widths of the specified typical section and thickness shown on the Plans.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The front of the screed or strike-off assembly shall be equipped with an automatic control device that produces a finished surface of the required evenness and texture without segregation, tearing, shoving, or gouging the mixture. The paver shall be capable of operation at forward speeds consistent with satisfactory laying of the mixture. Stop and go operations of the paver shall be avoided. Equipment used for shoulders and similar construction shall be capable of spreading and finishing the courses in widths shown on the Plans.

The screed of the paver shall be regulated by an automatically controlled grade leveling and slope control device. The device shall be adapted to the type of paver used, and shall provide control for producing a uniform surface to the established grade and a cross slope conforming to the requirements

of the typical section. The device shall also be equipped with the necessary controls to permit the operator to adjust or vary the slope throughout superelevated curves. Grade control shall be accomplished using a sensor following a traveling reference plane not less than 30′ (9 m) in length. If deemed necessary by the Engineer, a joint matching shoe referencing to an adjacent mat shall be used.

If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained. Manual operation will be permitted for constructing irregularly shaped and other areas as approved by the Engineer. If the Contractor fails to obtain and maintain the specified surface tolerance, the paving operation shall be suspended until satisfactory corrections, repair, or equipment replacements are made.

401.06 Rollers. Rollers shall be self propelled, static or vibratory steel wheel type or a combination thereof, or the pneumatic-tire type. All rollers shall be capable of reversing without backlash, and shall be operated according to manufacturer′s recommendations. Steel wheel rollers shall be equipped with scrapers. Pneumatic-tire rollers shall be of the oscillating type, equipped with smooth tires of equal size, diameter, and ply rating, all maintained at the same inflation pressure. Rollers shall have a system for moistening each wheel or roller. The number and weight of the rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Using equipment which results in excessive crushing of the aggregate or marring of the pavement surface will not be permitted.

All rollers shall be approved prior to use. The rollers shall be maintained in a satisfactory working condition, and shall bear the manufacturer′s name plate stamped with the model number and the weight without ballast.

CONSTRUCTION METHODS.

401.07 Application of Tack Coat. A tack coat diluted with 50% water shall be applied on all dry and broom cleaned portland cement concrete and bituminous pavement surfaces. Tack coat shall be applied at a rate of 0.05 to 0.15 gal/yd² (0.23 to 0.68 L/m^2), at a temperature of 70 to 160 °F (21 to 71 °C). The application rate appropriate for the surface being overlaid shall have prior approval of the Engineer. The tack coat should be a thin, uniform coating sufficient to bond the overlay to the underlying pavement. Tack coat shall be applied using pressurized distributing equipment with a spray bar or other approved distribution system. Tack coat shall be applied in advance of the hot-mix operation, but no further than is anticipated for the current day′s hot-mix operation.

All contact surfaces of curbing, gutters, manholes, and other facilities shall be coated with a uniform coat of hot asphalt cement (tack) or other approved bituminous material just before the mixture is placed.

401.08 Placing Bituminous Mixtures. Prior to the delivery of the mixtures on the job, the underlying course shall have been brought to line, grade, and cross-section, and all excess patching material, joint material, dirt, and foreign material shall be removed. The mixtures shall be placed only upon a surface that is dry, and only when weather conditions are suitable.

Upon arrival, the mixture shall be dumped into the approved mechanical spreader, and immediately spread and struck off in a uniform layer to the full width required. The placed mixture shall be of such depth that when the work is completed, it will have the thickness shown on the Plans or as specified in the Contract and will conform to the grade and surface contour required. Machine methods of spreading and screeding are required unless otherwise permitted.

Should unevenness of texture, tearing, or shoving occur during the paving operation due to unsatisfactory material, methods, or equipment, the Contractor shall immediately take action to correct

such unsatisfactory work.

The outside edges of the pavement shall be in true alignment, parallel to the centerline of the roadway. On Contracts requiring multiple lifts or courses, the width of the individual lifts shall be arranged such that the longitudinal joints of each successive lift are offset from the previous lift approximately 6" (150 mm). The longitudinal joint in the surface course shall be at the lane line.

The placement of roadway bituminous concrete shall be as continuous as possible. Intersections and irregular areas shall be paved after the adjacent roadway has been paved. Hand spreading with lutes will be permitted where irregularities or obstacles make the use of pavers impractical. The use of garden rakes will not be permitted.

No bituminous concrete shall be placed when the ambient air temperature at the location of the paving operation is below the temperatures indicated for the various types of bituminous concrete mixtures in the following table:

Table 401-A
Minimum Ambient Air Temperature for Placement of Types of Bituminous Material

Material Type	*1″ (25 mm) Lift or Less*	*1 to 2" (26 mm to 50 mm) Lift*	*Greater than 2" (50 mm) Lift*
A	65 °F (18 °C)	N/A	N/A
B	50 °F (10 °C)	40 °F (4 °C)	32 °F (0 °C)
C	50 °F (10 °C)	40 °F (4 °C)	N/A
D	50 °F (10 °C)	40 °F (4 °C)	N/A
E	N/A	N/A	32 °F (0 °C)

Note: Type A - Open graded plant mix wearing surface
Type B - Dense graded base and binder course
Type C - Dense graded surface course
Type D - Fine, dense graded surface course
Type E - Curb mix

No bituminous concrete shall be placed on any frozen surface or when, in the opinion of the Engineer, weather conditions, such as wind and low temperatures, prevent proper spreading, finishing, and compaction of the mixture. Subsequent lifts or courses shall not be placed over another lift or course placed on the same day while the temperature of the previously placed mix is 140 °F (60 °C) or greater. Traffic shall be kept off the bituminous concrete until the mat temperature is less than 140 °F (60 °C).

The Contractor shall fill low places in the base with a leveling material consisting of hot-mix bituminous concrete base course or surface course material. The locations along the base course to receive this leveling course material, the type of material to be used, and the method to be employed in each case shall be as directed. Hot-mix bituminous concrete material shall be placed as directed around all manholes, drainage inlets, valves, or similar features (with slopes 20:1 or flatter) when they are adjusted to the proposed grade. This material may be temporarily placed and shall be removed if directed.

After the hot-mix bituminous concrete base course is placed, it shall not lay exposed for a period longer than ten days. If, due to conditions of emergency, more than ten days elapse, a fog coat of RS-1 or CSS-l-h shall be sprayed uniformly on the exposed base course before placing the wearing course of hot-mix bituminous concrete. In addition, the Contractor shall plan the paving operation so that no bituminous base courses remain unsurfaced after the "winter shut-down" unless authorized by the Engineer.

The paving operation shall be conducted to minimize inconvenience to traffic and to protect

existing and finished surfaces. Unless otherwise permitted, no single lane of any course shall be constructed to a length which cannot be completed to a full width of the pavement the following day. All hot-mix resurfacing operations shall be properly signed at the Contractor's expense with notice of "Pavement Drop-Off" or "Uneven Pavement" in accordance with the approved traffic control plans.

At locations where the hot-mix is tapered to meet an existing roadway, a tack coat of bituminous material shall be uniformly applied on the tapered area at the rate of approximately 0.15 gal/yd² (0.70 L/m²).

401.09 Deep Lift Base Course. In addition to other tolerances specified in this Section, deep lift bituminous concrete base course shall be constructed in accordance with the following requirements:

(a) The base course shall be placed with an approved paver or spreader in approximately equal layers not exceeding 6" (150 mm) in depth after compaction.

(b) Base course placed in irregular shaped areas of pavement, such as transitions, turning lanes, crossovers, and entrances, may be placed in a single lift using a grader.

(c) Mix segregation will not be permitted regardless of method of placement. Should segregation occur, paving operations shall be stopped immediately and not resumed until the cause is determined and corrected.

401.10 Compaction. Immediately after the bituminous mixture has been spread and struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition, and when the rolling does not cause undue displacement, cracking, or shoving. Delays in rolling freshly spread mixtures will not be permitted. The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density.

The rollers shall be operated with the drive wheels positioned toward the paver, at speeds slow enough to avoid displacement of the mixture. Rolling shall start longitudinally at the sides, parallel to the centerline of the work, and progress towards the center, overlapping on successive trips by at least one-half the width of the roller. Alternate trips of the roller shall be of slightly different lengths. When paving in echelon or paving a lane which abuts a previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure. On superelevated curves, the rolling shall begin at the low side and progress towards the high side by overlapping, longitudinal trips, parallel to the center line. All roller marks shall be rolled out.

The motion of the roller at all times shall be slow enough to avoid displacement of the hot mixtures. All displacement occurring as a result of the reversing of the direction of the roller, or from any other cause, shall be corrected to the satisfaction of the Engineer. To prevent adhesion of the mixture to the wheels of the roller, they shall be kept properly moistened, but excess water will not be permitted.

Along curb, headers, manholes, railroad crossings, and similar structures, and at all places not accessible to the roller, thorough compaction shall be obtained using approved tampers. At all contacts of this character the joints between these structures and the mixture shall be effectively sealed. All mixtures which become loose and broken, mixed with dirt, or in any way defective, shall be removed and replaced with fresh, hot mixture. The replacement mixture shall be immediately compacted to conform with the surrounding area. Areas showing an excess of asphalt cement, as determined by the Engineer, shall be removed and replaced.

401.11 Compaction Testing. Compaction shall be controlled by the following methods at the discretion

of the Engineer:

(a) Bituminous mixtures shall be compacted to a degree of compaction of not less than 92% of the theoretical voidless density obtained by laboratory calculation for surface courses and not less than 90% of the theoretical voidless density obtained by laboratory calculation for base and binder courses. Laboratory compaction is the average density obtained by the Maximum Specific Gravity in accordance with AASHTO T 209 for the mixtures being produced and being placed. The degree of compaction shall be determined through measurement of actual pavement density using a nuclear density gauge in accordance with ASTM D 2950 and a laboratory compacted specimen density using the Maximum Specific Gravity and shall be expressed as a percentage:

$$Degree\ of\ Compaction = \frac{Pavement\ Density}{Theoretical\ Voidless\ Density} \times 100$$

(b) At the option of the Engineer, 4" (100 mm) diameter, diamond-bit drilled roadway cores shall be obtained from the constructed pavement mixtures for laboratory pavement density determination in lieu of the nuclear method.

(c) When theoretical voidless density values are not immediately available, or at the option of the Engineer, pavement compaction may be monitored by measuring the in-place density using a nuclear density gauge and comparing it to a control strip target density. The mean pavement compaction shall be at least 98% of the control strip target density and sufficiently uniform that individual test results are at least 96% of the control strip target density. If any individual test result falls below 96% of target density, the mixture represented by the test will be considered defective and the Contractor shall further compact the sublot. After further compaction, the original test site and one other randomly selected site within the sublot will be tested. The average of the two test results will be included in the mean density for that day′s production. The original test will not be included.

To determine the control strip target density, a control strip with a minimum length of 300′ (90 m) shall be constructed at the beginning of work on each pavement course. Each control strip is to remain in place and become a section of the completed roadway. A control strip shall have an area of approximately 400 yd² (325 m²) and shall be the same depth specified for the pavement course which it represents.

The materials used in the construction of the control strip shall conform to the requirements of the approved job mix formula. They shall be furnished from the same source and shall be of the same type used in the remainder of the pavement course represented by the control strip. The prepared base upon which a control strip is to be constructed shall have the prior approval of the Engineer.

The equipment used in the construction of the control strip shall be approved by the Engineer. It shall be of the same type and weight to be used on the remainder of the pavement course represented by the control strip.

Compaction of the control strip shall commence as soon as possible after the mixture has been spread to the desired thickness, and shall be continuous and uniform over the entire surface. Compaction of the control strip shall be continued until no appreciable increase in density can be obtained by additional roller passes.

Upon completion of the rolling, the mean density of the control strip will be determined by averaging the results of ten nuclear density tests taken at randomly selected sites within the control strip. The mean density of the control strip shall be the target

density for the remainder of the pavement course which it represents. Compaction shall be expressed as a percentage of the target density:

$$Percent\ Compaction = \frac{Nuclear\ Pavement\ Density}{Control\ Strip\ Target\ Density} \times 100$$

If the mean density of the control strip, as determined by cored samples taken in accordance with AASHTO T 230 Method B is less than 95% of the density of laboratory compacted specimens for surface mixtures, or 90% for base mixtures, the Engineer may order the construction of another control strip.

A new control strip may also be ordered by the Engineer if requested by the Contractor when:

(1) A change in job mix formula is made
(2) A change in the material from the same source is observed
(3) There is reason to believe that a control strip density is not representative of the bituminous mixture being placed.

If the densities are not obtained, additional rolling or the use of more approved rollers will be required. All roller marks shall be rolled out.

401.12 Joints. Placing of bituminous concrete shall be as nearly continuous as possible. The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint between old and new pavement or between successive days′ work, the joint shall be made by placing a bulkhead or tapering the course. If the course is tapered, the edge shall be cut back to its full depth and width on a straight line to expose a vertical surface to remove the taper prior to placing the next section. It is not the intent of this Section to require an existing (old) pavement to be cut back full depth transversely when the paving work being performed is an overlay tie-in unless such is designated in the Special Provisions or on the Plans. With either method, all contact surfaces shall be coated with an approved tack material before placing any fresh mixture against the joint.

Longitudinal joints shall be rolled directly behind the laying operations. The first lane shall be true to line and grade and have a vertical face. The material being placed in the abutting lane shall be tightly compacted against the vertical face of the previously placed lane. The finishing machine shall be positioned so that the spread material overlaps the edge of the lane previously placed by 1 to 2" (25 to 50 mm), and is left sufficiently high to allow for compaction. Before rolling, the material overlapping the joint shall be carefully deposited adjacent to the joint of the unrolled lane with a lute. When the abutting lane is not placed the same day, or the joint is distorted by traffic or other means, the edge shall be carefully trimmed to line and coated uniformly with tack material. The longitudinal joint in any layer shall offset that in the layer immediately below by approximately 6" (150 mm). However, the joints in the completed surfacing shall be at the lane line.

401.13 Surface Requirements. After final rolling, the surface will be tested longitudinally and transversely by the Engineer using a 10′ (3.048 m) rolling straightedge or straightedge at locations selected by the Engineer. The distance between the surface and the testing edge of the straightedge between any two contact points shall not exceed the following limits:

(a) For Base Courses:
  (1) Lower courses: ±3/8" (±10 mm)
  (2) Top course: ±¼" (±6 mm)
(b) For Surface Courses:

(1) Multiple and single course construction: ±¼" (±6 mm)

Areas found to exceed these tolerances shall be corrected, or removed and replaced by the Contractor, as directed, to conform to the required surface tolerances.

The Contractor shall have available at all times an approved 10′ (3.048 m) straightedge for use by the Engineer.

401.14 Method of Measurement. The quantity of hot-mix, hot-laid bituminous concrete will be measured as the actual number of tons (metric tons) for hot-mix bituminous concrete placed and accepted. The weight shall be calculated as specified in Subsection 109.01.

Actual measurement of the quantity of tack coat applied will not be required.

401.15 Basis of Payment. The quantity of hot-mix, hot-laid bituminous concrete will be paid for at the Contract unit price per ton (metric ton). Price and payment will constitute full compensation for furnishing, preparing, hauling, and placing all materials, including asphalt for tack coat; for removing hot-mix bituminous concrete from around manholes, drainage inlets, valves, and similar features; for removing and replacing excess asphalt cement, as determined by the Engineer; for applying a fog coat; and for all labor, equipment, tools, and incidentals required to complete the work, including the correction of defective work.

SECTION 402 – HOT-MIX BITUMINOUS CONCRETE AND COLD-LAID BITUMINOUS CONCRETE FOR TEMPORARY ROADWAY MATERIAL (TRM)

402.01 Description. This work consists of furnishing and placing hot-mix bituminous concrete and cold-laid bituminous concrete as temporary roadway material (TRM) for the maintenance and repair of the roadway, for pipe and utility crossings, for driveways and entrances, for temporary ramps up to curbs, and for other areas as directed by the Engineer. TRM under this Section shall not be used for constructing detour roads or other temporary roadway; however, it can be used for their maintenance.

402.02 Materials. Materials for TRM shall conform to the following Sections:

Cold-Laid Bituminous Concrete 815
Hot-Mix Bituminous Concrete 823

402.03 Construction Methods. Repair of the existing pavement and the placement of TRM, hot or cold, shall be done as approved or directed by the Engineer. The work shall be coordinated with all other work and operations necessary to maintain traffic.

402.04 Method of Measurement. The quantity of hot-mix bituminous concrete and cold-laid bituminous concrete for TRM will be measured as the actual number of tons (metric tons) for each type of bituminous mixture placed and accepted.

402.05 Basis of Payment. The quantity of hot-mix bituminous concrete and the quantity of cold-laid bituminous concrete will be paid for at the respective Contract unit prices per ton (metric ton). Price and payment will constitute full compensation for furnishing, preparing, hauling, placing, and compacting all materials and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 403 – PLANT MIX OPEN-GRADED WEARING SURFACE

403.01 Description. This work consists of furnishing all materials for and constructing an open-graded wearing surface.

403.02 Materials. Materials for open-graded wearing surfaces shall conform to the requirements of Section 823. An approved heat-stable, anti-stripping agent shall be added to all asphalt cement used for open-graded wearing surfaces.

EQUIPMENT.

403.03 Hauling Equipment. All requirements of Subsection 401.04 shall apply.

403.04 Pavers. All requirements of Subsection 401.05 shall apply.

403.05 Rollers. Rollers shall be in good condition and be capable of reversing without blacklash. The use of equipment which results in crushing of the aggregate will not be permitted. Rollers shall be steel-wheeled capable of exerting a load of not less than 250 lb/in (4.5 kg/mm) of width of compression roll or rolls. Rubber tired rollers will not be permitted on the open-graded wearing surface.

CONSTRUCTION METHODS.

403.06 Placement. The pavement shall be constructed in conformance with the requirements of all applicable Subsections of Section 401.

The mix shall be spread and struck-off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width of the roadway or over such partial width as may be practicable. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be spread and luted by hand tools.

No open-graded wearing surface shall be placed when the ambient temperature is below 65 °F (18 °C).

403.07 Compaction. After the bituminous mixture has been spread and struck off, and the surface irregularities adjusted, the mixture shall be thoroughly and uniformly compacted by rolling. The bituminous mixture shall be rolled in a longitudinal direction, commencing at the outside edge of the roadway and progressing towards the center. Rolling shall be accomplished with a steel-wheeled roller or rollers, conducted in such a manner that shoving, distortion, or stripping will not develop beneath the roller. On superelevated curves, the rolling shall commence on the low side and progress to the high side. The amount of rolling shall be limited to only that necessary for consolidating the bituminous mixture and bonding it to the underlying surface. Excessive rolling shall be avoided.

The completed bituminous mixture shall be protected from all traffic until it has cooled sufficiently to resist distortion, abrasion, or pickup.

The Contractor is advised that early breakdown is essential due to rapid temperature loss of the open-graded mix. It is anticipated that two complete passes of the roller will provide adequate compaction. Density tests on the open-graded wearing surface will not be conducted. The Contractor will be directed to cease rolling when, in the opinion of the Engineer, maximum density has been achieved. Determination will be by visual means. Over-rolling will result in aggregate fracture, which

shall be avoided.

403.08 Joints, Trimming Edges, and Cleanup. Placing of the bituminous mixture shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back the previous run to expose the full depth of the course. A tack coat shall be used on the contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

The exposed edges of the completed mat shall be cut off true to the required lines. Material trimmed from the edge, and all other discarded bituminous mixture, shall be removed from the roadway and disposed of by the Contractor.

403.09 Finished Work Samples. The Engineer may cut samples from the pavement for testing. Samples will be neatly cut by a saw or core drill. The Contractor shall supply and place new material to backfill voids left by sampling.

403.10 Method of Measurement. The quantity of bituminous plant mix open-graded wearing surface will be measured as the actual number of tons (metric tons) for bituminous plant mix open-graded wearing surface placed and accepted. The weight will be determined according to Subsection 109.01.

403.11 Basis of Payment. The quantity of bituminous plant mix open-graded wearing surface will be paid for at the Contract unit price per ton (metric ton). Price and payment will constitute full compensation for furnishing, preparing, hauling, and placing all materials, including anti-stripping agent; for furnishing and placing materials in voids left by sampling; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 404 – BITUMINOUS SURFACE TREATMENT

404.01 Description. This work consists of constructing one or more courses of bituminous material and aggregate upon the completed and accepted foundation or existing surfacing.

MATERIALS.

404.02 Asphalt. The asphalt for bituminous surface treatment shall be RC-70 or CRS-1 for the prime coat and RC-250 or CRS-2 for seal coats. All material shall conform to the requirements of Section 811 or 817 whichever is applicable.

The material used shall be applied within the following temperature limits:

Material	*Limits*
RC-70	80 to 150 °F (27 to 66 °C)
RC-250	100 to 175 °F (38 to 79 °C)
CRS-1	70 to 140 °F (21 to 60 °C)
CRS-2	125 to 185 °F (52 to 85 °C)

404.03 Coarse Aggregate. Coarse aggregate shall conform to the following requirements:

(a) Coarse aggregate for the initial treatment may consist of crushed slag composed of clean, tough, durable pieces of air-cooled blast-furnace slag, reasonably uniform in density and quality, and free of glassy particles, coke, dirt, or other objectionable matter.

(b) Crushed slag in dry condition shall weigh not less than 70 lb/ft³ (1120 kg/m³) when tested according to AASHTO T 19/T 19M, Rodded Method.

(c) Coarse aggregate for initial treatment may also be crushed stone or crushed gravel weighing not less than 95 lb/ft³ (1520 kg/m³) when tested according to AASHTO T 19/T 19M and conforming to the requirements of Section 805.

(d) The slag, crushed stone, or crushed gravel shall conform to the grading requirements of Section 813, Delaware No. 57 or 67.

(e) Coarse aggregate for the two treatments following the initial application shall consist of crushed chips composed of crushed stone, crushed gravel, or crushed slag, conforming to the requirements of Section 813, Delaware No. 8.

404.04 Fine Aggregate. Sand for tack coat shall conform to the requirements of Section 804.

EQUIPMENT.

404.05 Distributors. The distributors used shall be capable of uniformly applying the bituminous material in liquid form. Devices to control the pressure, volume, and temperature shall be provided. Each distributor shall have an approved calibration chart, be equipped with an approved sampling device, and conform to the following:

(a) *Pressure.* The pressure shall be supplied by a positive displacement pump or air compressor. The pressure shall be uniform throughout the entire width of spray. If pressure is supplied by an air compressor, automatic controls must be provided to maintain sufficient and even pressure throughout the application of an entire load.

(b) *Temperature.* The distributor shall be equipped with a heating system that applies heat uniformly across the width of the tank. Provisions shall be made for circulating or agitating the material whenever necessary while heating. The distributor shall be equipped with a thermometer marked in degrees Fahrenheit (Celsius) of sufficient range to determine the actual temperature of the material.

(c) *Tachometer.* All distributors shall be provided with an approved tachometer recording feet (meters) per minute with a tabulation of feet (meters) per load with adjustments. Each load tabulation shall start at zero. There shall also be a totaling tabulation of this instrument.

(d) *Volume.* A tachometer shall give correct readings of the speed, and the volumetric efficiency of the distributor shall ensure the correct volume at various speeds. Tests shall be required to prove the volumetric efficiency of the distributor at various speeds as directed by the Engineer.

(e) *Circulating System.* All pump distributors shall be equipped with a circulating system designed to maintain a homogenous liquid while circulating in the distributor tank. This circulating system shall also be arranged to circulate the material in the tank truck before application.

Air distributors shall be equipped with a device for agitating the bituminous material in the tank trucks when necessary.

(f) *Tests.* Necessary tests shall be made to determine the accuracy of all pressure gauges, tachometers, and pump efficiencies. The tests shall be made by the Contractor when and as required.

(g) *Spray Bars.* Each distributor shall be equipped with spray bars capable of applying material uniformly throughout the entire length of the spray bars when they are extended. Spray bar extensions shall be provided for applying up to a 24′ (7.3 m) width in one operation. Spray bars shall be equipped with a cleaning device and a shut-off valve to prevent dribbling, dripping, or streaking.

(h) *Tank Capacity Gauge.* A float or other approved type tank capacity gauge shall be furnished to indicate the volume in the tank in not less than 25 gal (100 L) units. The gauge shall have adjustments for correction.

Tanks shall have a minimum capacity of 750 gal (2800 L).

If the Engineer deems that the equipment applying the material is inadequate or fails to comply with all regulations, the Engineer will order the equipment to be removed from the job and require that another unit be placed on the work.

404.06 Mechanical Spreader. The Contractor shall furnish and operate at least one approved mechanical spreader capable of receiving the material to be spread and being accurately adjusted to distribute the aggregate uniformly at a regulated truck speed.

404.07 Broom Drag. A broom drag shall be furnished and used on the initial application of coarse aggregate. The broom drag shall be a non-revolving type, at least 15′ (4.5 m) in length, and shall have at least four rows of brooms. One row must be at each end of the drag.

404.08 Rollers. The Contractor shall furnish and operate at least two power rollers. One power roller shall be three-wheeled, rated by the manufacturer to be between 5 and 8 tons (4500 and 7300 kg). The other power roller shall be a self-propelled, pneumatic-tired roller of approved design and weight, unless otherwise directed.

The tires of the rubber tire roller shall be uniformly inflated. The difference between the pressure in any two tires shall never be greater than 5 psi (35 kPa). The Contractor shall provide means for checking the tire pressure on the job at all times.

CONSTRUCTION METHODS.

404.09 Seasonal and Weather Limitations. Surface treatment shall not be applied during the following conditions:

(a) on any wet or frozen surface,

(b) when the ambient temperature is below 50 °F (10 °C)
(c) between October 1 and April 15, without written permission from the Engineer, and
(d) when the weather conditions prevent the proper completion of the work, as determined by the Engineer.

404.10 Application. The bituminous surface treatment shall be completed according to the following procedure.

The first application of bituminous material shall not be applied until the moisture content of the foundation is within 2% of the optimum moisture content and the roadway has been properly shaped and approved. An initial application of priming asphalt shall be applied at the rate of approximately 0.5 gal/yd² (2.3 L/m²). Then, approximately 50 lb/yd² (27 kg/m²) of stone or 40 lb/yd² (22 kg/m²) of slag shall be spread from a mechanical spreader. After the initial treatment, two treatments shall be applied using approximately 0.30 gal/yd² (1.4 L/m²) of sealing asphalt and from 17 to 20 lb/yd² (9 to 11 kg/m²) of crushed chips for each application. If slag is used, approximately 0.35 gal/yd² (1.6 L/m²) of sealing asphalt shall be used for each treatment.

404.11 Heating and Application of Bituminous Material. Bituminous materials used for each treatment shall be heated in a manner that ensures even heating of the entire mass and maintained within the specified temperature and pressure range during application. Any material which has been damaged shall be rejected, and any section treated with damaged material shall be removed and replaced.

The bituminous material shall be applied in one application at the rates specified using the pressure distributor for the full width of the treatment, unless otherwise directed.

The nozzles of the spray bar shall be kept clean at all times. If one or more nozzles becomes blocked during the application of bituminous materials, the distributor shall be stopped immediately, and the nozzles shall be cleaned. The streaked areas shall be made uniform using a hand hose or other approved methods.

Joints shall be made by an approved method that ensures proper seal with the preceding application. All excess bituminous material at the transverse junction between distributor loads shall be removed and corrected in a satisfactory manner.

If the Contractor is unable to keep the application uniform, the operation shall be discontinued until a more experienced operator or a better distributor, or both, can be provided; or, the Contractor shall take such other precautions as may be necessary to keep the application within specified limits.

When applying bituminous materials adjacent to structures or curbs, the Contractor shall furnish and use effective means of protecting the structures or curbs from discoloration.

404.12 Spreading of Coarse Aggregate. As soon as the bituminous material has been applied, it shall be uniformly covered with the specified amount of coarse aggregate. The aggregates shall be applied immediately after the application of the bituminous material for prime and seal coats.

Spreading shall be done directly from trucks using approved mechanical spreaders. Trucks or spreaders shall not drive on the uncovered bituminous material.

During the spreading of coarse aggregate, a crew equipped with hand brooms shall broom all areas where the aggregate has been unevenly applied. Additional aggregate shall be placed by hand on all areas not properly covered. If directed, the surface shall then be dragged with a light broom drag until a smooth and even surface is obtained.

404.13 Rolling of Coarse Aggregate. Immediately after brooming and dragging, the coarse aggregate shall be rolled in a longitudinal direction with an approved pneumatic-tired roller or rollers. The rolling

shall begin at the outer edges of the treatment and progress toward the center, each pass overlapping the previous pass by one-half the width of the roller. This rolling shall be continuous. Enough rollers will be required to complete the rolling operation within one hour after the application of the asphalt. The rolling shall be repeated as often as required to ensure thorough keying of the coarse aggregate into the bituminous material.

404.14 Application of Sand. Sand shall be applied to asphaltic tack coats at the rate of approximately 10 lb/yd² (5.4 kg/m²) by means of approved mechanical spreaders or as directed.

404.15 Opening to Traffic. The roadway shall not be opened to traffic after the application of the treatments until bituminous materials have set and the coarse aggregate has embedded sufficiently to prevent picking up or whipping off by traffic.

Signs, barricades, lights, and necessary incidentals for detouring traffic shall be furnished and maintained by the Contractor.

404.16 Method of Measurement. The quantity of bituminous asphalt material will be measured as the number of gallons (liters) applied through calibrated distributors. To determine the number of gallons (liters) applied to the road at the application temperature, the volume of bituminous material in the distributor tank shall be measured while the distributer tank is on a level surface immediately prior to application and immediately following distribution using a rod graduated in 25 gal (100 L) increments.

The actual number of gallons (liters) distributed, corrected to the corresponding volume at 60 °F (16 °C), shall be determined using conversion tables and shall be noted on the tickets.

The quantity of coarse aggregate will be measured as the number of tons (metric tons) placed and accepted. The weight of each load will be determined according to Subsection 109.01.

404.17 Basis of Payment. The quantity of bituminous asphalt material will be paid for at the Contract unit price per gallon (liter). The quantity of coarse aggregate will be paid for at the Contract unit price per ton (metric ton). Price and payment will constitute full compensation for furnishing and storing all materials; for applying bituminous surface treatment materials and spreading, broom dragging, and rolling coarse aggregate; for removal and replacement due to damaged bituminous asphalt and aggregate material; for controlling traffic; and for all labor, equipment, tools, and incidentals required to complete the work.

Any demurrage or loss of time caused by inadequate or non-compliant equipment will be at the Contractor′s expense.

Sand will be paid for under Section 756.

SECTION 405 – BITUMINOUS SURFACE RETREATMENT

405.01 Description. This work consists of one or more applications of bituminous material followed by one or more applications of cover aggregate applied to a surface.

405.02 Materials. Materials shall conform to the requirements of Subsections 404.02 and 404.03.

405.03 Construction Methods. All provisions of Section 404 shall govern except as follows:

(a) The Contractor shall furnish all equipment, tools, labor, and incidentals required to prepare the traveled way so that it will be free from deposits of dirt, loose stone, or other

objectionable material before applying the bituminous material. Each surface or section of the traveled way must be approved before applying the bituminous material.

(b) Prime coats shall be omitted.

(c) The bituminous material application rate may be varied as directed.

(d) The covering aggregate shall be applied at approximately 17 lb/yd² (9 kg/m²), but may be varied as directed.

405.04 Method of Measurement. The quantity of retreatment and seal coats will be measured according to Subsection 404.16.

405.05 Basis of Payment. The quantity of retreatment and seal coats will be paid for according to Subsection 404.17.

SECTION 406 – HOT-MIX PATCHING

406.01 Description. This work consists of hot-mix patching portland cement and bituminous concrete pavement.

406.02 Materials. Hot-mix bituminous patching material shall conform to the requirements of Section 823.

Graded aggregate base course shall conform to the requirements of Subsection 302.02.

406.03 Construction Methods. Construction methods shall conform to the applicable Subsections of Sections 401 and 302.

The pavement shall be sawed before patching using a concrete cutting machine mounted on a sturdy frame equipped with control devices and a suitable-motor driven-diamond blade circular cutter. The equipment shall be capable of cutting a groove in a straight line to a sufficient depth so that an even, neat joint is cut to allow removal of material without damage to adjacent paving. Water shall be continuously supplied to the cutting element either by a water tank on the equipment or other means.

If the pavement is other than portland cement concrete, the equipment for cutting shall be of a type approved by the Engineer.

406.04 Method of Measurement. The quantity of hot-mix patching will be measured as the actual number of square yards per inch of thickness (square meters per 25 mm of thickness) of patching specified, placed, and accepted. The width will be measured from outside of the completed patches as constructed. The length will be the actual length measured along the centerline of pavement. The depth will be measured from patch surface to the subgrade.

406.05 Basis of Payment. The quantity of hot-mix patching will be paid for at the Contract unit price per square yard per inch of thickness (square meter per 25 mm of thickness) specified. Price and payment will constitute full compensation for removal and disposal of existing materials, for preparing the subgrade, and for all labor, equipment, tools, and incidentals required to complete the work.

Furnishing, hauling, and placing hot-mix bituminous concrete pavement and graded aggregate base course will be paid for under Sections 401 and 302 respectively.

Excavation of unsuitable material will be paid for under Section 212.

Payment for sawing and removing portland cement concrete pavement will be made in accordance

with Sections 762 and 758 respectively unless otherwise required by the Plans or Special Provisions.

DIVISION 500 – RIGID PAVEMENT

SECTION 501 – PORTLAND CEMENT CONCRETE PAVEMENT

501.01 Description. This work consists of constructing a jointed, portland cement concrete pavement on a prepared base using either fixed forms or slip forms.

When requested by the Contractor and approved by the Engineer, use of the slip-form method for portland cement concrete pavement construction will be permitted. However, when unsatisfactory performance characteristics as described in this Section warrant, the slip-form method of construction shall be discontinued.

The Engineer will evaluate the smoothness of the riding surface by using either a rolling straightedge, a straightedge, or a California-type profilograph.

501.02 Materials. Materials for portland cement concrete pavement shall conform to the following Section and Subsections:

Materials for Sealing Joints:
- Hot-Poured Joint Sealant 808
- Preformed Elastomeric Compression Seals 808
- Low-Modulus Silicone Sealant 808

Curing Materials:
- Liquid Membrane Compounds 812.02
- Polyethylene Sheeting 812.02
- Waterproof Paper 812.02

Concrete Mix Composition, Class B, Fixed-Form Paving 812.04

Concrete Mix Composition, Class B, Slip-Form Paving 812.04

Embedded Hardware:
- Tie Bars 824.02
- Coated Dowel Bars 824.02
- Load Transfer Assemblies 824.02
- Tie Bolts (including hook bolts and W-bolts) 824.02

Samples of fine aggregate, coarse aggregate, and cement shall be submitted to the Department at least 60 calendar days before any paving operations begin so that trial mixes may be made by the Department to determine the water-cement ratio and the proportions of fine and coarse aggregate.

CONSTRUCTION METHODS FOR FIXED-FORM PAVING.

501.03 Preparation of the Base Course. The base course shall be shaped, rolled, uniformly compacted, and brought to a firm, unyielding surface as specified under the appropriate Section in Division 300 or 400. The foundation shall conform to the lines and grades including 24" (600 mm) extension outside each edge of the proposed pavement, or as shown on the Plans, before any concrete forms are placed. Any portion inaccessible to the roller shall be compacted thoroughly with hand tampers weighing not less than 50 lb (22 kg), having a bearing or tamping face that does not exceed 100 in^2 (65 000 mm^2) in area. All unsuitable, soft, and yielding material which will not compact readily, shall be removed and backfilled with suitable material, and the grade shall be recompacted until no depressions develop. Should sufficient time elapse between the rough grading and the laying of the pavement to allow the foundation to become baked and hardened, whether traffic has been allowed on the grade or not, the surface shall be dampened, rescarified, and recompacted, if directed.

In preparing the foundation, the material excavated shall not be piled outside and along the line of the forms in such a manner as to interfere with the proper operation of finishing tools or machinery.

Ditches and drains shall be provided to drain the foundation. Pavement shall not be placed on frozen material. Frost crystals or mud caused by freezing and thawing shall be removed and replaced with suitable material before placing any pavement on the foundation.

The grade shall be in final condition for the placement of pavement for a distance of at least 100′ (30 m) before any paving may begin. No trucks transporting proportioned aggregates, mixed concrete, or other materials shall be permitted on the grade, unless otherwise directed.

Before any concrete may be placed, the Contractor shall check each section of the grade with an approved grade tester, mounted on rollers, wheels, or tracks, and designed to move backwards and forwards. The grade tester shall be adjustable vertically and constructed so that the points may be set not more than 1/8" (3 mm) above the required grade elevation. The 1/8" (3 mm) tolerance provided in the grade tester shall in no way be construed as permitting less than the full thickness of pavement as specified on the Plans. Measurement by string line or other methods may be employed if deemed necessary. When marks or indentations are made by the tester, the grade shall be lowered to the required depth and the tester again passed over the grade until all high spots are removed. The grade tester must be in place on the forms immediately in advance of the point where the concrete is placed. No loose earth shall be placed on the portion of the grade which lies between the grade tester and the newly deposited concrete.

501.04 Temperature Requirements for Concrete Placement. The following requirements shall govern the placing of concrete during cold and hot weather, however, the Contractor shall be responsible for the quality of the concrete placed in any weather or atmospheric conditions:

(a) Concrete may be placed when the air temperature in the shade and away from artificial heat is at least 35 °F (2 °C) and rising.

(b) The concrete shall have a temperature of 70 ± 20 °F (21 ± 11 °C) at the time of placement unless prior permission has been granted to exceed these tolerances.

(c) When concrete is being placed during cold weather and the air temperature may be expected to drop below 35 °F (2 °C), a sufficient supply of straw, hay, grass, or other suitable blanketing material shall be provided along the line of work. When the temperature may be expected to reach the freezing point, 32 °F (0 °C) during the day or night, the material so provided shall be spread over the pavement including the vertical face of the sides and/or end of the concrete to a sufficient depth to prevent freezing of the concrete. The insulating material shall be adequately secured to hold it in place on the pavement and the material shall meet the requirements of Subsection 602.11 (c). This protection shall be maintained for not less than five days. A longer period may be required if directed by the Engineer. The Contractor shall be responsible for the quality and strength of the concrete laid during cold weather. Any concrete injured by frost or freezing action shall be removed and replaced.

(d) In hot weather, when the temperature of the plastic concrete reaches 85 °F (29 °C) at the mixing plant, particular attention shall be given to the sprinkling and wetting of the foundation and forms, the placing and finishing operations, and the prompt starting of the curing operation.

(e) Concrete shall not be placed when its temperature exceeds 90 °F (32 °C) in the plastic state after mixing.

501.05 Construction Equipment. The Contractor shall furnish and maintain all equipment necessary

to complete the work. The equipment shall be at the Project site sufficiently ahead of the start of construction operations to be thoroughly examined and approved. The Contractor shall, no later than 15 calendar days prior to paving, supply the Engineer with the manufacturer′s specifications for each piece of equipment the Contractor intends to use.

The concrete shall be placed, spread, consolidated, screeded, and finished by approved equipment in such a manner that a minimum of hand finishing will be necessary to produce a dense and homogeneous pavement in conformance with the Plans and Specifications.

The finishing machine shall be power driven, designed and operated to strike-off, screed, and consolidate the concrete as it travels. It shall be of ample weight and strength to furnish pressure and withstand the requirements of the construction. The finishing machine shall be capable of being adjusted to produce the crown, width, and finish required. It shall have sufficient power and be geared to operate consistently and smoothly. All finishing machines shall be maintained in first class working order at all times. Each machine shall be equipped with two screeds and at least one pair of extra shoes for each screed. Worn shoes shall be removed and replaced.

Vibrators providing full-width vibration of concrete paving slabs may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Vibrators may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. Vibrators shall not come in contact with the joint, load transfer devices, grade, or side forms. The frequency of the surface vibrators shall not be less than 3500 impulses per minute. The frequency of the internal type vibrator shall not be less than 5000 impulses per minute for tube vibrators and not less than 7000 impulses per minute for spud vibrators. When either hand-operated spud type internal vibrators, or spud-type internal vibrators attached to spreaders or finishing machines are used adjacent to forms, they shall have a frequency of not less than 3500 impulses per minute. Contractor shall provide impulse calibrator for verification of vibrators impulses at all times. Where the existing pavement is used to support the finishing machine in lieu of a form, the wheels of finishing machines shall be adjusted to provide full bearing on the pavement and extended to prevent breaking the pavement edge.

501.06 Forms and Form Setting. Side forms shall be metal of approved design and cross-section, of depth equal to, or not more than 1" (25 mm) in excess of, the designed edge thickness of the pavement. Side forms shall have no horizontal joints. The forms shall be in lengths of not less than 10′ (3 m) except on curves of 150′ (45 m) radius or less, in which case 5′ (1.5 m) lengths may be used. Flexible or curved forms of proper radius shall be used for curves of 100′ (30 m) radius or less.

The sections shall be connected so that the joint connection has no play or movement in any direction. The forms shall be of an approved section with a base width equal to the depth of the form. The forms shall be secured to resist, without spring or settlement, the pressure of the concrete when placed and the impact and vibration of the spreading or finishing machine. The forms shall be straight and free from warp. The top surface of any section shall be at the final grade and shall not deviate from a straight line by more than 1/8″ (3 mm).

The grade under the forms shall be hard and true so that the form set upon it will be firmly in contact for its whole length and at the desired grade. All foundation that, at the form line, is found to be below established grade shall be filled to grade for a distance of 24" (600 mm) on each side of the base of the form and thoroughly rerolled or tamped. Imperfections and variations above grade shall be corrected by tamping or by cutting as necessary. No settlement or springing of forms under the spreading or finishing machine will be permitted.

Forms shall be accurately set to line and grade, joined, and staked by using no less than three 7/8" (22 mm) diameter pins 30" (750 mm) long for each 10′ (3 m) section. Shorter pins may be allowed for use if a 30″ (750 mm) length is found to be impractical.

Conformity of the alignment and grade elevation of forms with the alignment and grade elevation shown on the Plans shall be checked and, if necessary, corrections shall be made by the Contractor immediately prior to placing the concrete. Where any form has been disturbed, or any foundation become unstable, the form shall be reset and rechecked after restoring the required grade.

Where alignment permits, forms shall be set at least 800′ (250 m) in advance of the point where concrete is being placed and shall remain in place at least 12 hours after the concrete has been placed against them. The forms shall be cleaned and oiled each time they are used.

501.07 Placing Concrete. The grade shall be in a moist, but not muddy, condition at the time of placing the concrete. If required, the grade shall be thoroughly wetted with an approved sprinkling device. If the grade subsequently becomes dry, the foundation shall be sprinkled.

No concrete shall be placed adjacent to railway tracks, or around manholes, inlets, or other structures until they have been brought to the required grade and alignment. All structures that project through the pavement shall be cleaned thoroughly to permit adhesion of the concrete.

The concrete shall be placed by approved methods so that the batches will be deposited without segregation, and will be uniformly distributed and spread over the entire width of the required pavement section using a mechanical spreader. The mechanical spreader shall be self-propelled, capable of spreading the concrete mix to the desired cross-sections, and easily adjustable to spread different elevations of concrete.

The concrete shall be deposited on the grade from agitator truck chutes without segregation or from non-agitating hauling equipment with means for discharge, without segregation, through a hopper on the spreader, moving hopper or belt, or other approved conveyance. Non-agitating equipment may not be used with fixed-form paving, unless approved by the Engineer. The concrete shall be placed in horizontal layers with each successive batch placed against previously placed concrete. Spreading shall be accomplished with the mechanical spreader. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with hand shovels, not rakes. Workers shall not walk in the freshly mixed concrete with boots or shoes that are coated with earth or foreign substances.

When concrete is to be placed adjoining a previously constructed lane of pavement by mechanical equipment that is to be operated upon the previously constructed lane of pavement, then the previously constructed lane of pavement shall have attained a minimum compressive strength of 3000 psi (20 MPa) as determined by representative cylinders. If only finishing equipment is operated on the edge of the previously constructed lane, paving in adjoining lanes may be permitted after the concrete in the previously constructed lane achieves a minimum compressive strength of 2000 psi (15 MPa).

Concrete shall be thoroughly consolidated against and along the faces of all forms, and along the full length and on both sides of all joint assemblies, using vibrators. Vibrators will not be permitted to come in contact with a joint assembly, the grade, or the side form. In no case shall the vibrator be operated longer than ten seconds in any one location.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing the joints, but shall not be dumped from the discharge bucket, chute, or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

Should any foreign matter or substances fall on or be worked into the surface of a completed slab, such materials shall be removed immediately by approved methods.

501.08 Consolidating and Screeding Concrete. Following the placement of concrete, it shall be struck off to conform to the cross-section shown on the Plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the

Plans. As soon as the concrete has been spread, it shall be leveled and struck off with a finishing machine to such elevation above the finished grade that when properly consolidated, the surface shall conform to the lines and grades shown on the Plans.

Segregated particles of coarse aggregate which collect in front of the screeds shall be either thrown outside the forms or thoroughly mixed by hand with the mass of concrete already on the grade. Under no circumstances shall segregated particles be carried forward by the finishing machine and pushed into the grade in front of the concrete. Care shall be exercised to control the operation of the machine to prevent excess mortar and water from being worked to the top. The number of operations of the machine over a given area shall be held to the minimum necessary to secure the required strike-off. While the concrete is being struck off, a sufficient number of workers shall be leveling, spading along forms, and shaping the concrete ahead of the machine.

Where it is necessary to complete variable width pavement at a width of less than 10′ (3 m) or where the full design width of pavement is less than 12′ (3.6 m), a mechanical concrete spreader and finishing machine will not be required, and the concrete may then be struck off and consolidated using an approved vibrating screed and hand operated spud vibrators. The vibrating screed for the surface shall be at least 24″ (600 mm) longer than the maximum width of the slab to be struck off. It shall be of approved design and sufficiently rigid to retain its shape. The screed shall be constructed either of metal or of other suitable material shod with metal.

During the striking off process, the vibrating screed shall be moved forward on the forms, always moving in the direction that the work is progressing and manipulated so that neither end is raised from the side forms. If necessary, the striking off process shall be repeated until the surface is of uniform texture, true to grade and cross-section, and free from porous areas.

501.09 Finishing. After screeding, all laitance, surplus water, and inert material shall be worked entirely off the pavement, and the surface shall be made smooth by scraping or dragging with an approved rigid straightedge having a length of 10′ (3.048 m).

The straightedge shall be placed at the inner edge of the slab with the blade parallel to the centerline and pulled slowly and uniformly to the edge. This operation shall be repeated until the surface of the concrete is free from irregularities and makes contact at all points with the bottom of the straightedge. The straightedge shall then be moved forward one-half of its length and the process repeated.

Depressions found in the surface shall be filled with fresh concrete and consolidated by floating with a long handled float not less than 36″ (900 mm) in length. This float may also be used to smooth sections of the surface which may have become rough or torn by scraping with the straightedge.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray using approved spray equipment.

Directly after fog spraying, the straightedge shall be used in a similar manner a second time. However, at this time the smoothness of the surface will be checked, and no more scraping than is absolutely necessary will be done. During this process, the contact of the straightedge with the concrete shall be uniform over the entire length tested. At the time of this final checking, the surface shall be free from soft mortar and excess water. No floating operation will be permitted following the final straightedge.

All the edges of the new pavement shall be tooled with approved edging tools as specified. The work of tooling the edges shall be done in an acceptable manner. All tooled edges and faces shall be smooth with no irregularities, bumps, or depressions remaining in the concrete after the tooling operation is completed. The edges shall be perfectly shaped to the radius of the edging tools. The outside edge

of the face of the edging tools shall not gouge irregular depressions in the surface of the pavement. On all joints, the tools shall be guided in such a manner that the full width of the face of the tool will make a uniform depression in the surface of the pavement. This depression shall not exceed 1/16″ (1.6 mm), and it shall extend the full length of all joints. All corners, including the intersections of longitudinal joints with transverse joints, shall be molded and tooled into true corners. The concrete shall be sound and homogeneous in all cases.

When the straightedge and edge tooling operations have been successfully accomplished and all excess moisture has disappeared, the plastic concrete shall be textured transversely for the full width of the pavement using a mechanized texturing device. The texturing device shall ride on forms or be guided electronically by stringline and shall utilize use a wire comb consisting of 3/32″ (2.5 mm) wide flat steel tines, 5 to 6″ (125 to 150 mm) long, with a ½″ (13 mm) spacing between tines. The tines shall form rectangular shaped grooves approximately 3/32 to 3/16″ (2.5 to 5 mm) in width and approximately 3/16″ (5 mm), but not less than 1/8″ (3 mm), in depth. The wire comb shall meet the approval of the Engineer. The texture shall be produced by drawing the approved comb across the pavement in a transverse direction in one pass without tearing or dragging the mortar. The concrete shall be dry enough to prevent the plastic concrete from flowing back into the grooves being formed. The method used shall produce a uniform finish. The texturing device shall be kept free of hardened concrete particles. Hand brooms about 4′ (1.2 m) wide and made of wire comb as specified above shall be made available by the Contractor for use where mechanical tining cannot be performed.

501.10 Curing of Concrete. As soon as possible after the texturing operations and without marring the surface, the freshly laid concrete shall be covered with polyethylene sheeting or waterproof paper, or sprayed with membrane curing compound.

As soon as the forms are removed, all honeycombed areas shall be repaired by filling with 1:2 mortar (one part cement to two parts sand) and the ends of the transverse joints shall be opened and cleaned to full depth. After all honeycombed areas have been repaired and all transverse joints have been opened and cleaned, the edges of the pavement shall be properly cured as described in Subsection 501.11, 501.12, or 501.13.

501.11 Curing with Liquid Membrane Compounds. Application of the material shall be made immediately following final finishing or texturing before any dehydration of the concrete or checking of the surface.

The curing compound shall be applied to the finished surfaces by means of an approved automatic spraying machine. The spraying machine shall be self-propelled and shall ride on the side forms or on previously constructed pavement, straddling the newly paved lanes. The machine shall be equipped with one or more spraying nozzles that can be controlled and operated to completely and uniformly cover the pavement surface with the required amount of curing compound. The curing compound being used for the spraying operation shall be thoroughly and continuously agitated in its storage drum during the application. Spray pressure shall be sufficient to produce a fine spray and cover the surface thoroughly and completely with a uniform film. The spray nozzle shall be provided with an adequate wind guard. The curing compound shall be applied with an overlapping coverage which will give a two-coat application at a coverage of not more than 200 ft^2/gal (5 m^2/L) for each coat.

The application of curing compound by hand operated pressure sprayers will be permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms, as authorized by the Engineer. When application is made by hand operated sprayers, the second coat shall be applied at right angles to the direction of the first coat.

The compound shall form a uniform, continuous, coherent film, free from pin holes and other

imperfections, that shall not check, crack, or peel. If pin holes or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes.

Concrete surfaces that are subjected to heavy rainfall within three hours after the curing compound has been applied shall be resprayed by the method and at the coverage rates specified above. Necessary precautions shall be taken to ensure that none of the curing compound enters joints which are to be sealed. Rope of moistened paper, fiber, or other suitable material shall be used to seal the top of the joint opening. The concrete in the region of the joint shall be sprayed with curing compound immediately after the rope seal is installed. Other methods of protecting the joints may be used when approved by the Engineer.

Approved standby equipment or approved alternate methods for curing the concrete pavement shall be provided at a readily accessible location at the site of the work. The standby equipment or other method shall be used in event of mechanical failure of the spraying equipment or any other condition which may prevent correct application of the membrane curing compound at the proper time. In the event of a failure of the regular spraying equipment, the paving operation shall be suspended and the standby equipment or alternate curing method shall be used only on the remaining portion of the paving already placed.

Concrete surfaces to which membrane curing compounds have been applied shall be adequately protected for the entire curing period from pedestrian and vehicular traffic, except as required for joint sawing operations and surface tests, and from any other cause which will disrupt the continuity of the membrane. The curing compound seal shall be given utmost protection for a minimum of five days so that it will not be broken. If the curing compound is damaged by subsequent construction operations within the curing period, the area shall be resprayed.

501.12 Curing with Polyethylene Sheeting. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The sheeting units used shall be lapped at least 18″ (450 mm). The sheeting shall be placed and weighted such that it will remain in close contact with the surface covered. The sheeting shall extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for five days after the concrete has been placed, except for the limited removal necessary for joint sawing. Immediately following joint sawing, the polyethylene shall be replaced and maintained in place for the remaining specified curing duration.

501.13 Curing with Waterproof Paper. Each waterproof paper cover shall be not less than 20′ (6 m), and not more than 75′ (23 m) in length and shall be of such width that, when in place, it will extend at least 18″ (450 mm) beyond the edges of the slab to be covered. Covers may be furnished in widths corresponding to that of the slab, provided that supplemental stringer sheets, at least 18″ (450 mm) wide, are used. Such stringer sheets shall be placed along the edges of the slab under the covers. Covers not manufactured in sizes that provide the proper width shall be securely sewed or cemented together with minimum laps of 4″ (100 mm) to produce an air-tight, waterproof joint that will not open or separate during the curing period. The covers shall be unrolled from suitable poles or spools, and placed in such a manner that the surface of the concrete will not be marred. The covers shall be securely held in place along the edges of the pavement with banks of earth placed just inside the form. When placed, the adjoining covers shall overlap transversely at least 12″ (300 mm), and the lap shall be securely weighted to form a sealed joint. Additional mounds of earth shall be placed at random on the covers as necessary to keep the covers in close contact with the surface of the pavement.

Upon removal of the forms, the excess width of the cover or the supplemental stringer sheets shall be pulled over the edges and carried down to the bottom of the pavement and promptly secured

with a continuous bank of earth. When the pavement to be cured is adjacent to a previously constructed slab, the cover shall be lapped over the pavement already in place and securely held in position by a bank of earth or other suitable weight to provide a continuous sealed joint. Unless otherwise specified, the covering shall be maintained in place for five days after the concrete has been placed, except for the limited removal necessary for joint sawing. Immediately following joint sawing, the waterproof paper shall be replaced and maintained in place for the remaining specified curing duration.

In the event that hair-checking develops before the cover can be applied, curing with polyethylene sheeting or waterproof paper will not be permitted. Such hair-checked areas shall be protected with wet burlap.

All rips or holes occurring in the covers while in use shall be immediately repaired with a sealed patch to render them airtight. Covers that have become damaged or soiled to the extent that they will not provide satisfactory curing, or will mar the concrete, shall not be used.

501.14 Protection Against Rain. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than 2″ (50 mm) and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the pavement surface of the pavement. When rain appears imminent, all paving operations shall stop, and all available personnel shall begin placing forms against the exposed sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

501.15 Protection of Concrete. The Contractor shall erect and maintain suitable barricades and employ watchpersons, if required, to exclude traffic from the newly constructed pavement for the period herein prescribed. These barriers shall be arranged so as not to interfere with or impede public traffic on all lanes intended to be kept open. Necessary signs and lights clearly indicating the lanes open to the public shall be maintained by the Contractor. When it is necessary to provide for traffic across the pavement, the Contractor shall construct a suitable and substantial crossing to bridge the concrete. The bridge shall be adequate for traffic and satisfactory to the Engineer. Any part of the pavement damaged prior to its final acceptance shall be repaired or replaced by the Contractor in a manner satisfactory to the Engineer. The Contractor shall protect the pavement against public traffic and the traffic of its employees and agents.

501.16 Joints. Joints of the type and dimensions indicated shall be constructed at locations required by the Plans or Special Provisions.

(a) *Transverse Contraction Joints.* Transverse contraction joints shall be spaced at intervals no less than 6.5′ (2 m) and no greater than 45′ (13.5 m), or as directed.

A load transfer device as shown on the Plans or an approved alternate design shall be placed across each contraction joint. The device shall include positive, rigid means for accurately positioning and adequately supporting the load transferring parts regardless of the nature of the foundation material. The positioning and supporting components shall be capable of resisting all normal forces imposed on joint devices during shipment, handling, installation, and during all the concreting operations. The dowels shall be installed and maintained parallel to each other and parallel to the pavement surface, and shall be placed midway in the depth of the pavement.

At least two weeks prior to concrete paving, the Contractor shall submit, for approval, a representative assembled load transfer device. The representative device shall be complete in all details including tools, installation equipment, and other appurtenances. When so directed, the Contractor shall maintain the approved representative device on the Project. All load transfer devices furnished for use on the Project shall be at least equivalent to the approved device.

The device shall be so designed that extreme accuracy in locating the saw-cut over the center of the device is not necessary for it to function properly.

When the load transfer device is in place on the foundation, it shall act as a rigid unit with each component part securely held in position relative to the other members of the assembly. The entire device shall be held securely in place during the placing, consolidating, and finishing of the concrete by means of metal stakes which shall penetrate the foundation at least 12″ (300 mm). At least ten stakes shall be used for each section of assembly that is between 10 and 12′ (3.0 and 3.6 m) long. The Contractor shall check the horizontal alignment of the dowel bars by an approved means and the vertical alignment of each dowel bar by means of a leveling device. The leveling device shall be so constructed that it may be adjusted to the correct grade when set on the side forms. All deviations from correct alignment greater than 1/8″ in 12″ (3 mm in 300 mm) shall be corrected before any concrete is placed.

Care shall be exercised in depositing the concrete at the dowel bar assemblies so that the horizontal and vertical alignment of the assemblies will be maintained.

The load transfer device shall be fabricated from corrosion resistant, coated dowel bars conforming to AASHTO M 254, Type A or Type B coating. Type B fusion-bonded, epoxy powder coated dowels shall be lubricated at least one hour before the concrete is placed around the load transfer device. Each dowel bar shall be rendered bondless with an approved bond breaker. If a graphite lubricant paste is used, the paste shall consist of an approved mixture of flake graphite, oil vehicle, and dryers. The lubricant shall be applied to the dowels by daubing, mopping, or gloved hand to produce a coating approximately 1/16″ (1.6 mm) thick. Brushes shall not be used to apply the lubricant.

Unless otherwise specified or directed, all transverse contraction joints shall be sawed. Sawing shall be done with approved sawing equipment. The saw shall be equipped with adequate guides, blades, guards, water cooling system, and a method of controlling the depth of cut. An adequate supply of water, and a standby saw in good working condition with an ample supply of blades shall be available at the site of the work during the sawing of contraction joints.

Joints shall be sawed in succession as soon as the saw can be operated on the pavement without damaging the surface or washing the mortar away from the coarse aggregate adjacent to the joint. The sawing shall be regulated so that each joint is sawed at the proper time. Sawing shall continue until all joints in the newly placed concrete are completed. The joints shall be sawed completely from edge to edge of the pavement. When a membrane curing agent is used, the edge of exposed pavement shall be sprayed with the curing agent upon the completion of the sawing of joints. All transverse joints shall be sawed without delay to prevent uncontrolled random cracking, usually four to 24 hours after the concrete placement, depending on the weather. Adequate lighting shall be provided to facilitate sawing operations performed during the night. If the wet sawing method is used, the joint shall be flushed clean with water after the concrete has gained sufficient strength to preclude washing of mortar from the joint faces.

A chalk line or other suitable guide shall be used to mark the alignment of joints. The saw cut shall not vary more than ½″ (13 mm) from true alignment. Where the pavement is built in two or more separately poured lanes, the joints shall be continuous for the full width of pavement.

A rolled crepe tissue paper, foam backer rod, or approved similar product, of suitable width shall be inserted in the joints immediately after the sawing and flushing operations have taken place.

(b) *Longitudinal Contraction Joints.* Deformed steel tie bars of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured on chairs or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, approved hook bolts, or W-bolts, as specified on the Plans shall be used.

Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width, and line shown on the Plans. Suitable guide lines or devices shall be used to ensure cutting the longitudinal joint on the true line as shown on the Plans. Sawing of longitudinal joints shall be performed prior to the widening of transverse joints in a two-stage sawing operation. The longitudinal joint shall be sawed not later than five days after the concrete has been placed and before any equipment or vehicles are allowed on the pavement. When a multiple lane pavement is being constructed, all required sawing of longitudinal joints shall be performed on the pavement in place before additional lanes are constructed. Sawing of longitudinal joints shall be continuous across all transverse joints. Whenever sawing is discontinued, the cut shall terminate at a transverse joint. The sawed area shall be thoroughly cleaned and the joint shall immediately be filled with sealer or approved backer rod.

(c) *Construction Joints.* The finished pavement shall be constructed to the full pavement width regardless of whether the fixed-form or slip-form method is used. Finished pavement in excess of 24′ (7.2 m) wide and ramps or other pavement of non-uniform width shall be constructed in a manner to minimize formation of longitudinal construction joints. Transverse construction joints shall be constructed when there is an interruption of more than one hour in the concreting operations. Transverse construction joints shall not be constructed within 10′ (3 m) of an expansion joint, contraction joint, or transverse plane of weakness. If necessary, an unanticipated construction joint shall be moved back to the last plan joint and the excess concrete removed and disposed of as directed.

Construction joints shall be formed by securing in place a removable bulkhead or header board, or alternatively as specified in Subsection 501.27. If a header board is used, it shall conform to the full cross-section of the pavement and shall be secured flush with the subbase and parallel to the normal transverse joints. The board shall be slotted or drilled to accommodate reinforcement as required by the Plans. The face of the form shall be oiled prior to concrete placement.

The roll of laitance and grout that usually forms in front of the paver shall not be used adjacent to transverse construction joints. Concrete adjacent to transverse construction joints shall be consolidated full width and depth using mechanical, hand-type, spud vibrators. One auxiliary vibrator shall be available for use in the event of mechanical malfunctions.

The Contractor shall stringline and correct variations of the concrete surface within

30′ (9 m) on either side of transverse construction joints before the final finish is applied to the concrete. The surface shall be stringlined longitudinally. Surface deviations of more than 1/8″ in 10′ (3 mm in 3.048 m), in any direction, shall be corrected while the concrete is in a plastic condition.

Longitudinal construction joints shall be constructed by skilled concrete workers using tooling devices and edging tools while the concrete is in a plastic state. The Contractor shall use methods and equipment that ensure that joint reinforcement is properly located and not disrupted during construction.

All construction joints, transverse and longitudinal, shall be tooled with rounded or beveled edges to a radius or length specified on the Plans, or as directed, to accept the required joint sealant. Any joint of insufficient size or radius, or of poor workmanship, shall be corrected and sealed as directed.

501.17 Surface Test. The surfaces of finished concrete pavements will be tested by the Engineer using either a rolling straightedge, a straightedge, or a California-type profilograph. The California-type profilograph will be used unless otherwise stated in the Contract. All surface variations that exceed the tolerances specified for the type of test will be corrected and all excessive roughness shall be corrected before the work will be considered acceptable.

(a) *General.* In the absence of the requirement for profilograph testing as specified in (b) below, surface testing will be performed with a rolling straightedge or a straightedge as described in the following paragraph. The finished surface of the pavement shall be within the tolerance of the following surface trueness test.

Finished concrete pavement will be tested by the Engineer for trueness in each wheel lane at the completion of the required curing or protection period. The surface will be tested by means of a rolling 10′ (3.048 m) straightedge, or a 10′ (3.048 m) straightedge placed parallel to the center line of the pavement, parallel to the grade line and touching the surface. Surface variations of the pavement measured by the 10′ (3.048 m) rolling straightedge or measured from the base of the straightedge to the surface of the pavement shall not exceed 1/8″ (3 mm). Surface variations which exceed 1/8″ (3 mm) up to and including ½″ in 10′ (13 mm in 3.048 m) will be marked and shall be removed by an approved grinding tool or a device consisting of multiple saws. The use of a bush hammer or other impact devices will not be permitted. Determination of pavement thickness will be made after the removal of high spots.

Areas which vary from the true surface by more than ½″ (13 mm) shall be diamond ground or removed and replaced with pavement of the specified quality and smoothness. When it is necessary to remove the pavement to eliminate surface variations, the sections removed shall be full lane width or the total width between longitudinal joints of the pavement, and shall be not less than 10′ (3 m) in length. Pavement to be removed shall be saw-cut full depth along the faces of the patch. Pavement replaced shall conform to Section 501 in every respect.

(b) *Profilograph Testing.*

(1) *General.* This test is performed in accordance with Department's Materials Manual to provide a value (Profilograph Ride Index, or PRI) for the riding surface smoothness of a traveled way and to locate excessive deviations ("must-correct" areas) in the relative profile of the riding surface.

The areas subject to smoothness testing will be designated as Primary

Surfaces, Secondary Surfaces, and Shoulder Surfaces. Unless otherwise designated on the Plans, Primary Surfaces, Secondary Surfaces, Shoulder Surfaces, and surfaces not subject to smoothness testing are defined as follows:

a. Primary Surfaces will be the traveled way consisting of mainline pavements (width limited to lane widths as shown on typical sections), shoulders described on the Plans as future traffic lanes, bridge transition and approach slabs, bridge decks, connectors, and ramps with radii of curvature of at least 1000′ (300 m).

b. Secondary Surfaces will be the traveled way consisting of full-width acceleration and deceleration lanes and ramps with radii of curvature less than 1000′ (300 m).

c. Shoulder Surfaces shall be concrete shoulders of at least 3′ (1 m) width.

d. Areas not subject to surface smoothness testing will be shoulders less than 3′ (1 m) wide, driveways, parking areas, tapers, gore areas, and within 20′ (6 m) of the ends of areas that lead to and leave from areas not subject to surface smoothness testing.

Any areas of riding surfaces not subject to surface testing using the profilograph will remain subject to other surface smoothness requirements of this Section.

(2) *Construction Requirements.* The profile of all areas subject to smoothness testing shall be within 1″ (25 mm) of the plan design profile.

The Contractor shall identify the locations of the limits of each test segment as identified by the Engineer with approved permanent markings in the pavement. This identification may be a scribe mark made at the time of paving into the top surface of the plastic concrete near the side of the slab. This marking must remain visible until all of the riding surface testing is complete.

(3) *Initial Testing Schedule.* Upon acceptable completion of the construction of each test segment of Primary or Secondary Surface, including all patching and other such work which may change the measured smoothness of the riding surface, but before any grinding or other such surface altering work, the Engineer will test and evaluate the riding surface smoothness.

Testing will be performed as soon as practical after construction of a full test segment, after curing has progressed to the point that the test equipment can properly ride the surface, and after the Contractor has cleared the area and requested testing by the Engineer. Results of this first evaluation will include a listing of "must-correct" areas and an Initial PRI. These results will be available to the Contractor within three working days after the test has been performed. All profilograph traces for the Project will be available for the Contractor′s review at the Engineer′s field office.

(4) *Performance Requirements.* Each area having a deviation in excess of 0.30″ (7.5 mm) above a reference line between two points which are up to 25′ (7.62 m) apart on the traveled way surface constitute a "must-correct" area. The Engineer will report these deviations by station count where the approximate greatest deviation exists for each run made.

Prior to attempting to correct any "must-correct" area, the Contractor must receive approval for the proposed equipment and procedures from the Engineer.

For bridge deck surfaces, the Contractor must furnish and use a pachometer to locate the top of the reinforcing steel prior to any corrective work. Generally, the Contractor may use grinding equipment that utilizes diamond cutting blades gang-mounted on a self-propelled machine. As a requirement for approval, this equipment must have demonstrated previous successful use in grinding similar riding surfaces. The use of bush hammers or other impact devices will not be permitted. Any areas of spalls, aggregate fractures, disturbed joints, cross-slope discontinuities, or raveling pavement will not be accepted. Grinding work shall be performed parallel to, or at right angles to, the travel lane centerline. The final texture of the surface shall be acceptable to the Engineer in terms of cross-slope drainage, skid resistance, and appearance. Cross-slope deviations in excess of 1/8″ (3 mm) over a baseline distance of up to 3000′ (900 m) will be unacceptable. In order to be accepted, the correction work may need to extend into adjacent test segments and into area not previously subject to profilograph testing.

The Contractor shall furnish and use a California-type profilograph to determine the limits of the proposed correction work for each "must-correct" area identified by the Engineer. The Contractor shall also evaluate the success of the attempted correction work with this equipment.

In addition to "must-correct" work, the Contractor may attempt to improve the PRI of a test segment. Prior to receiving acceptance of nonconforming test segments and prior to attempting to improve the PRI of a test segment, the Contractor must acceptably correct all "must-correct" areas in the test segment and present to the Engineer an acceptable profilograph trace of the full length of the test section showing satisfactory results of the correction efforts. The Engineer reserves the right to use one working day to validate this evaluation. In case of disagreements, the standard equipment used for acceptance of the correction work shall be the Engineer′s California-type profilograph and bump template. Should the Engineer′s validation work reveal a lack of conformance to these requirements, the Contractor shall perform adequate corrections and shall request another evaluation by the Engineer. The cost to the Contractor for the Engineer to validate acceptable correction of "must-correct" areas is indicated in Subsection 501.40 (d).

Also prior to attempting to improve the PRI of a test segment, the Contractor must receive approval from the Engineer for the proposed procedures and for the proposed individual locations of corrective work for the test segment. Generally, the Contractor may use similar procedures as those used for correcting "must-correct" areas and must meet the same final performance requirements for work at "must-correct" areas. The Contractor, in attempting to improve the PRI, should address the most rough areas within and immediately adjacent to the segment so that an evenly smooth traveled way results. The roughest areas may, or may not, be located where "must-correct" areas had existed. When the Initial PRI is acceptable (although a negative pay adjustment may be assessed), correction of "must-correct" areas alone may not be considered acceptable in attempting to improve the PRI. The Engineer will complete the evaluation of the improvement plan within three working days after it was received.

(5) *Final Testing and Work Schedule.* As soon as practical after the Contractor performs PRI improvement work and requests another PRI determination from the

Engineer, the Engineer will evaluate the smoothness of the test segment riding surface (but not necessarily before the Engineer has completed outstanding work in determining Initial PRI and validating "must-correct" correction work of other test segments). The result of this evaluation will be a Final PRI. This result will be available to the Contractor within three working days after the test has been performed.

If any "must-correct" deviations exist when the Final PRI is determined, the Contractor must correct them before that segment will be accepted for payment. In order to receive acceptance of any such segment after correction, the Contractor must request additional testing by the Engineer. The cost to the Contractor for the Engineer to validate acceptable correction of "must-correct" areas is indicated in Subsection 501.40 (d).

Should the total area of patching (full depth or partial depth) exceed 50 ft^2 (4.5 m^2) of the surface within a test segment, this patching occurring after the Engineer has performed PRI testing, that PRI value is no longer valid; the Contractor must request additional testing to determine a Final PRI. Regardless of the value of the Initial PRI (or the Final PRI, if that value was also determined), patching which requires retesting shall result in the Contractor requesting another PRI determination.

The Contractor has the option of requesting extra profilograph testing in addition to the runs provided by the Engineer. There will be a cost for this work as described in Subsection 501.40 (d). Also, there may be a delay before this work is completed.

Damage to joint sealants, striping, etc. caused by corrective work performed on the riding surface shall be acceptably repaired by the Contractor.

Determination of the pavement thickness will be performed after all corrective work is completed.

The Engineer will perform the work as soon as practical upon the Contractor's request but not necessarily before the Engineer has completed outstanding work in determining Initial PRI's. For scheduling purposes, the Contractor may expect the Engineer to evaluate about five test segments during a normal work day with acceptable environmental conditions. The Engineer will advise the Contractor of the results of these PRI determination tests within three working days and within one working day for validation of acceptable correction of "must-correct" areas.

501.18 Sealing Joints. Final sealing of all sawed, formed, or tooled longitudinal and transverse contraction and construction joints shall be done after all construction traffic has finished using the pavement. Transverse joints shall be filled with an approved backer rod prior to any vehicular traffic using the pavement. No widening of the joint shall be performed until construction traffic has been eliminated from the pavement. The type of pavement joint sealant to be used shall be as shown on the Plans or specified in the Special Provisions. Prior to sealing, each joint shall be thoroughly cleaned for the full depth of the saw cut by brushing, oil-free compressed air, sand blasting, or other means. The cleaning shall completely remove all traces of laitance, curing compound, saw residue, dirt, and all foreign material, in accordance with the recommendations of the sealant manufacturer.

All doweled transverse construction joints shall be sawed to the configuration of a contraction joint and sealed. Transverse construction joints tied with deformed bars may be tooled or sawed as

directed, and sealed.

(a) *Longitudinal Joint Sealant.* All longitudinal joints in the finished concrete pavement shall be sealed with hot-poured joint sealant to the configuration shown on the Plans.

All sawed joints to be sealed with hot-poured joint sealant shall utilize a polyethylene or urethane foam rod, or other approved bond breaker, sufficiently heat resistant to develop the required parabolic sealant shape and depth.

Construction joints shall be tooled and sealed as shown on the Plans. Immediately prior to installation of the backer rod and joint sealant, each joint shall be air blown, clean and dry.

Hot-poured joint sealant shall be placed in conformance with the manufacturer's recommendations concerning joint cleaning, application, and safe heating temperature.

For rounded or beveled joints, the sealant shall be installed to a depth as shown in the Standard Construction Details.

The sealing material shall be applied to each joint opening in accordance with the details shown on the Plans or as directed. Application shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. All excess material on the surface of the concrete pavement shall be removed immediately, and the pavement surface cleaned. The use of sand or similar material as a cover for the seal will not be permitted. Hot-poured joint sealing material shall not be placed when the air temperature in the shade is less than 50 °F (10 °C), unless approved by the Engineer.

(b) *Transverse Joint Sealant.* All sawed transverse joints in finished portland cement concrete pavement shall be sealed with preformed compression seals. The equipment shall be as recommended by the manufacturer of the seal and approved by the Engineer before construction is permitted to start.

Detailed design or configurations of the seals will not be specified. The Contractor shall submit the design details of the proposed seal for the Engineer's approval prior to the seal's delivery to the Project site. This approval must be requested in writing. In addition, the Contractor shall furnish a 5′ (1.5 m) sample section of the seal. The manufacturer shall certify that the seals comply with the specifications. Test data must be submitted in writing to the Department to support the certification. The size of the seal for a transverse joint shall be 1¼" (30 mm) (uncompressed width) in a 5/8″ (16 mm) joint.

Transverse joints may be constructed by stage sawing or by sawing the joint 5/8″ (16 mm) wide initially. Transverse sawing should be done as soon as possible without damage to the concrete surface. When transverse joints are constructed in two stages, the second-stage sawing will not be permitted until the concrete is at least three days old. All saw cuts must be made the full width of pavement. Decreasing the depth of saw cut at pavement edges to eliminate the need for form removal will not be permitted. In addition, scoring the area to be sawed with a trowel is also not permitted. Forms, if used, must be removed from the location of the saw cut.

When transverse joints are constructed by the two-stage method, the Contractor should be prepared to vary the width of the secondary cut. The additional width of the cut required will be equal to the width of the cracked joint below the initial saw cut. The Contractor must coordinate its final sawing and seal insertion so that a 5/8″ (16 mm) minimum width joint results. The Contractor will not be permitted to install seals in joints less than 5/8″ (16 mm) wide.

The edges of the transverse joints shall be beveled 45 degrees. Permissible

tolerances for the bevels are 1/8 to 1/4″ (3 to 6 mm) measured along the pavement surface. Should non-uniform width cracking occur at transverse joints, the Contractor may be required to supply and install wider neoprene seals in accordance with manufacturers recommendations.

The joints shall be sealed immediately following the curing period, or as soon thereafter as weather conditions permit. At the time of application of the compression seals, the atmospheric and pavement temperatures shall be above 40 °F (4 °C). The sealing can continue as long as the joints do not have water in them.

The equipment for cleaning joint openings shall consist of plows, powered and hand brooms or wire brushes, air compressors, and if necessary, joint cleaning and grooving machines to produce a satisfactory, clean and dry joint.

Before sealing the joints, the Contractor shall demonstrate that the equipment and procedures for placing the compression seal will provide a satisfactorily sealed joint. The top outer edges of the seal should be in contact with the joint faces. There should be no tendency for the seal to roll towards its center.

Installation of seals manually will not be permitted. Machine installation will be required. The installation equipment for the elastic joint seal material shall be fabricated for that purpose. The installation equipment shall be capable of installing the seal in the joints, with the vertical axis of the seal being parallel to the joint interfaces, without twisting, curling, or nicking of the seal, and shall ensure against the seal being in tension within the joint.

A lubricant shall be used to install the preformed elastic joint seal. Each lot of the lubricant shall be delivered in containers plainly marked with the manufacturer′s name or trademark, lot number, and date of manufacture. The Contractor shall submit the manufacturer′s certification that the lubricant conforms to the requirements of Subsection 808.02. The elastic seal shall be installed in the joints with the lubricant covering both sides of the seal over the full area in contact with the sides of the concrete joint. The lubricant may be applied to the concrete or seal, or both.

The seal shall be installed in a compressed condition at a depth of not less than 3/16″ (5 mm) but not more than 5/16″ (8 mm) below the surface of the pavement. The transverse seal shall be placed first.

In transverse joints, the seal shall extend the full width of the pavement without cuts or splices. In three or more lane sections, splices shall be staggered from longitudinal or adjacent joints by 12″ (300 mm). Seals shall not be spliced between adjacent joints or slab edges.

The method of installation shall be such that the joint seal shall not be stretched more than 5% of its minimum theoretical length. The method of installing the transverse joint seal shall be checked for stretching. The check shall consist of installing the seal in five joints of full pavement width, and then removing the seal immediately after installation and checking the length. If the measured length of any of these five seals is less than 95% of the length required to seal the joint, the installation method shall be modified so that stretching greater than 5% no longer occurs. Once sealing operations have started, one joint per hundred shall be removed and checked for stretch in excess of 5%. If a stretched condition is detected, the joint seals on either side shall be removed until the condition disappears. The affected joints, including the checked joints, shall be resealed in a satisfactory manner.

501.19 Opening to Traffic. The pavement shall be closed to traffic for not less than ten days after the concrete is placed. The Engineer may elect to close the pavement to traffic for a longer period of time if weather conditions make it advisable to do so. The pavement may be opened to traffic prior to the expiration of the ten-day period when the compressive strengths of representative cores taken by the Department indicate that the strength of the pavement exceeds 3500 psi (25 MPa).

501.20 Tolerance in Pavement Thickness. For the purpose of establishing an adjusted unit price for pavement lanes, units to be considered separately are defined as 1000′ (300 m) of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. The last unit in each lane shall be 1000′ (300 m) plus the fractional part of 1000′ (300 m) remaining. One core in each unit will be taken at random by the Department. When the measurement of the core from a unit is not deficient more than 0.2″ (5 mm) from the plan thickness, full payment will be made. When such measurement is deficient more than 0.2″ (5 mm) and not more than 1.0″ (25 mm) from the plan thickness, two additional cores, at intervals not less than 50′ (15 m) on either side of the short core, will be taken and used to determine the average thickness for that unit. An adjusted unit price, as provided in Subsection 501.40, will be paid for the average thickness of pavement.

Areas other than pavement lanes, such as intersections, entrances, crossovers, and ramps, will be 1000 yd^2 (800 m^2) units. The thickness of each combined unit will be determined separately. Small irregular unit areas may be included as part of another unit. At such points as the Engineer may select in each unit, one core will be taken for each 1000 yd^2 (800 m^2) of pavement, or fraction thereof, in the unit. If the core so taken is not deficient more than 0.2″ (5 mm) from the plan thickness, full payment will be made. If the core is deficient in thickness by more than 0.2″ (5 mm) but not more than 1.0″ (25 mm) from the plan thickness, two additional cores at random will be taken from the area represented and the average of the three cores determined. If the average thickness of these three cores is not deficient more than 0.2″ (5 mm) from the plan thickness, full payment will be made. If the average thickness of the three cores is deficient more than 0.2″ (5 mm) but not more than 1.0″ (25 mm) from the plan thickness, an adjusted unit price as provided in Subsection 501.40 will be paid for the area represented by these cores.

For all pavement areas, in calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 0.2″ (5 mm) will be considered as the specified thickness plus 0.2″ (5 mm). Measurements which are less than the specified thickness by more than 1.0″ (25 mm) will not be included in the average. When the measurement of any core is less than the specified thickness by more than 1.0″ (25 mm), the actual thickness of the pavement in this area will be determined by taking additional cores at not less than 10′ (3 m) intervals parallel to the centerline in each direction from the affected location until in each direction a core is found that is not deficient by more than 1.0″ (25 mm). Areas found deficient in thickness by more than 1.0″ (25 mm) shall be evaluated by the Engineer. If, in the Engineer′s judgment, the affected areas warrant removal, these areas shall be removed and replaced with concrete of the thickness shown on the Plans.

CONSTRUCTION METHODS FOR SLIP-FORM PAVING.

501.21 Prepaving Meeting. At least seven days prior to the construction of any pavement with the slip-form method, the Contractor shall conduct a prepaving meeting with the Engineer and other involved parties. Topics of discussion shall include a review of the Specifications, proposed equipment, and contingency plans in case of various possible problems.

501.22 Preparation of the Base Course. Preparation of the base course shall conform to the

requirements of Subsection 501.03; and, fine grading of the foundation and setting of the grade and alignment controls shall be completed for a distance of at least 1000′ (300 m) before any slip-form paving may begin.

501.23 Limitations of Mixing. Limitations of mixing shall conform to the requirements of Section 812.

501.24 Construction Equipment. Construction equipment for slip-form paving shall conform to the requirements of Subsection 501.05 and the following. The Contractor shall use at least one approved mechanical concrete spreader in advance of the slip-form paver. The spreader shall be independently powered and capable of spreading the concrete over the minimum width and depth of the placement area, as shown on the Plans, in a manner which will prevent segregation of the materials. The spreader shall be of such design and construction as to permit the striking-off of the concrete to a uniform thickness. No single lane placement will be permitted in mainline areas except for acceleration/ deceleration or "third lane" areas.

The Contractor shall use only a slip-form paver that has been approved by the Engineer prior to its delivery to the Project site. The slip-form paver shall be fully self-propelled, equipped with crawler type tracks, and designed so that the pavement line and surface elevation are automatically controlled by a sensor contacting a taut string or wire. The paver shall be readily and accurately adjustable as to crown and superelevation, and be able to shape and compact concrete to the required cross-section in transitions.

The paver shall be of sufficient size, weight, power, and gearing in order to furnish the needed pressure to the surface of the concrete while negotiating the expected grades and requirements for at least 24′ (7.2 m) wide concrete placement and while finishing without track slippage. No tractive force shall be applied to the paving machine except that which is controlled from the paving machine.

Vibrators, for full-width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Vibrators may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. Vibrators shall not come in contact with the joint, load transfer devices, grade, or side forms. The frequency of the surface vibrators shall not be less than 3500 impulses per minute, and the frequency of the internal type shall not be less than 5000 impulses per minute for tube vibrators and no less than 7000 impulses per minute for spud vibrators.

The paver shall have a vibrating screed or pan to operate on the surface of the concrete. The paver must be so equipped that when the forward motion is interrupted, all vibration equipment stops.

Sliding forms of sufficient shape, dimension, and strength behind the paver may be required for such a distance that no appreciable slumping of the concrete will occur. The sliding forms if needed shall be rigidly held together laterally to prevent spreading of the forms.

The Contractor may elect to submit for approval a slip-form paver having an automatic dowel bar inserter (DBI). If approved, use of the DBI would eliminate the need for pre-assembled load transfer devices. Should a DBI be approved for use, the Engineer will give consideration to place concrete directly from delivery trucks onto the grade in front of the advance spreader if the Contractor desires and can propose and demonstrate successful protection of the base course. In no case may the base course be used as a haul road. If approved by the Engineer, the concrete trucks would enter onto the base course just in front of the paving equipment and would exit from the base course as soon as possible after placement of the concrete. If a DBI is proposed and approved, use of an advance spreader may be eliminated if the Contractor can demonstrate techniques to properly protect the base course, during concrete placement, achieves acceptable rideability numbers, and meets all other criteria required for slip-form paving. The Department reserves the right to require use of an advance spreader in

conjunction with a paver having DBI capabilities should initial paving runs with the DBI machine prove unsuccessful as determined by the Engineer.

An advance spreader will be required for slip-form paving operations whenever pre-assembled load transfer devices are utilized.

501.25 Forms and Form Setting. Forms and form setting for slip-form paving, if required, shall conform to the requirements of Subsection 501.06.

501.26 Preparation for Placing Concrete. Paving shall be stopped and a transverse construction joint installed whenever paving comes to within 200′ (60 m) of completed preparation, except for the ends of the design pavement.

When placing concrete next to existing concrete pavement, the wheels of the equipment shall be adjusted to provide full bearing on the existing pavement and extended to prevent breaking the pavement edge. Edge of pavement shall be beveled before allowing equipment to run on edge. The existing concrete shall have attained a minimum compressive strength of 3000 psi (20 MPa) as determined by representative cylinders.

The location of the load transfer devices shall be accurately marked to ensure sawing the transverse joints over the center of the dowels. A pachometer will be utilized to verify load transfer dowel locations. The Contractor shall provide a suitable pachometer as approved by the Engineer.

The Contractor shall employ an adequate number of persons trained in the operation and maintenance of slip-form paving equipment.

The Contractor shall have on hand at least 100′ (30 m) of temporary forms to immediately bulkhead the pavement edges to prevent possible slumping of the concrete at the pavement edges.

The Contractor shall also have on hand a transverse bulkhead for placement of a transverse construction joint in case of an emergency stop or interruption in work.

501.27 Placing Concrete. Whether or not a DBI is used, vertical, longitudinal, and horizontal translation, and vertical and horizontal rotation will be checked by the Department for compliance with the Standard Construction Details.

These tolerances will be checked by the Department during the paving operation while the concrete is still plastic and also after the paving is completed by use of a pachometer. Initial testing will be performed on the first day′s paving run. Should any of the parameters be out of tolerance, additional use of the DBI will be prohibited until the Contractor proposes corrective methods acceptable to the Engineer. The Department reserves the right to require full depth patch replacement and new installation of dowel bars at any joint where it is determined that dowel bar locations are out of specification to the extent that future pavement failure could occur as a result of the dowel location.

The concrete may be placed by the spreader in one lift, if so desired, to roughly the full depth of the pavement. If the Contractor uses a DBI, the concrete may be deposited directly from the concrete delivery trucks onto the grade, if approved by the Engineer, to roughly the full width and depth of pavement, or an advance spreader may be utilized. The slip-form paver shall bring the concrete to final elevation and shall finish it in accordance with this Section.

If the Contractor elects to place the concrete in two equal layers, the top layer of concrete shall be placed and immediately struck off before the bottom layer becomes nonplastic. Any portion of the bottom layer of the concrete which has become nonplastic, or has been placed more than 20 minutes without being covered with the top layer, shall be removed and replaced with freshly mixed concrete. Each lift must be placed by an approved spreader in advance of the final paver.

The slip-form paver shall be operated with as nearly a continuous forward motion as possible,

and all operations of mixing, delivering, and spreading the concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum.

The load transfer dowels for a transverse construction joint shall be placed as in accordance with the Plans and Specifications before the effected concrete sets (loses plasticity). The joint installation must be completed while the concrete is still plastic and workable.

Should placement of concrete be interrupted for a period exceeding 30 minutes, a transverse construction joint shall be installed. Material shall be removed by sawing the concrete full depth and full width to create a vertical face. The location of the transverse construction joint shall occur at the planned location of a transverse joint, or is at least 10′ (3 m) from any existing or planned transverse contraction joint. Dowels would then be inserted by drilling and anchoring using methods and materials approved in advance by the Department. Should the construction of the transverse construction joint not meet requirements, the concrete placed in the area shall be completely removed to the nearest acceptable joint and a full-depth, full lane width, tied concrete patch shall be constructed by the Contractor as directed by the Engineer.

501.28 Consolidating and Screeding Concrete. Consolidating and screeding concrete shall conform to the requirements of Subsection 501.08.

501.29 Finishing. The amount of manipulation of the mix shall be held to the minimum required to bring the concrete to a proper finish.

The elevation of a new pavement edge placed adjacent to an existing pavement shall conform as closely as possible to the elevation of the existing pavement edge. Any difference in elevation which may cause ponding of water on either side of the contact joint shall be eliminated by finishing the new pavement within 12″ (300 mm) of the existing pavement by hand methods, adding or removing concrete as necessary while the concrete is still plastic and no greater than 20 minutes after placement.

501.30 Placement Performance Requirements. Several performance characteristics shall warrant the Engineer′s ordering the Contractor to halt the paving operations. Unless the Contractor can modify the operations in a manner which produces satisfactory performance, the use of the slip-form method of pavement construction shall be discontinued, and the pavement shall be properly repaired and constructed by means of the fixed-form method. Unsatisfactory performance characteristics shall include, but are not limited to, the following:

(a) Failure of the Contractor to maintain a continuous forward movement or consistent height of mix across the face of the screed or both;

(b) Failure of the Contractor to prevent excess edge slump (greater than ¼″ (6 mm), exclusive of the edge rounding). Edge slump will be tested by placing a 10′ (3.048 m) straightedge perpendicular to the centerline of the pavement and taking a vertical measurement from the bottom of the straightedge to the surface of the concrete. Edge slump will be tested while the concrete is still plastic;

(c) Failure of the Contractor to construct a smooth finished surface of pavement; and

(d) Failure of the Contractor to maintain an edge of pavement within 0.15′ (45 mm) of the specified horizontal alignment or to maintain any change in horizontal alignment within a rate of change of 1 in 50.

The surface variations of edge slump exceeding allowable tolerances shall be corrected by the Contractor, using approved methods.

501.31 Curing. Curing shall conform to the requirements of Subsection 501.10.

501.32 Protection Against Rain. Protection against rain shall conform to the requirements of Subsection 501.14.

501.33 Protection of Concrete. Protection of concrete shall conform to the requirements of Subsection 501.15.

501.34 Joints. Joints shall conform to the requirements of Subsection 501.16.

501.35 Surface Test. Surface testing shall conform to the requirements of Subsection 501.17.

501.36 Sealing Joints. Sealing joints shall conform to the requirements of Subsection 501.18.

501.37 Opening to Traffic. The pavement shall conform to the requirements of Subsection 501.19 prior to opening to traffic.

501.38 Tolerance in Pavement Thickness. Tolerance in pavement thickness shall conform to the requirements of Subsection 501.20.

501.39 Method of Measurement. The quantity of portland cement concrete jointed pavement will be measured as the number of square yards (square meters) completed and accepted. The width for measurement will be the width of the pavement shown on the typical cross-section of the Plans, the width of the additional widening where called for, or the width as otherwise directed in writing. The length will be measured on the surface along the centerline of each roadway or ramp.

The quantity of pavement subjected to surface smoothness testing will be measured as the total surface area in square yards (square meters) of all the test segments. The test segments will be continuous, but not overlapping, throughout the Project, interrupted only by areas not subject to smoothness testing. The length of each test segment will be the actual length of the segment. The total width of the test segments will be limited by the width of the traveled way indicated by the striping plan. The width of the surface material placed during the same construction operation will not alter this limitation.

Wire reinforcement, dowels, tie bars, hook bolts, load transfer devices, cleaning, sawing, tooling, and sealing of joints will not be measured.

501.40 Basis of Payment.

(a) *General.* The accepted quantity of portland cement concrete jointed pavement will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for furnishing and placing all materials, constructing all joints, curing concrete, installing and testing seals, constructing temporary bridges for access to the work, patching and installing new dowel bars at joints where dowel bar locations are out of specification, rescarifing hardened foundation, removing and replacing rejected concrete pavement, repairing substandard concrete pavement, and all labor, equipment, and incidentals required to complete the work.

(b) *Price Adjustments for Thickness Deficiency.* Where the average thickness of pavement is deficient in thickness by more than 0.2″ (5 mm), but not more than 1.0″ (25 mm), payment will be made at an adjusted price as specified in the following table:

Table 501-A
Price Adjustments for Concrete Pavement Thickness Deficiency

Deficiency in Average Pavement Thickness Determined by Cores	*Proportional Part of Contract Unit Bid Price (%)*
0.00 to 0.20″ (0.0 to 5.0 mm)	100
0.21 to 0.30″ (5.1 to 8.0 mm)	80
0.31 to 0.40″ (8.1 to 10.0 mm)	72
0.41 to 0.50″ (10.1 to 13.0 mm)	68
0.51 to 0.75″ (13.1 to 19.0 mm)	57
0.76 to 1.00″ (19.1 to 25.0 mm)	50

When the thickness of pavement is deficient by more than 1.0″ (25 mm) and the judgement of the Engineer is that the area of such deficiency should not be removed and replaced, there will be no payment for the area retained.

No additional payment over the unit Contract price will be made for any pavement which has an average thickness in excess of that shown on the Plans.

(c) *Price Adjustments for Smoothness of Riding Surface.* Payment for the work containing Primary and Secondary Surfaces will be adjusted in a manner that relates to the measured smoothness of the riding surface, as described in the following paragraphs.

No payment will be made for any subject area which has not been properly evaluated. No payment will be made for any segment which contains any "must-correct" areas. No payment will be made for any segment which has an excessively high PRI as indicated by the Payment Adjustment Schedules below. No payment will be made for repairs to damaged joint sealants, striping, etc. caused by corrective work performed on the riding surface.

Values as calculated from the Payment Adjustment Schedule for a segment′s Initial PRI will be used as a basis for payment adjustment only when the Contractor does not request a Final PRI determination.

Values as calculated from the Payment Adjustment Schedule for a segment′s Final PRI will be used when the Contractor requests a PRI determination after an Initial PRI was determined, or when the Contractor has attempted an improvement of the segment′s PRI after the initial construction of the test segment.

There may be negative adjustment values and, when the Initial PRI is used as a basis of adjustment, there may also be positive adjustment values for each of the test segments. The final total adjustment for the Project will be the addition of all the individual adjustment values calculated for all the test segments.

Table 501-B U.S. Customary Units
Payment Adjustment Schedule for Primary Surfaces

Initial PRI (in/mi)	*Contract Unit Price Adjustment (per yd²)*
Less than 5.0	$1.50
5.0 to 15.0	($0.30) multiplied by (10.0 minus "Initial PRI")
Greater than 15.0 (200 mm/km)	Corrective Work Required
Final PRI (in/mi)	*Contract Unit Price Adjustment (per yd²)*
Less than 4.0	$1.20
4.0 to 13.0	($0.30) multiplied by (8.0 minus "Final PRI")
Greater than 13.0	Additional Corrective Work Required

Table 501-C
Payment Adjustment Schedule for Secondary Surfaces

Initial PRI in/mi	*Contract Unit Price Adjustment (per yd²)*
Less than 7.0	$1.50
7.0 to 17.0	($0.30) multiplied by (12.0 minus "Initial PRI")
Greater than 17.0	Corrective Work Required
Final PRI (in/mi)	*Contract Unit Price Adjustment (per yd²)*
Less than 5.0	$1.20
5.0 to 15.0	($0.30) multiplied by (10.0 minus "Final PRI")
Greater than 15.0	Additional Corrective Work Required

Table 501-D
Smoothness Requirement Schedule for Shoulder Surfaces

Initial PRI (in/mi)	
Greater than 15.0	Corrective Work Required
Final PRI (in/mi)	
Greater than 13.0	Corrective Work Required

Table 501-B Metric Units
Payment Adjustment Schedule for Primary Surfaces

Initial PRI (mm/km)	*Contract Unit Price Adjustment (per m²)*
Less than 50	$1.50
50 to 200	($0.02) multiplied by (125 minus "Initial PRI")
Greater than 200	Corrective Work Required
Final PRI (mm/km)	*Contract Unit Price Adjustment (per m²)*
Less than 40	$1.20
40 to 175	($0.02) multiplied by (100 minus "Final PRI")
Greater than 175	Additional Corrective Work Required

Table 501-C
Payment Adjustment Schedule for Secondary Surfaces

Initial PRI mm/km	*Contract Unit Price Adjustment (per m^2)*
Less than 100	$1.50
100 to 250	($0.02) multiplied by (175 minus "Initial PRI")
Greater than 250	Corrective Work Required
Final PRI (mm/km)	*Contract Unit Price Adjustment (per m²)*
Less than 90	$1.20
90 to 225	($0.02) multiplied by (150 minus "Final PRI")
Greater than 225	Additional Corrective Work Required

Table 501-D
Smoothness Requirement Schedule for Shoulder Surfaces

Initial PRI (mm/km)	
Greater than 200	Corrective Work Required
Final PRI (mm/km)	
Greater than 175	Corrective Work Required

Other than through the above described payment adjustment, there will be no additional payment for the work involved for any "must-correct" area, or for the attempted PRI

improvement work, for any areas or segments.

(d) *Profilograph Costs.* All profilograph testing work by the Contractor shall be performed at no additional cost to the Department.

The Engineer will perform profilograph testing work, at no cost to the Contractor, to determine the Initial PRI, to determine one Final PRI, and, at the option of the Engineer, to validate (for each test segment) one set of the Contractor′s profilograph traces which showed acceptable correction of "must-correct" areas.

The Engineer reserves the right to perform other profilograph work, at no cost to the Contractor, for research purposes. The results of this research work will have no impact on the acceptability of, or the pay adjustments for, the Contractor′s work.

The Contractor may request extra work to be performed by the Engineer; there will be a cost for this work. The cost for determining the PRI shall be $500.00 per test segment. The cost for validating acceptable correction of "must-correct" areas shall be $250.00 per test segment. These costs will be deducted from the Contract payments to the Contractor.

(e) *Price Adjustment for Low Strength Concrete.* Concrete which fails to reach full 28-day design strength (f'_c) shall be subject to remedial action and prorated payment as specified in Subsections 602.25 and 602.27 respectively.

SECTION 502 – RESERVED

SECTION 503 – PATCHING PORTLAND CEMENT CONCRETE PAVEMENT

503.01 Description. This work consists of saw cutting, removing and disposing of existing portland cement concrete pavement, and replacing it with new portland cement concrete pavement.

MATERIALS.

503.02 Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 812, Class A or Class B.

Class A concrete shall have a minimum temperature of 75 °F (24 °C) at the time of placement and a compressive strength of 2000 psi (15 MPa) in six hours as measured by Sure-Cure Mold test cylinders. The Sure-Cure Mold test cylinders and all associated equipment shall be provided by the Contractor; the concrete will be sampled and tested by the Engineer. The following shall be the mix-design for Class A concrete:

Cement Content:	799 lb/yd³ (474 kg/m³)
Water to Cement Ratio by Weight:	0.34 to 0.38
Air Content:	3 to 7%
Crushed Stone to Sand Ratio by Volume:	0.60 to 0.70
Slump:	2 to 5″ (50 to 125 mm)
Admixture:	Either (a) or (b) noted below:

(a) A combination of 32 to 64 oz (900 to 1800 g) of Type E water reducing accelerating admixture per sack of cement, and 3 to 5 oz (85 to 140 g) of Type A water reducing admixture per sack of cement.

(b) A combination of 32 to 64 oz (900 to 1800 g) of Type E water reducing and accelerating admixture per sack of cement, and 3 to 5 oz (85 to 140 g) of Type D water reducing and retarding admixture per sack of cement.

Class B concrete shall be used for conventional concrete patching when early opening to traffic is not specified or required. Class B concrete shall have a minimum temperature of 75 °F (24 °C) at the time of placement and a compressive strength of 2000 psi (15 MPa) in 72 hours. Class B concrete shall conform to the following requirements:

Air Content:	3 to 7%
Slump:	2 to 5 ″ (50 to 125 mm)

The consistency of portland cement concrete, Class A or Class B, shall conform to the requirements of Subsection 812.04, except as noted above.

503.03 Bar Reinforcement. Deformed bar reinforcement shall be 5/8″ (No. 16) bars conforming to the requirements of Subsection 824.02. Dowel bars shall conform to the requirements of Subsection 824.02.

Bar reinforcement for patching of continuously reinforced portland cement concrete pavement shall conform to the requirements of Subsection 824.02. If longitudinal reinforcement bars are required, they shall conform to the requirements of AASHTO M 31/M 31M, Grade 60 (420), and shall be a minimum of 40′ (12 m) in length. If transverse reinforcement bars are required, they shall conform to the requirements of AASHTO M 31/M 31M, Grade 40 (300) or 60 (420).

503.04 Wire Mesh. Wire mesh reinforcement shall conform to the requirements of Subsection 824.02. If approved by the Engineer, fiber reinforcement may be substituted for the wire mesh. The fiber shall conform to the requirements of Subsection 824.02 and be introduced at a rate of 1.50 lb/yd³ (0.89 kg/m³) at the production plant to allow dispersion of the fibers in the concrete.

503.05 Joint Sealants. Hot-poured joint sealant shall conform to the requirements of Section 808. Low-modulus silicone rubber joint sealant shall conform to the requirements of Section 808.

CONSTRUCTION METHODS.

503.06 Patching Limits. The areas of old pavement to be patched will be indicated on the Plans, or identified by the Engineer.

The limits of the area where the pavement is to be removed and patched will be painted on the existing pavement by the Department.

Patches can be either Type I or Type II. A Type I patch is 16′ (4.8 m) or less in length and contains no wire mesh. A Type II patch is greater than 16′ (4.8 m) in length and contains wire mesh. The type of patch required will be designated on the Plans.

503.07 Conventional Concrete Pavement. The minimum length of the area to be repaired, measured along the centerline of pavement, shall be not less than 6′ (1.8 m). The pavement slab adjacent to the section being repaired shall be cut to a true, neat line with straightedges, perpendicular to the longitudinal centerline of pavement and perpendicular to the plane of the finished foundation. An approved diamond blade concrete saw shall be used to sever the patch area from the existing pavement. The existing pavement shall be removed by sawing the slab along the lines of the limits of the area to be patched, making a vertical cut to the full depth of the pavement to produce a straight, clean, vertical face. The concrete in the patch area shall be lifted out using locking keys and lifting pins or other devices inserted into holes drilled through the concrete to be removed. Additional lift-out clearance can be achieved by making wide cuts inside the patch boundaries and diamond blade saw cuts using a wheel cutter with carbide steel tips. When the lift-out method is not feasible, concrete in the patch area shall be broken by an approved mechanical pavement breaker or light jackhammers. When removing the old pavement, the foundation shall not be disturbed below the elevation of the bottom of the new concrete patch.

All removed concrete shall become the property of the Contractor and shall be disposed of according to the requirements of Section 106.09.

503.08 Foundation Preparation. The foundation shall be cut to the desired elevation to eliminate the necessity for backfilling. The foundation shall then be properly shaped, compacted, and brought to a firm and unyielding surface by tamping or by other approved methods to meet the requirements of Subsection 302.04 (c). Upon removing the existing pavement, if the foundation materials are found unsatisfactory, the Engineer may direct that the unsuitable material be removed and replaced with approved material. The replacement material shall be placed and compacted as required under Subsection 202.05 or as specified on the Plans.

The foundation shall be sprinkled to be moist, but not muddy, at the time of placing concrete.

503.09 Placing Concrete. Portland cement concrete shall be placed according to the requirements of Subsection 501.07. The concrete shall be deposited directly on the foundation and shall be uniformly distributed and spread over the entire foundation.

The type and size of side forms and methods of setting shall conform to the requirements of Subsection 501.06, except that the patches shall be constructed in single lane widths unless otherwise directed. Timber forms may be used where required. Forms are required in all areas, such as along the shoulders, where existing conditions will not provide a completed patch with smooth, vertical sides.

In order to accomplish 2000 psi (15 MPa) compressive strength in six hours for Class A concrete, the Contractor shall establish actual combination of weights and proportion of admixtures as required by the field conditions, ambient temperature, humidity, and wind conditions. If because of unfavorable ambient temperature the concrete is unable to achieve the desired strength in six hours, the Contractor may reschedule for proper conditions to perform the patching work. Also, the Contractor shall contact the Department′s Materials and Research Section for consultation when the ambient temperature/concrete temperature is expected to rise above 80 °F (27 °C) during the construction of Type II patching.

503.10 Consolidating and Finishing Concrete. It is intended that the amount of manipulation be held to the minimum required to bring the concrete to a proper finish. Short patches that are generally less than 12′ (3.6 m) can be screeded either transversely or longitudinally. If a pavement is rutted, screeding in the longitudinal direction (placing the screed parallel to the centerline) may be directed by the Engineer so the patch matches the existing cross-section of the pavement. For patches over 12′ (3.6 m) in length, the screed shall be placed perpendicular to the centerline.

As soon as the concrete has been deposited, it shall be leveled and immediately struck off by means of vibratory screeds or templates. The first or forward screed shall not be less than 10″ (250 mm) in width, shall be from 18 to 24″ (450 to 600 mm) longer than the width of the pavement, and shall be constructed of a channel iron weighing not less than 25 lb/ft (37 kg/m), or other approved design. The second or follow up screed shall not be less than 8″ (200 mm) in width, shall be of the same length and construction as the first screed, and shall weigh not less than 18 lb/ft (27 kg/m), or other approved design. These screeds shall be shaped to the approved cross-sections and shall be of sufficient strength to retain their shape under all working conditions. During the screeding operation, the second screed shall follow the first screed at a reasonable distance as determined by the Engineer. The screed shall be moved forward with a combined longitudinal and crosswise motion. If necessary the screeds shall be used a second time or until a true surface is obtained. While the concrete is being struck off, at least two workers shall be at work leveling, spading, and tamping the concrete directly in front of the screed.

Hand spud vibrators shall be used to facilitate consolidation of the concrete.

503.11 Joints. Filler material shall conform to the requirements of AASHTO M 153, Type I or Type II and shall be placed directly against face of the existing concrete. For Class A concrete the joint filler shall be 1/2″ (13 mm) thick, and for Class B concrete, the joint filler shall be 3/4″ (19 mm) thick. The filler material shall extend the full width of the patch, and from the bottom of the existing pavement slab to within 3/4″ (19 mm) of the top concrete surface.

When specified on the Plans, all transverse joints shall have deformed steel tie bars and coated dowel bars installed as shown in the Plans. Tie bars shall be 18″ (450 mm) long. Dowel bars shall be 1¼″ (32 mm) diameter and 18″ (450 mm) long. Tie bars and dowel bars shall be drilled into the face of the existing pavement by approved methods. Each tie bar and dowel bar must be placed parallel with the centerline of slab, both vertically and horizontally. A guide should be used during the drilling of the holes into the existing slab to guarantee conformance with this requirement. Dowels shall be grouted in place with an approved material. The end of the dowel bar that will be in the new concrete shall be coated with grease or graphite paste.

No tie bar to adjacent concrete pavement slabs at longitudinal joints is required except when removing and replacing less than the full slab width. A bond breaker shall be placed on all concrete faces along the longitudinal joints exposed within the patch. A coat of approved latex paint or an approved alternate system may be used.

For patches longer than 16′ (4.8 m) in the longitudinal direction, wire mesh reinforcement of longitudinal 0.160″ (4.06 mm) wire spaced at 6″ (150 mm) on center and transverse 0.226″ (5.74 mm) wire spaced at 12″ (300 mm) on center shall be used. The mesh shall be placed resulting in 3 to 4″ (75 to 100 mm) of concrete cover to the surface and sides of the patch.

All transverse and longitudinal joints within the existing concrete pavement that extend through the patch area and the surface edges of all patches adjacent to the existing concrete pavement shall be tooled, formed, sawed, and cleaned to result in a properly dimensioned reservoir for sealant. The dimensions of the sealant reservoir shall be 1/2 by 3/4″ (13 by 19 mm). A bond breaking material, such as tape or a rod, shall be placed on the bottom of the reservoir prior to placement of the sealant system, in order to allow bonding of the system material to only the vertical surfaces of the concrete in the

reservoir. All joints so constructed and to be overlaid with hot-mix shall be sealed with hot-poured joint sealant within five working days of concrete placement prior to placement of the overlay hot-mix. All other joints remaining exposed as part of the existing concrete pavement shall be sealed according to the requirements of Subsection 501.18 with low-modulus silicone rubber joint sealant.

503.12 Finished Surface. The cross-section of the patch shall be finished to match the existing cross-section of the roadway. Any existing rutting shall be continued for the first 10′ (3 m) length in the direction of travel. A broomed texture, or tining as applicable, to match the existing concrete surface, is required. Surface variations greater than 1/8″ (3 mm) in a 10′ (3 m) interval along the longitudinal direction will render the work defective. Grinding is an acceptable patch-surface correction procedure.

503.13 Curing and Protecting. Curing shall conform to the requirements of Subsection 501.10. When a liquid membrane curing compound is used, it shall be applied uniformly, immediately upon completion of the patch texturing, at a rate of 0.75 gal/100 ft² (0.3 L/m^2).

Immediately after Class A concrete has achieved initial set, the entire patch shall be covered with a layer of wet burlap, followed by a 4 mil (100 μm) polyethylene sheet and an approved insulating blanket, until the concrete has reached designed strength. The patched areas shall not be open to traffic until so permitted by the Engineer.

503.14 Opening To Traffic. The pavement shall be opened to traffic when directed, but shall not be opened in less than 72 hours after placing Class B concrete or until the concrete has achieved a minimum compressive strength of 2000 psi (15 MPa) as determined by testing representative cylinders.

503.15 Continuously Reinforced Concrete Pavement. The Special Provisions, the applicable methods of Section 503, and the following requirements shall govern the patching of continuously reinforced concrete pavement.

The pavement shall be patched to preserve the continuity of the pavement. Repairs shall be made for the full width of the slab. If possible, patches shall be placed during stable weather conditions when the daily temperature variation is small.

Patching shall be done as follows:

(a) The minimum length of patch shall be 10′ (3 m).

(b) The patch shall be placed on a 1 to 4 skew across the pavement to avoid both wheels of an axle crossing the construction joint simultaneously.

(c) A groove shall be cut 1″ (25 mm) deep at each boundary of the patch without cutting the bar reinforcement.

(d) The Contractor shall saw two cuts parallel to and located 3′ - 0″ and 3′ - 6″ (0.9 and 1.05 m) respectively inside of each of the grooves which define the patch boundaries.

(e) The Contractor shall chip the concrete from between each pair of cuts down to the bar reinforcement and cut the bar reinforcement with a torch or bolt cutter.

(f) The Contractor shall remove all the concrete between patch boundaries with an air hammer, being careful not to unduly injure the stabilized foundation course, leaving 36″ (900 mm) of bar reinforcement exposed at each end of the patch area.

(g) The Contractor shall repair the stabilized foundation course as prescribed in the Plans and Specifications.

(h) The Contractor shall splice deformed bars to each member of bar reinforcement which extends into the patch area from the ends of the existing pavement. The bar reinforcement shall be lapped 36″ (900 mm). The laps shall be secured with wire ties.

Welding will not be permitted. If the bar reinforcement buckles, the Contractor shall correct just prior to placing concrete by removing and replacing the wire ties at the laps.

(i) The Contractor shall provide supplementary bars to increase the area of longitudinal steel by 50%. The splicebars and the supplementary bar reinforcement shall be firmly supported at the proper elevation above the foundation course by approved metal chairs.

(j) The Contractor shall place concrete in the patch area, using extreme care to consolidate so as to avoid honeycombing. This is particularly important because of the close spacing of the steel.

(k) The Contractor shall finish the surface of the patch to match the surface of the existing pavement. The patch shall be cured according to Subsection 501.10, and shall not be opened to traffic until the concrete has attained a compressive strength of 2000 psi (15 MPa).

503.16 Method of Measurement. The quantity of portland cement concrete pavement patch will be measured as the actual number of square yards (square meters) of concrete patch placed and accepted. The width for measurement will be the width from outside of the completed patches as constructed, measured parallel to the transverse saw cuts. The length will be the actual length measured parallel to the centerline of pavement. The thickness of the concrete patching will be the thickness specified on the Plans.

503.17 Basis of Payment. The quantity of portland cement concrete pavement patch will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for furnishing, hauling, and placing all materials, including high-early strength concrete; bar reinforcement, joint filler, and hot-poured joint sealant; for saw cutting, removing, and disposing of existing concrete; for preparing the foundation; for tooling, finishing, curing, sealing, and protecting the new concrete; for grinding the finished patch; for disposing of excess material; and for all labor, equipment, tools, and incidentals required to complete the work. In addition, the price and applicable payment(s) will be based on patches 16′ (4.8 m) or less in length without bar reinforcement (Type I patch), and patches greater than 16′ (4.8 m) in length with bar reinforcement (Type II patch).

Any damage caused by lift-out procedures will be at the Contractor′s expense.

DIVISION 600 – STRUCTURES

SECTION 601 – TIMBER STRUCTURES

601.01 Description. This work consists of furnishing, treating, and constructing timber structures of treated, untreated, and structural glue-laminated (glulam) timber.

MATERIALS.

601.02 Structural Lumber and Timber. The lumber and timber shall be dense quality long leaf or short leaf southern yellow pine or close-grained Douglas fir conforming to the requirements of AASHTO M 168. The grade of structural lumber and timber shall be as shown on the Plans. Unless otherwise specified, the timber shall be cut square and surfaced on four sides.

601.03 Glue-Laminated Timber.

(a) *General.* Glulam lumber shall be kiln-dried Douglas fir or southern pine meeting the engineering properties, such as bending stress, shear, and modulus of elasticity, as stated on the Plans and the standards of ANSI/AITC A190.1. All members shall be bonded with an exterior "Wet-Use" adhesive conforming to Voluntary product Standard PS 56-73 of the U.S. Department of Commerce, NIST.

(b) *Decks.* All milling and glue lamination shall be performed prior to treating. Planing shall be done on one side only. The top of the deck shall be left rough to ensure proper bonding with bituminous material.

The deck panel manufacturer shall have experience in manufacturing glue-laminated wood bridge members, and a qualified licensee of the American Institute of Timber Construction (AITC).

(c) *Members.* Glulam timber members manufactured for the Department's bridges shall bear a custom quality product mark as specified in ANSI/AITC A190.1. A certificate of material conformance shall be provided to the Engineer upon delivery of the member to the Project.

601.04 Preservative Treatment. Preservative treatment of timber shall conform to the requirements of Section 814 and the requirements of the AASHTO Standard Specifications for Highway Bridges.

601.05 Inspection. The timber, and the operation of treatment, will be inspected at the treating plant, both before and after treating, and all acceptable timber will be marked with the Department's standard hammer mark. All timber shall also be subject to inspection at the site of the work. If the timber is found defective, it shall be subject to rejection.

601.06 Structural Steel. Structural steel shall conform to the requirements covering carbon shapes, plates, and bars of structural quality for use in the construction of bridges. Carbon shapes, plates, and bars shall be completely galvanized according to AASHTO M 111. Thickness Grade 85 shall be used. For further material requirements refer to Section 826.

601.07 Hardware. Machine bolts, drift pins, dowels, nuts, washers, lag screws, and nails shall conform to the requirements of ASTM A 307.

Machine bolts shall have square heads and nuts, unless otherwise specified. Nails shall be cut or round wire of standard form. Spikes shall be cut or wire spikes, or boat spikes, as specified.

Nails, spikes, bolts, dowels, washers, rods, plates, and lag screws shall be completely galvanized according to the requirements of AASHTO M 232.

For glulam timber, the fabricator shall provide all steel connections and all hardware for joining wood members to each other and to the substructure. All hardware shall be galvanized mild steel AASHTO M 270/M 270M. Washers may be cast iron or malleable iron.

601.08 Working Drawings. Working drawings shall be submitted in accordance with Subsection 105.04.

CONSTRUCTION METHODS.

601.09 Storing and Handling. All lumber and timber on the site of the work shall be stacked to prevent warping. Untreated material shall be open stacked at least 12″ (300 mm) above the ground surface, and so piled as to shed water. Material shall be protected from the weather by suitable covering. Treated timber shall be carefully handled, without sudden dropping, breaking of outer fibers, bruising, or penetrating the surface with tools. Treated timber, other than piling, shall be handled with rope slings. Canthooks, peaveys, pikepoles, or hooks shall not be used. Treated timber shall be close stacked. The ground under and in the vicinity of all stacks shall be cleared of weeds and rubbish.

All bridge lumber shall be delivered and stored above grade on wooden blocks. Members shall be well supported and be leveled to avoid warping. When stacking, measures shall be taken to permit air to circulate around all four sides of each member.

601.10 Workmanship. All framing shall be true and exact. Unless otherwise specified, heads of nails and spikes shall be driven flush with the surface of the wood. Deep hammer marks in wood surfaces, splitting due to nailing, or spiking shall be considered evidence of poor quality of work and will be sufficient cause for removal of the workers causing them.

601.11 Cutting and Framing. All lumber and timber shall be accurately cut and framed to a close fit in such a manner that the joints have an even bearing over all contact surfaces. No shimming will be permitted in making joints, nor will open joints be accepted. All cutting and framing of treated timber shall be done before treatment insofar as is practicable.

All cuts and abrasions in creosote treated timbers glulam timber shall be treated shall be carefully trimmed, and then covered with two applications of a mixture of 60% creosote oil and 40% roofing pitch, or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch. The creosote oil shall be heated sufficiently to secure deep penetration but shall not be heated to the boiling point.

All cuts and abrasions in CCA treated timbers shall receive one brush application of the CCA solution used in the treatment process.

601.12 Holes for Bolts, Dowels, Rods, and Lag Screws. Bolt holes shall be treated with creosote oil-tar or CCA solution as applicable, by means of an approved device that applies the creosote oil-tar or CCA solution to the inside of the hole. Any unfilled holes shall be treated in the same manner and then shall be plugged with creosoted or CCA treated plugs.

Holes for round driftbolts or dowels shall be bored with a bit 1/16″ (1.6 mm) less in diameter than the bolt or dowel to be used. The diameter of the holes for square driftbolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

A washer, of the size and type specified, shall be used under all bolt heads and nuts which would otherwise come in contact with the wood.

All bolts shall be thoroughly checked after the nuts have been finally tightened.

601.13 Countersinking. Countersinking shall be done wherever smooth faces are required. Recesses formed for countersinking shall be treated with material as specified in Subsection 601.12 and as approved by the Engineer.

601.14 Caps. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All pile caps shall be secured in the manner shown on the Plans.

601.15 Bracing. The ends of bracing shall be bolted through the pile, post, or cap as shown on the Plans. Intermediate intersections shall be bolted as shown on the Plans.

601.16 Stringers. Stringers shall be sized at bearings and shall be placed in position so that knots near edges are in the top portion of the stringers, except over continuous supports.

Outside stringers may have butt joints, but interior stringers shall be lapped to take bearings over the full width of the floor beam or cap at each end.

Cross-bridging between stringers shall be neatly and accurately framed and securely toenailed with at least two nails in each end.

601.17 Method of Measurement. The quantity of structural lumber and timber will be measured by the thousand feet, board measure (cubic meter). The quantity will be determined from actual widths and thicknesses and the actual lengths of the pieces in the finished and accepted structure.

The quantity of glue-laminated timber deck will be measured by the square foot (square meter). The quantity will be determined from the actual length and width of the finished deck completed and accepted.

The quantity of glue-laminated timber used for other members of the structure as specified on the Plans will be measured by the thousand feet, board measure (cubic meter).

601.18 Basis of Payment. The quantity of timber will be paid for at the Contract unit price per thousand feet, board measure (cubic meter). Price and payment will constitute full compensation for furnishing all materials; for applying preservative treatment when required; for placing all material including hardware; for the replacement of all defective materials; and for all labor, equipment, tools, and incidentals required to complete the work.

The quantity of glue-laminated timber deck will be paid for at the Contract unit price per square foot (square meter). The quantity of glue-laminated timber used for other members of the structure will be paid for at the Contract unit price per thousand feet, board measure (cubic meter). Price and payment will constitute full compensation for furnishing and placing all materials, including hardware; for fabricating glue-laminated timber decks and members; for applying preservative treatment; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 602 – CONCRETE STRUCTURES

602.01 Description. This work consists of furnishing and placing portland cement concrete for structures and incidental construction.

MATERIALS.

602.02 Materials. Materials for concrete structures shall conform to the following Section and Subsections:

602.03 Permanent Steel Bridge Deck Forms and Supports. Permanent steel bridge deck forms and supports shall be fabricated from steel conforming to ASTM A 653/A 653M Grade 40 for 14-18 gage, Grade 80 for 19-22 gage and Grade 40 for accessories, and shall have a coating of Z600 according to ASTM A 924/A 924M. Deck forms shall be 20 gage (0.9 mm) minimum.

602.04 Pipe For Weep Holes. Cast iron soil pipe for weep holes shall conform to the requirements of ASTM A 74. Plastic pipe shall conform to the requirements of ASTM D 2665.

602.05 Sheet Metal For Flashing and Waterstops. Sheet copper shall conform to the requirements of ASTM B 370. Sheet lead shall conform to the requirements of ASTM B 29. Sheet zinc shall conform to the requirements of ASTM B 69.

602.06 Form Oil For Concrete Formwork. Form oil shall be a nonstaining petroleum distillate free from water, asphaltic, and other insoluble residue or equivalent product.

602.07 Waterstops. Waterstops shall be polyvinyl chloride (PVC) compounded as necessary to conform to the requirements of U.S. Army Corps of Engineers Specification CDR-C572. No reclaimed PVC from any sources shall be incorporated in the compounding. The extruded material shall be dense, homogeneous, and free from porosity or other imperfections that could affect its durability or performance.

CONSTRUCTION METHODS.

602.08 Formwork. Except where indicated elsewhere in this Section, forms shall be designed and constructed so they can be removed without injuring the concrete. Forms shall be designed for strength and deflection to resist all loads and pressures of the wet concrete, the weight of the forms, the rate of pour, the affect of vibration, the time of setting, and an addition of 50 lb/ft² (2.4 kPa) of construction live load applied to all horizontal surfaces.

For removable forms, no member shall have a deflection, under total load, in excess of 1/360 of its span length, and in no case shall the deflection exceed ¼″ (6 mm), except that deflections of form surfaces for concrete floor slabs where such forms are supported by beams, stringers, or girders may be 1/180 of the span length but not to exceed ½″ (13 mm). Where the design of the forms requires deflections in excess of these amounts, the forms shall be cambered.

Concrete shall be assumed to weigh 150 lb/ft³ (2400 kg/m^3). Lumber in forms shall be assumed to weigh 4lb per board foot (700 kg/m^3). For all other materials, other than lumber in forms, the unit weight of the material shall be used.

Formwork plywood (without backing) shall be used with the face plies running parallel to the span (or perpendicular to supports) for maximum working strength and minimum deflection.

The Contractor shall prepare and submit for approval complete detailed plans of all formwork to be constructed. Working formwork drawings shall be submitted in accordance with Subsection 105.04. The Contractor shall not proceed with formwork construction until its plans have been approved. However, approval of these plans shall not relieve the Contractor of complete responsibility for the safety and adequacy of all formwork.

The form drawings shall show all major design values and loading conditions. These include assumed values of live and dead load, rate of placement, temperature of concrete, height of drop, weight of moving equipment which may be operating on formwork, foundation pressures, design stresses, deflection and camber diagrams, and other pertinent applicable information. All pertinent design calculations shall be submitted for walls greater than 10′ (3 m) in height. In addition to specifying types of materials, sizes, lengths, and connection details, formwork drawings shall provide for applicable details such as: 1) Anchors, shores, and braces; 2) field adjustment of the form during placing of concrete; 3) waterstops, keyways and inserts; 4) working scaffolds and runways; 5) weepholes or vibrated holes where required; 6) screed and grade strips; 7) crush plates or wrecking plates; 8) removal of spreaders or temporary blocking; 9) cleanout holes; 10) construction, control and expansion joints; 11) chamfer strips; 12) notes to cover conduits and pipes to be embedded; and 13) details on shoring, reshoring, or leaving original shores in place as forms are stripped.

The material to be used for forms for exposed surfaces shall be either plywood, metal in which all bolts and rivet holes are countersunk, fiber, or other approved material. In either case, a plain, smooth surface of the desired contour must be obtained. For surfaces to be given a rubbed finish, the material shall be plywood unless otherwise specifically approved. For curved or special surfaces, the above requirements may be modified.

The form material shall be placed so a smooth surface free from irregularities is obtained. Sheets of material shall be placed so that joints are in regular and true horizontal and vertical lines. Full sized plywood sheets shall be used except where a single smaller piece covers an entire area. Where form lining is used, it shall be used in pieces as large as possible. All joints shall be solidly backed, butted tightly together, and sealed with white lead paste or other approved crack fillers. All holes shall be filled as well as depressions or hammer marks so that the completed surface is as smooth as possible. When steel forms are used, the panels shall be as large as practical and of sufficient thickness to prevent surface irregularities. Panels shall be assembled in uniform patterns and firmly locked and braced

together to form a smooth surface. Bent or irregular panels shall not be used. Round fiber column forms shall be furnished full height and shall be fitted with circular wooden templates at top and bottom and with wooden collars at intermediate points. Fiber forms shall be removed not later than ten days after pouring.

Moldings, fluting, rustification, and other ornamental details shall be formed of material specifically manufactured for the job. Samples or details of the material shall be submitted for approval by the Engineer prior to use.

All lumber shall be free from knotholes, loose knots, cracks, splits, warps, or other defects impairing the strength or the appearance of the finished structure.

When necessary because of thin wall construction, forms shall be daylighted at intervals not greater than 10′ (3 m) vertically, the openings being sufficient to permit free access to the forms for the purpose of inspecting, working, and vibrating the concrete.

The forms shall be built true to line and braced in a substantial and unyielding manner. They shall be mortar tight and, to close cracks due to shrinkage, shall be thoroughly soaked with water.

Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. The interior surfaces of the forms shall be adequately oiled, greased, or soaped to ensure non-adhesion of mortar. Form plywood and/or lumber which is reused shall be free from bulge, warp or damage and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete and any defects shall be remedied and all dirt, sawdust, shavings, or other debris within the forms shall be removed.

Blocks and bracing shall be removed with the forms and in no case shall any portion of the wood forms be left in the concrete. Special attention shall be paid to the ties and bracing and when forms appear to be insufficiently braced or unsatisfactorily built, either before or during construction, the work will be ordered stopped until the defects have been corrected. The forms shall be so constructed that the finished concrete shall be of the form and dimensions shown on the Plans and true to line and grade.

On the structures having cement concrete masonry decks, supported by beams and girders, the forms for the deck slabs shall be so constructed that under full dead load, the slabs will be of the required thickness shown on the Plans and the surface of the roadway will accurately conform to the profile grades, cross-sections and alignments as shown on the Plans. Allowance shall be made for the camber of the beams and stringers as fabricated and erected and also for the additional deflections due to dead load. The depth of haunches between the top of the stringers and the bottom of the slab as shown on the Plans, is theoretical, and due to variations in obtainable camber in the stringers and to usual inaccuracies of fabrication and erection, the depths of haunches to be constructed may vary considerably from the theoretical. The formwork shall be constructed so as to provide for any and all necessary variations in actual depths of haunches required.

602.09 Falsework. Falsework shall be designed in accordance with FHWA-RD-93-032, dated November 1993. Falsework shall be designed to be built on a firm foundation and to carry the anticipated loads without appreciable deflections as specified in Subsection 602.08 for formwork. It shall be constructed so as to provide the camber shown on the Plans for the completed structure. Proper allowance shall be made for takeup in timbers and probable falsework settlement. A "telltale" or other approved type indicator shall be attached to the forms in a manner to indicate any settlement, movement or deflections in the forms or falsework. If any of them is in excess of the prescribed tolerance(s), the work shall be stopped and the Contractor shall be required to rectify the problem to the full satisfaction of the Engineer.

The Contractor shall engage a Professional Engineer registered in Delaware to design the falsework separately for every bridge on the Project. The Professional Engineer′s signature and seal

shall be affixed to the working drawings. Working falsework drawings shall be submitted in accordance with Subsection 105.04. It is the Contractor's responsibility to obtain approval of the working drawings from the Department prior to the construction of the falsework. Such approval, when given by the Department, shall not relieve the Contractor from the responsibility for the adequacy and satisfactory performance of the falsework.

Falsework systems shall be designed to handle all vertical and horizontal loadings and should contain enough redundancy to prevent a failure in the entire system. Vertical loading and differential settlement forces, and horizontal lateral and longitudinal forces shall also be taken into account for design of the falsework.

After placement of the falsework, the Contractor's Professional Engineer shall certify that the falsework system has been assembled according to the approved falsework drawing prior to placing loads on the falsework. When falsework installations are to be erected adjacent to a highway, special design consideration and protection shall be taken to ensure that falsework system is not disturbed by errant highway vehicles or by the vibration forces caused by the passing vehicles.

In the event falsework is moved from one bridge to another, the falsework shall be thoroughly inspected for structural damage and plumbness and approved by the Contractor's Professional Engineer prior to its use to ensure that all members are in place and properly aligned and connected.

602.10 Placing Concrete. No concrete shall be placed until the depth of the excavation and character of the foundation material, the adequacy of the forms and falsework, and the placing of reinforcement and other embedded items have been inspected and approved by the Engineer.

Concrete shall be placed in daylight unless an adequate lighting system meeting the approval of the Engineer is provided.

In preparation for the placing of concrete, all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of forms. Hardened concrete and foreign matter shall be removed from tools, screeds, and conveying equipment.

The temperature of the concrete shall not be greater than 90 °F (32 °C), nor less than 50 °F (10 °C) at the time of placing, except where other temperatures are required in this Section. The temperature of concrete for bridge decks shall not exceed 85 °F (29 °C). During hot weather, the Contractor may be required to chill the mixing water, incorporate ice into the concrete mixture as part of the mixing water, or take other measures as prescribed in Section 812 to maintain concrete temperatures below the specified maximum temperatures. In addition, any combination of wind velocity, high air temperatures and low relative humidity, which, in the opinion of the Engineer, will impair the quality of fresh or hardened concrete due to rapid concrete moisture evaporation shall be sufficient cause to discontinue or prohibit concrete placement. The ACI Recommended Practice for Hot Weather Concreting will be used as a guide in assessing the hazards of hot weather.

No concrete shall be used which does not reach its final position in the forms within the time stipulated in Subsection 812.06.

Surfaces other than foundations on which concrete is to be placed shall be thoroughly cleaned and wetted immediately before placing concrete in order to facilitate bonding.

Placing of concrete shall be so regulated that the pressures caused by the wet concrete shall not exceed those used in the design of the forms.

The external surface of all concrete shall be thoroughly worked during the placing by means of tools of an approved type. During the placing of concrete, care shall be taken that the methods of compaction used will result in a surface of even texture free from voids, water, or air pockets, and that the coarse aggregate is forced away from the forms in order to leave a mortar surface.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the

reinforcement. Concrete may be placed with the aid of buckets, chutes, troughs, pipes, or conveyors. Open troughs or chutes shall be metal or metal lined and extend as nearly as possible to the point of deposit. Aluminum will not be permitted as the contact surface for concrete placed through any conveyance.

Chutes on steep slopes shall be equipped with baffle boards or be in short lengths that reverse the direction of concrete movement. Chutes shall not slope greater than 1:2 (vertical to horizontal) or less than 1:3 (vertical to horizontal). Concrete placed with chutes over 25′ (7.6 m) long or not meeting these slope standards shall discharge into a hopper before distribution unless otherwise directed.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. The water used for flushing shall be discharged clear of the structure.

Dropping the concrete a distance of more than 5′ (1.5 m) or depositing a large quantity at any point and running or working it along the forms will not be permitted, except that the 5′ (1.5 m) limitation will not apply to the dropping of concrete into the forms for the walls of box culverts, or retaining walls unless directed by the Engineer.

Care shall be taken to fill each part of the form by depositing the concrete as near its final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the projecting reinforcement or other items embedded in the concrete, except where unavoidable on structures being widened under traffic.

Concrete shall be placed in continuous horizontal layers, the thickness of which generally shall not exceed 10 to 12″ (250 to 300 mm). However, slabs shall be placed in a single layer. When it is necessary in an emergency to place less than a complete horizontal layer in one operation, such layer shall terminate in a vertical bulkhead. In any given layer, the separate batches shall follow each other so closely that each one shall be placed and consolidated before the preceding one has taken initial set in order that the fresh concrete shall not be injured and there shall be no lines of separation between the batches. Each layer of concrete shall generally be left somewhat rough to secure efficient bonding with the next layer above. A succeeding layer placed before the underlying layer has become set shall be consolidated in a manner that will entirely break up and obliterate the tendency to produce a construction joint between the layers.

Layers completing a day′s work or placed prior to temporarily discontinuing operations shall be cleaned of all laitance and other objectional material as soon as the surface has become sufficiently firm to retain its form. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be finished being smoothed with a trowel.

Horizontal layers so located as to produce a construction joint at a location wherein a feather edge might be produced in the succeeding layer shall be so formed by inset formwork that the succeeding layer will end in a body of concrete having a thickness of not less than 6″ (150 mm).

In no case shall the work on any section or layer be stopped or temporarily discontinued within 18″ (450 mm) of the top of any face, unless the details of the work provide for a coping having a thickness of less than 18″ (450 mm) in which case at the option of the Engineer, the construction joint may be made at the underside of the coping.

Care shall be exercised during the placement of concrete to minimize the coating of reinforcing steel, structural steel, forms, and other items which extend into areas involved in a subsequent placement. In the event coating of the steel does occur, no attempt shall be made to remove the mortar until after the concrete steel bond of the earlier placement has developed sufficiently to withstand a cleaning operation. Any coating of mortar on deformed bars which cannot be removed by hand brushing with a wire bristle brush, or by a light chipping action, will not have to be removed.

The method and manner of placing concrete shall be so regulated as to place all construction joints across regions of low shearing stress and in such locations as will be hidden from view to the greatest possible extent.

The operations of depositing and consolidating the concrete shall, in general, be conducted so as to form a compact, dense, impervious mass of uniform texture which will show smooth faces on exposed surfaces. Any section of concrete found to be defective shall be removed or repaired as directed by the Engineer.

If concrete operations are permitted to extend into the night, the work shall be brightly lighted so that all operations are plainly visible. Lighting requirements are indicated in Subsection 602.24.

602.11 Placing Concrete During Cold Weather. The following requirements shall govern the placing of concrete during cold weather:

(a) *General.* No concrete shall be placed when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35 °F (2 °C) without permission of the Engineer. The temperature of the concrete shall not be less than 55 °F (13 °C) and not more than 80 °F (27 °C) at the time it is placed in the forms.

The aggregates shall be free from ice, frost, and frozen particles, and concrete shall not be placed on frozen foundation material.

The Contractor shall protect all concrete by means of heated enclosures or by insulation whenever any of the following conditions occur:

(1) The concrete has been placed when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35 °F (2 °C).

(2) The air temperature, measured at the location of the freshly placed concrete in the shade away from artificial heat, is below 35 °F (2 °C) and the concrete has not yet attained an age of 72 hours.

The Contractor shall provide and place at locations directed by the Engineer a sufficient number of maximum-minimum recording thermometers to provide an accurate record of the temperature surrounding the concrete during the entire protection period.

The Contractor shall assume all risks connected with the placing of concrete under the cold weather conditions referred to herein. Permission given by the Engineer to place concrete when the temperature is below 35 °F (2 °C) and the subsequent protection of the concrete as required herein shall not relieve the Contractor in any way of the responsibility for obtaining the required results.

(b) *Heated Enclosures.* Portland cement concrete, that is placed when the air temperature is below 35 °F (2 °C) and portland cement concrete that has not yet attained an age of 72 hours before the air temperature falls below 35 °F (2 °C), shall be immediately enclosed with a housing consisting of canvas or other approved material supported by an open framework or with an equally satisfactory housing, and the air surrounding the concrete shall be maintained at a temperature of not less than 50 °F (10 °)C nor more than 70 °F (21 °C) for the remainder of the 72-hour period. The air surrounding the concrete shall be maintained at temperatures above 32 °F (0 °C) for not less than 48 hours immediately thereafter. The time periods referred to above shall not begin until the manipulation of each separate mass of concrete has been completed.

The Contractor shall provide such heating apparatus as stoves, salamanders, or steam equipment, and the necessary fuel. When dry heat is used, means of preventing loss of moisture from the concrete shall be provided.

(c) *Insulation.* Protection of concrete by the use of approved insulated forms or insulation blankets will be permitted in lieu of the heated enclosure. Insulation will be required under the same conditions that heated enclosures are required, and shall be placed on the concrete as soon as initial set will permit.

Insulating materials shall have a minimum thickness of 1″ (25 mm). The thermal conductivity ("k" factor) of the insulation shall not exceed 0.27 BTU per hour square foot (0.85 W/m^2) for a thermal gradient of one degree F per inch (0.02 °C/mm) as determined by ASTM C 177. Results of tests conducted in accordance with ASTM C 177 by an acceptable commercial testing laboratory shall be furnished to the Engineer for approval. Such approval shall be secured prior to use of the material. Insulating blankets shall be faced or covered, top and bottom, with polyethylene or similar waterproofing material. Blankets shall be placed on the concrete in such a manner that they form a waterproof surface for the concrete being protected. When the anticipated low temperature expected to occur during the protection period is lower than 10 °F (-12 °C), 2″ (50 mm) of insulation will be required.

Blanket insulation mats shall overlap at the edges by at least 6″ (150 mm). Rigid type insulation sheets shall be tightly butted together and sealed. Particular care shall be taken to provide effective protection of curbs, corners, and around protruding reinforcing steel. Overhang forms shall be insulated both on the outside vertical faces and on the underside with a 1″ (25 mm) minimum thickness of either rigid or blanket type insulation.

Should the air under the insulation fall below 50 °F (10 °C) during the protection period, the Contractor will be required to immediately cover the concrete with canvas and framework or other satisfactory housing and apply heat uniformly at a rate such that the air surrounding the concrete is not less than 50 °F (10 °C) for the remainder of the protection period.

602.12 Pumping Concrete. Placement of concrete by pumping will be permitted only when approved by the Engineer. Prior to starting the pumping operation, the Contractor shall also get a method approved by the Engineer for maintaining continuous placement of concrete in case of breakdown of the concrete pump. Pumping equipment shall be located so that no vibrations result which might damage the freshly placed concrete. Pumping equipment, including the conduit system, shall not contain any aluminum or aluminum alloy in contact with the concrete. The conduit system shall consist of 5″ (125 mm) minimum inside diameter rigid or flexible pipe.

Grout used to lubricate the inner surfaces of the conduit system shall be wasted.

Operation of the pump shall be such that a continuous stream of concrete without air pockets is delivered. When pumping is completed, any concrete remaining in the pipeline which is to be used in the work shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

Samples of concrete to be used for test purposes shall be taken from the discharge end of the conduit system and shall be taken as close as possible to the final position of the concrete.

602.13 Consolidation of Concrete by Vibration. Concrete, except that placed under water, or as otherwise approved, shall be compacted during and immediately after depositing by means of approved mechanical vibrating equipment.

Internal mechanical vibrators shall be of sturdy construction, with a cutoff switch at the vibrator, adequately powered and capable of transmitting vibrations to the concrete in frequencies of not less than 5000 impulses per minute and shall produce a vibration of sufficient intensity and amplitude to cause

settlement of the concrete into place without a separation of the aggregates.

In using internal vibrators, the vibratory element shall be inserted into the concrete at the point of deposit and in the areas of freshly-placed concrete. The time of vibration shall be long enough to accomplish thorough consolidation of the concrete and complete embedment of the reinforcement, to produce a smooth surface free from honeycombing and air bubbles, and to work the concrete into all angles and corners of the forms. However, over-vibrating shall be avoided. Vibration shall continue in a spot only until the concrete has become plastic and shall not continue to the extent that pools of grout are formed. The correct length of time of vibration will depend upon the frequency of the vibration impulses per minute, the size of vibrators and the slump of the concrete.

Internal vibrators shall be applied at points uniformly spaced, not farther than the radius over which the vibration is visibly effective and shall be applied close enough to the forms to effectively vibrate the surface concrete. The vibration shall not be dissipated in lateral motion but shall be concentrated in vertical settlement in consolidating the concrete. Vibrators shall not be used to move concrete.

The vibrating element shall be inserted in the concrete mass a sufficient depth to vibrate the bottom of each layer effectively and in as nearly a vertical position as practicable. It shall be withdrawn completely from the concrete before being advanced to the next point of application.

To secure an even and dense surface free from aggregate pockets or honeycomb, vibration shall be supplemented by working or spading by hand in the corners or angles of the forms and along form surface while the concrete is plastic under the vibratory action.

A sufficient number of vibrators shall be employed so that at the required rate of placement thorough consolidation is secured throughout the entire volume of each layer of concrete. Extra vibrators shall be on hand for emergency use and for use when other vibrators are being serviced.

The use of surface vibrators to supplement internal vibration will be permitted only when satisfactory surfaces cannot be obtained by internal vibration alone, and only upon approval. Surface vibrators shall be applied only long enough to embed the coarse aggregate and to bring enough mortar to the surface for satisfactory finishing.

The use of approved form vibrators will be permitted only when it is impossible to use internal or surface vibrators. When permitted, they shall be attached to or held on the forms in such manner as to effectively transmit the vibration to the concrete and so that the principal paths or motions of the vibration are in a horizontal plane.

602.14 Joints.

(a) *Construction Joints.* Construction joints shall be made only where located on the Plans or shown in the placing schedule, unless otherwise approved by the Engineer.

If not detailed on the Plans, or in the case of emergency, construction joints shall be placed as directed by the Engineer. Shear keys or inclined reinforcement shall be used where necessary to transmit shear or bond the two sections together. Joints shall be so constructed that feather edging does not occur.

For construction joints in deck slabs, a 2 by 1½″ (50 by 38 mm) shear key shall be provided between the mats of reinforcing steel.

In construction joints exposed to view or in other construction joints where seepage of water is particularly objectionable, or where specified on the Plans, an approved waterstop shall be inserted. The waterstop shall be placed not less than 3″ (75 mm) from the face of the concrete and shall extend into each section of the concrete a distance of not less than 2″ (50 mm) or as specified on the Plans.

When longitudinal joints are specified or permitted, they shall be spaced so that each

placement of concrete is not less than 10′ (3 m) in width. Transverse joints shall be placed at the centerlines of piers or as specified on the Plans. Concrete shall be placed in one continuous operation between construction joints. The minimum volume of concrete in any one placement shall be not less than the volume of concrete in one end span. The falsework under all spans from edge to edge of slab or from edge of the slab to an open joint shall remain in place until the concrete in the entire slab has attained the minimum 28-day design compressive strength required for the mix.

(b) *Bonded Construction Joints.* If joining fresh concrete to concrete that has already set, the work already in place shall have its surface roughened thoroughly with a suitable tool and all shavings, sawdust or other loose and foreign material shall be removed. The surface shall be washed and scrubbed with wire brooms when necessary to remove substances that may interfere with the bond. The concrete of the preceding placement shall be thoroughly wetted prior to the placement of the next unit of fresh concrete.

For construction joints in deck slabs, the vertical face shall be epoxy coated prior to placement of adjoining concrete with epoxy bonding compound.

In order to bond successive courses, suitable keys shall be formed at the top of the upper layer of each day′s work and at other levels where work is interrupted. These keys shall be formed by the insertion and subsequent removal of beveled wood strips which shall be saturated thoroughly with water to induce swell prior to insertion in the fresh concrete. Rough stone or steel dowels may, at the discretion of the Engineer, be used in lieu of keys. Dowels shall extend an equal distance on each side of the construction joint. Prior to inserting or driving of dowels into predrilled or preformed holes, the holes shall be filled with portland cement grout in the proportion of one part cement to two parts sand. The size and spacing of keys and dowels shall be determined by the Engineer.

When bonding fresh concrete to hardened concrete, or hardened concrete or steel to hardened concrete, an epoxy bonding compound conforming to AASHTO M 235 shall be used. Surface preparation, mixing and application requirements, and limitations as specified by the manufacturer shall be strictly followed. Bonding compounds shall be approved prior to use.

The Contractor shall schedule its concreting operations so that the concrete is placed while the epoxy bonding compound is still uncured and tacky. If, in the opinion of the Engineer, the bonding compound has begun to cure, no concrete shall be placed until a new film of bonding compound has been applied to the required areas.

(c) *Expansion Joints.* Expansion joints shall be provided as shown on the Plans. They shall be made by building keyed faces and are to be covered with bituminous expansion felt or other approved material to prevent leakage and the adhesion of the concrete faces. Roofing paper will not be considered as expansion material.

602.15 Joint Sealants. Sealant type shall be as specified on the Plans.

(a) *Rubber Joint Sealant.* A primer shall be used as recommended by the sealant manufacturer. A bond breaker such as masking tape, polyethylene film, or backing rod as supplied by the manufacturer shall be used at the bottom of the joint.

The surfaces of the joints or recesses must be clean and dry, and free of corrosion, scale, rust, oil, wax, tar, paint, and other contamination. Masonry joints shall be sandblasted to remove contamination. Metal surfaces shall be given a commercial sandblast.

Masking tape shall be applied along the edges of joints where required. Joint faces shall be primed in accordance with sealant manufacturer′s instructions. Sealant shall

be placed following the manufacturer's instructions regarding mixing and application. Sealant shall not be applied on wet or frosty surfaces or when the surface temperatures are below 40 °F (4 °C) or above 130 °F (55 °C). Adjacent surface shall be cleaned free of sealant with mechanical action or solvent as necessary. Finished work shall be left in a neat and clean condition.

(b) *Bituminous Joint Sealant.* Bituminous joint sealant shall be hot applied or cold applied elastomeric sealant.

602.16 Waterstops. The size and configuration of waterstop shall be as shown on the Plans. Waterstop should preferably be spliced only at joints made necessary by construction design. All joints shall be made in strict accordance with the procedures recommended by the manufacturer. No appreciable loss in strength, elasticity, or durability shall result at splices.

Plastic waterstop shall be carefully placed at the locations shown on the Plans or as directed. A split form technique shall be used during installation. Bending of the waterstop along the face of form shall not be permitted. Precautions shall be taken that the waterstop shall neither be displaced nor damaged by construction operations or other means. All surfaces of the waterstop shall be free from oil, grease, dried mortar, or other foreign matter while the waterstop is being embedded in concrete. Means shall be used to ensure that all portions of the waterstop designed for embedment are tightly enclosed by dense concrete.

If requesting approval of a waterstop, the Contractor shall furnish a 12″ (300 mm) length of the extruded section of waterstop that it intends to supply, with a certification that the material conforms to all requirements of this Subsection.

602.17 Finishing Concrete Surfaces.

(a) *General.* All concrete surfaces shall be true, even, and free from open or rough places, depressions, or projections. The concrete in all bridge seats, parapets, sidewalks, curbs, railings, and walls shall be brought flush with the finished top surface and shall be struck off with a template and floated to a finish free from irregularities and true to line and grade.

All masonry bearing areas as prescribed in Subsection 605.29 shall be placed to the final elevation specified. They shall be bush-hammered down to within ¼″ (6 mm) of the final elevation and ground with an approved device to a smooth, level, true plain surface which must be within 1/8″ (3 mm) of the prescribed bearing elevation. The concrete in the bearing area shall be poured high enough so that no part of the bearing area, after bush-hammering, is lower than the surrounding bridge seating surface.

Unless otherwise specified on the Plans, all surfaces shall be given an ordinary surface finish unless after form removal they are in such a condition that they cannot be repaired to the satisfaction of the Engineer. In these cases, the entire structural unit shall be given a rubbed finish.

(b) *Ordinary Surface Finish.* Immediately following the removal of the forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or are not to be water-proofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished. Mortar used in pointing shall be not more than 30 minutes old. The mortar patches shall be cured as specified in Subsection 602.18. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its

full length with clean and true edges.

(c) *Rubbed Surface Finish.* After removal of forms, the rubbing of concrete shall be started as soon as its condition permits. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set. The surface to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in proportions used in the concrete being finished. Rubbing shall be continued until all form marks, projections, and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

(d) *Float Finish.* This finish, for horizontal surfaces, shall be achieved by placing an excess of material in the form and removing or striking-off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of a concave surface shall be avoided. After the concrete has been struck off, the surface shall be thoroughly worked and floated with a suitable wood, canvas, or cork floating tool. Before the finish has set, the surface cement film shall be removed with a fine brush in order to have a fine grained, smooth but sanded texture.

(e) *Special Surface Finish.* As an alternative to the rubbed surface finish, an acrylic or latex bonded mortar finish may be used when and where designated in the Plans and Special Provisions.

(f) *Tooled Finish.* A tooled finish shall be made on the surfaces previously spaded by cutting into the body of the concrete with a pointing tool or bush-hammer as indicated on the Plans.

602.18 Curing. All exposed surfaces shall be cured by one of the following methods:

(a) *Water Methods.* The concrete shall be kept continuously wet by the application of water for a minimum period of seven curing days after the concrete has been placed.

When cotton mats, burlap, or earth or sand blankets are to be used to retain the moisture, the entire surface of the concrete shall be kept damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with the curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface. At the expiration of the curing period, the concrete surface shall be cleared of all curing mediums.

(b) *Membrane Curing Compound Method.* The entire surface of the concrete shall be sprayed uniformly with a liquid membrane curing compound conforming to the requirements of Subsection 812.02.

The membrane curing compound shall be applied after the surface finishing has been completed, and immediately after the free surface moisture has disappeared.

The surface shall be sealed with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the manufacturer or as directed by the Engineer, but not less than 1 gal/150 ft² (0.27 L/m^2) of area.

At the time of use, the compound shall be in a thoroughly mixed condition with

the pigment uniformly dispersed throughout the vehicle. If the application of the compound does not result in satisfactory coverage, the method shall be stopped and water curing, as set out above, applied until the cause of the defective work is corrected.

At locations where the coating shows discontinuities, pinholes, or other defects, or if rain falls on the newly coated surface before the film has dried sufficiently to resist damage, an additional coat of the compound shall be applied immediately after the rain has stopped at the same rate specified herein.

Any curing compound adhering to a surface to which new concrete is to be bonded shall be completely removed by sandblasting, steel wire brushes, bush-hammers, or other approved means.

The concrete surfaces to which the compound has been applied shall be protected from abrasion or other damage which results in perforation of the membrane film for seven curing days after the concrete is placed. If the film of membrane compound is damaged or removed before the expiration of seven curing days, the exposed concrete shall be immediately cured by the water method until additional compound is applied or until seven curing days have expired.

In the event that the application of curing compound is delayed, the application of water shall be started immediately and shall be continued until application of the compound is resumed or started.

(c) *Waterproof Sheeting Method.* The exposed finished surface of concrete shall be wetted with water, using a nozzle that so atomizes the flow that a mist and not a spray is formed, until the concrete has set, after which the waterproof sheeting shall be placed. Curing shall continue for seven curing days after the concrete has been placed. If the sheeting is damaged or removed before the expiration of seven curing days, the exposed concrete shall be immediately cured by the water method until additional sheeting is placed or until seven curing days have expired.

Waterproof sheeting shall consist of paper or polyethylene conforming to the requirements of Subsection 812.02. The waterproof sheeting shall provide a complete continuous cover of the entire concrete surface. Sheets shall lap a minimum of 12″ (300 mm) and shall be securely weighed down or cemented together in such a manner as to provide a waterproof joint.

Should any portion of the sheets be broken or damaged before the expiration of the curing period, the broken or damaged portions shall be immediately repaired with new sheets properly cemented in place.

Sections of sheeting which have been damaged to such an extent as to render them unfit for curing the concrete shall not be used.

(d) *Forms-In-Place Method.* Formed surfaces of concrete shall be cured by retaining the forms in place for a minimum period of seven days after the concrete has been placed.

If the Contractor elects to leave forms in place for a part of the curing period and use one of the other methods of curing included in this article for the remainder of the curing period, the concrete surfaces shall be kept wet during the time the curing methods are being changed.

602.19 Removal of Forms and Falsework, and Placement of Superimposed Vertical Loads. The minimum period during which forms and supports for concrete structures must remain in place are listed in Table 602-A and are defined either by the "Time" or the "Cylinder Strength" requirements.

Table 602-A
Minimum Requirements for Removal of Formwork, Placement of Superimposed Vertical Loads, and Placement of Backfill

Structural Element	*Removal of Formwork*		*Placing Superimposed Vertical Dead Loads**		*Placement of Backfill*	
	Time (days)	*Strength (%f′c)*	*Time (days)*	*Strength (%f′c)*	*Time (days)*	*Strength (%f′c)*
Arch [Span ≤ 65′ (20 m)](B.F.)	3	40	21	95	21	95
Arch (Span ≤ 65′ (20 m)](S.F.)	2	30				
Concrete Beam (B.F.)	7	60	12	80	n/a	n/a
Concrete Beam (S.F.)	2	30				
Slab [Span ≤ 10′ (3 m)] and Diaphragms	2	30	14	85	n/a	n/a
Slab [Span > 10′ (3 m)]	5	50				
Piers/Columns	2	30	5	50	n/a	n/a
Pile Cap and Pier Cap	5	50	7	60	5	50
Footing	2	30	3	40	2	30
Cast-In-Place Concrete Piles	n/a	n/a	5	50	n/a	n/a
Subfoundation Concrete	1	20	2	30	1	20
Retaining Wall, Headwall, and Wingwall	2	30	2	30	21	95
Parapet Wall, Curb, and Backwall	1	20	1	20	5	50
Abutment Wall, Rigid Frame Wall, and Box Culvert Wall	2	30	5	50	21	95

B.F. - Bottom Form S.F. - Side Form

* Examples of such are as follows; placement of parapet on slab, placement of wall on footing, placement of beam on pier cap, etc...

During cold weather [less than 40 °F (4 °C)] and hot weather [greater than 85 °F (30 °C)] forms for vertical surfaces shall remain in place for a minimum of five days. Forms may be removed prior to five days only if the concrete is protected in a manner suitable to the Engineer. The Contractor shall submit a protection plan for the concrete in writing to the Engineer and have it approved by the Engineer prior to form removal.

Upon removal of the forms or protection, surface cavity repairs, finishing, and curing of the exposed areas shall begin immediately.

Except during weather conditions noted above, the forms for rubbed surfaces shall be removed no longer than 48 hours after placing of the concrete.

In using Table 602-A, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the material used in the mix. The use of retarder or special cements shall require special attention.

The minimum required strength of concrete listed in Table 602-A shall be used as a guide when and where field operations are controlled by the "Cylinder Strength" and approved by the Engineer. If

the Contractor intends to begin removing forms as soon as the concrete has reached the minimum required strength of Table 602-A, the Contractor shall give the Engineer written notice, 48 hours prior to pouring the concrete, that the start of form removal will depend on the "Cylinder Strength" requirements.

When the Contractor desires cylinder testing other than seven- and 28-day testing, it shall be the responsibility of the Contractor to supply the molds and to make the cylinders under the supervision of the Engineer. The molds for structural concrete shall be 4″ (100 mm) by 8″ (200 mm) and shall meet the requirements of *Cylinder Molds* under AASHTO T 23. If the Contractor requests cylinder testing other than seven- and 28-day testing and does not perform the testing, the Department's Materials and Research Section will perform the testing; however, the Contractor shall be charged for the testing and a credit will be given to the Department.

Cylinders cast for the specific use as "Cylinder Strength" testing for form removal shall be cured in the field under the same conditions as the concrete they represent. It shall also be the responsibility of the Contractor to ensure that the seven- and 28-day cylinders are cured for the first 24 to 48 hours in an environment to provide satisfactory moisture and temperature control as per AASHTO T 23.

Department personnel will test the cylinders made by the Contractor to determine concrete strength at the time the Contractor wishes to remove forms or place loads on the concrete.

These "Strength" and "Time" requirements listed in Table 602-A are intended only for the construction operations indicated and shall not apply to the use of equipment or other live loads on the structure. Stockpiling of materials and the use of unauthorized equipment on the structure will not be permitted.

Truck mixers, dump trucks, cranes, and other heavy construction equipment will be not permitted to cross or to be parked on a completed structure, nor will the structure be opened to construction or public traffic until so authorized by the Engineer. The "Cylinder Strength" must have attained full design compressive strength (f'_c), and concrete must be at least ten days old before this authorization will be given.

All forms shall be removed whether above or below the ground line or water level.

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without the approval of the Engineer.

Supports shall be removed in such a manner as to permit the concrete to take, uniformly and gradually, the stress due to its own weight.

Falsework under all spans shall be completely released before forms are constructed and concrete is placed for parapets and curb.

Forms for footings constructed within cofferdams or cribs may be left in place, when, in the opinion of the Engineer, their removal would endanger the safety of the cofferdam or crib, and when the forms so left intact will not be exposed to view in the finished structure.

The interior forms supporting the roadway slab of box girder type structures shall be supported on wales or similar supports fastened, as nearly as possible, to the top of side walls, and may be left in place. The interior forms supporting the roadway slab shall not be shored to or supported on the box girders bottom slab.

As soon as forms are removed, all form ties used for holding the forms in place shall be removed and the holes, depressions, or small voids thus made which show upon the removal of the forms, shall be filled with cement mortar mixed in the same proportions as that which was used in the body of the work.

The work shall be so planned and executed that form removal and specified finishing is performed within the required limits. Otherwise, subsequent placement of concrete in other parts of the structure or structures shall be ordered stopped.

Concrete which is to be exposed to sea water or tidal brackish water shall be placed in the dry unless otherwise directed. Sea water or brackish water shall not come in direct contact with concrete prior to the times indicated in Table 602-B unless otherwise directed.

Table 602-B
Requirements for the Removal of Formwork for Concrete in Contact with Sea Water or Brackish Water

Water Salinity (ppm dissolved salts)	*Days to Elapse Prior to Salt Water Contact*
0 to 10 000	Normal Curing
10 000 to 20 000	15
20 000 to 30 000	25
over 30 000	30

602.20 Bridge Decks.

(a) *Permanent Steel Bridge Deck Formwork.* Permanent steel bridge deck forms for concrete deck slabs of bridges shall be used when shown on the Plans.

(1) *Design.* The steel forms shall be designed on the basis of dead load of the form, reinforcement, and plastic concrete plus 50 lb/ft² (2.4 kPa) for construction loads. The unit working stress in the steel sheet shall be not more than 72.5% of the specified minimum yield strength of the material furnished, but not to exceed 36,000 lb/in² (250 MPa).

Deflection under the weight of the forms, the plastic concrete, and the reinforcement shall not exceed 1/180 of the form span or ½″ (13 mm), whichever is less, however, the deadload design weight for this minimum deflection shall be no less than 120 lb/ft² (5.75 kPa) total.

The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

The design span of the form sheets shall be the clear span of the form plus 2″ (50 mm) measured parallel to the form flutes. Physical design properties shall be computed in accordance with requirements of the AISI Specification for the Design of Cold-Formed Steel Structural Members.

All deck reinforcement shall have a minimum concrete cover of 2″ (50 mm) for the top mat of steel and 1″ (25 mm) for the bottom mat unless otherwise specified on the Plans.

The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

Permanent steel bridge deck forms shall not be considered as lateral bracing for compression flanges of supporting structural members.

Permanent steel bridge deck forms shall not be used in panels where longitudinal deck expansion joints are located between stringers.

Welding shall not be permitted to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.

Fabricators′ shop and erection drawings shall be submitted to the Engineer for approval. These drawings shall indicate the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets, and a clear indication of

locations where the forms are supported by steel beam flanges subject to tensile stresses.

(2) *Construction.* All forms shall be installed in accordance with approved fabrication and erection drawings.

Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1″ (25 mm) at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam. All attachments shall be made by permissible welds, bolts, clips, or other approved means. However, welding of form supports to flanges of steels not considered weldable and to portions of a flange subject to tensile stresses shall not be permitted. Welding and welds shall be in accordance with the provisions of AWS D2.0 pertaining to fillet welds, except that 1/8″ (3 mm) fillet welds will be permitted.

Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned, wire brushed, and painted with one coat of organic zinc paint, to the satisfaction of the Engineer. Minor heat discoloration in areas of welds need not be touched up.

The direction lapping of forms shall be consistent with the direction of concrete placement.

(3) *Inspection.* The Contractor′s method of construction should be carefully observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures; concrete placement and vibration; and finishing of the bridge deck. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, the Contractor shall remove at least one section of the forms at a location and time selected by the Engineer for each span in the Contract. This should be done as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the Contractor′s procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines that there has been any change in the concrete mix or in the Contractor′s procedures warranting additional inspection.

After the deck concrete has been in place for a minimum period of two days, the concrete shall be tested for soundness and bonding to the forms by sounding with a hammer as directed by the Engineer. If areas of doubtful soundness are disclosed by this procedure, the Contractor will be required to remove the forms from such areas for visual inspection after the pour has attained adequate strength.

At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and support shall be repaired to present a neat appearance and ensure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing and other defects. If irregularities are found, and it is determined by the Engineer that these irregularities do not justify rejection of the work, the concrete shall be repaired as the Engineer may direct and shall be given an ordinary surface finish, in accordance with the Contract. If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed to inspect and repair the slab, and the Contractor′s methods of construction shall be modified as required to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed and repaired as directed by the Engineer.

The amount of sounding and form removal may be moderated, at the Engineer′s discretion, after a substantial amount of slab has been constructed and inspected, if the Contractor′s methods of construction and the result of the inspections as outlined above indicate that sound concrete is being obtained throughout the slabs.

The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer′s inspection procedures.

(b) *Concrete Work.* A smooth, durable riding surface of uniform texture, true to the required grade and cross-section, shall be obtained on all bridge decks.

Concrete shall be placed in accordance with the Contract. Particular emphasis should be placed on proper vibration of the concrete to avoid honeycomb and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets. Pouring sequences, procedures, and mixes shall be approved by the Engineer.

The placing of concrete in bridge decks will not be permitted until the Contractor has satisfied the Engineer that it has adequate personnel and equipment to deliver, place, spread, finish, and cure a minimum of 20 yd^3 (15 m^3) of concrete per hour, that experienced finishing machine operators and concrete finishers are employed to finish the deck, and that weather protective equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use.

Prior to any deck concreting, a "pre-pour" conference will be held with the Contractor and representatives of the Department in attendance. At this time, the Contractor shall present its plan and procedures for deck construction.

Supports for screeds or finishing machines shall be completely in place and firmly secured before placing of concrete will be permitted. Supports shall be set to elevations necessary to obtain a bridge deck true to the required grade and cross-section, with allowance being made for anticipated settlement. Supports shall be of a type and shall be so installed that no springing or deflection will occur under the weight of the finishing equipment, and shall be so located that finishing equipment may operate without interruption over the entire bridge deck being furnished.

Immediately prior to placing bridge deck concrete, the Contractor shall check all falsework and shall make all necessary adjustments. Suitable means such as telltales shall be provided by the Contractor to permit ready measurement by the Engineer of deflection as it occurs.

On continuous steel beam or girder spans, the order of casting shall be as shown on the Plans. On simple spans, and for any section between construction joints for continuous spans, the concrete in the floor slab may be placed by beginning at the end and working along the roadway or by beginning at the side and working across the roadway. The screeding method used shall have been approved by the Engineer.

Screeding operations shall include a mechanical screed of the power-actuated oscillating type. Vibrating screeds will not be permitted unless specifically approved by the Engineer. The screed shall be sufficiently rigid and easy to control in order to provide substantially uniform treatment over the deck surface. Screeds shall be of the transverse type and shall be of sufficient weight to strike off the surface at the specified grade. Longitudinal type screeds shall not be used without prior written approval from the Engineer.

When the longitudinal type screed is used, the over-all length shall be such as to screed independently supported spans up to and including 80′ (24 m). In no case shall the length of the screed be less than the full length of the span for spans less than 80′ (24 m). When using the longitudinal type screed on independently supported spans exceeding 80′ (24 m) in length with a screed length less than the full length of the span, the center half of the span, preferably

more, shall be completed first and then the remaining portions completed. Bulkheads or other substantial supports for the screed shall be placed over the abutments and/or piers and at the terminal point of placements within the span. The surface of a previously placed section shall not be used as a bearing area for the screed track until control cylinders have attained a minimum strength of 0.6 f'_c where f'_c is the design minimum laboratory compressive strength as specified on the Plans.

When a transverse screed is used, the screed shall be of a sufficient size to finish the full width of the deck between curbs or parapets unless a longitudinal joint in the deck is specified. In this case, the portion on either side of the joint shall be placed and finished separately. The wheels of the screed shall bear on temporary rails which shall be adequately supported on and directly above the main structural members or on form supports. In case of continuous spans, the form supports shall be fully supported by the principal structural members supporting the deck. The rails shall be sufficiently rigid and strong to permit the screed to finish the surface of the deck within the requirements of this Section. If the rails are placed within the roadway area, they shall be elevated a sufficient distance above the deck to permit the simultaneous finishing by hand of any portion not finished by the screed. Rail supports extending above the roadway surface shall be fabricated and installed in such a manner as to permit their removal to at least 2″ (50 mm) below the top surface of the deck slab. Any portion of the rail support to remain in the deck concrete shall be fusion bonded epoxy coated. Where rail supports are placed in that portion of the deck under the curbs or parapets, the supports shall be so placed that they will be at least 2″ (50 mm) from the face of the curb parapet walls or outside edge of the slab.

During the screeding operation, an adequate supply of concrete shall be kept ahead of the screed and a slight excess shall be maintained immediately in front of the screed. Workers will not be permitted to walk on the concrete after screeding. The Contractor shall provide a sufficient number of work bridges or other suitable platforms to provide adequate access to the work, and so that screeding, finishing, and curing operations can progress without delay. The work bridge shall be supported outside the limits of the concreting.

An adequate supply of suitable coverings which will protect the surface of the freshly placed bridge deck from rain shall be readily available at the site of the work.

Where the concrete in the deck of a continuous beam or girder span group cannot be placed in one operation, the location of construction joints and sequence of placement shall be in accordance with an approved placement schedule. After the initial placement has been made in any one group of a continuous span, no further placement shall be made until all previously placed concrete in the deck of that group has been in place for at least three days or until the cylinder strength is at least 0.5 f'_c.

Roadway surfaces of bridge decks and approach slabs shall be wet cured, as soon as possible, according to Subsection 602.18 (a). Membrane curing compound shall not be used on bridge decks and approach slabs except when cold weather dictates its use. The Engineer will determine when cold weather requires membrane curing. When required, membrane curing compound shall be applied in accordance with the requirements of Subsection 501.11 immediately after the finishing operation. Within 24 hours, the roadway surfaces shall also be covered with waterproof covers as set forth in Subsection 501.13. The waterproof covers shall remain in place for not less than seven days. Extreme care shall be taken to protect adjacent reinforcing steel from the membrane curing compound.

The Contractor shall test the fresh concrete deck surface with a 10′ (3.048 m) straightedge, and the Contractor shall rescreed the deck surface as many times as is necessary to ensure a smooth riding surface. The straightedge shall be held in successive positions at the

edges, quarter points, and on the centerline, parallel thereto and in contact with the surface. Advancement along the deck shall be in successive stages of not more than one-half the length of the straightedge. The surface shall also be checked transversely at the ends, quarter points, and center of the span. Areas showing high spots or depressions of more than 1/8″ (3 mm) in 10′ (3.048m) in the longitudinal direction and 1/4″ (6 mm) in 10′ (3.048 m) in the transverse direction shall be struck off or filled with freshly mixed concrete as the case may be. Special attention shall be given to ensure that the surface across joints meets the requirements for smoothness.

After the deck has cured the surface will be tested using either a straightedge, a rolling straightedge, or a California-type profilograph. If surface testing using a California-type profilograph is required, testing and corrective work shall conform to the requirements of Subsection 501.17. Surface testing the cured concrete with a straightedge or rolling straightedge will be performed as described above for fresh concrete. High spots or depressions of more than 1/8″ (3 mm) in 10′ (3.048 m) in the longitudinal direction and 1/4″ (6 mm) in 10′ (3.048 m) in the transverse direction shall be corrected by patching and/or grinding at no cost to the Department. Any cracking which occurs prior to opening to traffic shall be sealed or repaired in a manner approved by the Engineer at no cost to the Department. The deck shall also be sounded and any delaminated areas shall be removed and replaced in a manner approved by the Engineer at no cost to the Department.

(c) *Surface Texture.* All bridge deck surfaces shall be textured either by mechanical grooving or by manual texturing. Unless otherwise noted in the Contract, texturing will be done by mechanical grooving.

(1) *Mechanical Grooving.* Bridge deck and approach slab surfaces shall be textured by first dragging a fabric over the final screeded concrete and then by sawing transverse grooves in the cured concrete. After final screeding of the surface, the Contractor shall drag multiple-ply damp fabric over the surface to provide a gritty texture. After the bridge deck or approach slab has been cured and attained 75% of the 28-day design compressive strength, the Contractor shall saw uniformly pronounced grooves transverse to the centerlines.

Grooves shall be sawn approximately 1/10″ (2.5 mm) wide, 1/8 to 3/16″ (3 to 5 mm) deep, and on 1½″ (38 mm) (nominal) centers. Grooves shall terminate 18 ± 1″ (450 ± 25 mm) from the face of the parapet. Grooves shall not be sawn any closer than 2″ (50 mm) nor further than 3″ (75 mm) from the edge of any joint. When the width of the cutting head on the grooving machine is such that grooves can not be practically sawn to within the required tolerance for a skewed transverse joint, grooving shall begin on the side of the deck having the acute angle corner, and nominal spacing of the grooves at the starting point shall be 1½″ (38 mm) on center. In the event that a single pass of the grooving machine can not be made across the width of the bridge or approach slab, then the mating ends of subsequent passes shall not overlap previous grooves nor leave more than 1″ (25 mm) of surface ungrooved.

For bridge lengths over 300′ (90 m), a randomly spaced groove pattern shall be used. The random spacing shall be from 1 3/8″ (35 mm) centers to 1 5/8″ (40 mm) centers, as determined by the Engineer.

Removal of all debris, including slurry, resulting from the grooving operations shall be continuous. Surfaces must be immediately left in a washed and clean condition, free of all slipperiness from the slurry. All debris and surplus material removed from the

grooving operations shall be deposited in a truck, or other conveyance, and disposed.

(2) *Manual Texturing.* When specified, after the concrete has been consolidated and struck off and before the concrete becomes non-plastic, the surface shall then receive a transverse texture. Texturing shall be done by use of a wire broom having a single row of tines or a finned float having a single row of fins. The broom or float shall produce transverse grooves that are spaced at intervals of approximately ½ to 3/4″ (13 to 19 mm) center to center. The grooves in the hardened surface shall be approximately 0.08 to 0.12″ (2 to 5 mm) in width and 0.15 to 0.25″ (3 to 6 mm) in depth. The grooving shall be applied to the entire deck surface except that area within 18″ (450 mm) from the face of curb.

602.21 Drainage and Weep Holes. Drainage openings and weep holes shall be constructed in the manner and at locations indicated on the Plans, or as directed. No deduction in the computed volume of concrete masonry, except for openings in pipe headwalls, will be made.

602.22 Placing Pipe and Conduits. Pipes and conduits which are to be encased in the concrete, as shown on the Plans, shall be placed by the Contractor during construction. Such pipes and conduits shall be furnished and placed by the Contractor unless otherwise stated on the Plans.

602.23 Placing Anchors, Bolts, Grills, and Other Embedments. Anchors, bolts, grills, and other embedments, which are to be placed in the concrete as indicated on the Plans, shall be furnished and placed by the Contractor during construction.

602.24 Night Lighting. The Contractor shall be responsible for submitting to the Engineer a lighting plan showing the locations and aiming of the floodlights. After the Engineer has reviewed the lighting plan, the Contractor shall conduct a test run of the floodlighting system at the proposed construction area prior to the proposed use. The lighting system will be checked for proper aiming and positioning, level and uniformity of illuminance, and any hazard to maintenance of traffic. The floodlighting system shall be capable of being adjusted to avoid glare that may blind the traffic and mobile enough to allow for proper aiming and positioning to provide the desired results. Any adjustments required by the Engineer shall be corrected by the Contractor. No nighttime construction shall begin until the floodlighting system with the lighting plan has been approved in writing by the Engineer.

Lamps for floodlights shall be either tungsten halogen, mercury vapor, metal halide, or high pressure sodium. The floodlighting system shall provide maximum uniformity of light, producing a level of illuminance of 20 average horizontal ft-c (215 lx) over the construction work area. The Contractor shall supply a photometer to test the illuminance level during the test run. The Contractor shall submit to the Engineer, not less than 30 days prior to the test, the type, style, or catalog number of the photometer to be used for the test. At the same time, the Contractor shall include a written certification that the equipment was calibrated by a testing agency approved by the Engineer not more than 60 days prior to the date when such tests are to be performed. The test is to be performed by the Contractor and witnessed by the Engineer. The photometer is to be of the latest available type and cosine corrected. The angle between the beam center of the flood light and vertical shall not exceed 60 degrees. The mounting height of the floodlights shall be not less than 30′ (9 m) above any traveled roadway which is directly influenced by the floodlights. Otherwise, the floodlights shall be not less than 20′ (6 m) above the work area.

The Contractor shall exercise reasonable care to avoid any interruptions of the lighting system during working operations. If a portable generator is used, it shall have a rated capacity large enough

not to create flickering during work operations. An emergency backup system shall be available on the job site if a portable generator is used. The fuel tank for the generator shall be of sufficient capacity to permit operation at full load for at least 12 hours.

All materials involved in this Subsection shall remain the property of the Contractor.

602.25 Defective Work. Any defective work discovered after the forms have been removed shall be immediately removed and replaced. If the surface of the concrete is bulged or uneven, or shows honeycombing that cannot be repaired satisfactorily, the entire section shall be removed and replaced.

Concrete which fails to reach full 28-day design strength (f'_c) will be considered defective concrete. If the concrete is determined to not be structurally adequate by the Engineer, then it shall be removed and replaced. If the concrete is determined to be structurally adequate by the Engineer and the concrete can remain in place, the Contractor shall have the following options:

(1) Accept the low strength concrete test results and all remedial action as described in the below categories or;

(2) Challenge the low strength concrete test result by coring the area which the test cylinders represent.

If the Contractor elects to take cores to challenge the cylinder strength results, it shall be the Contractor's responsibility to obtain two cores (one for the Department and one for the Contractor) at the location determined by the Engineer. After the cores have been obtained, the concrete cores shall be tested for compressive strength in the as-cored moisture condition and the Contractor's core testing results shall be provided to the Department no later than five working days after verbal notification that the cylinder strength test results were substandard.

If the average of the core testing results (Department and Contractor) are greater than or equal to the specified 28-day design strength, the Contractor shall be paid the full bid price for the concrete in question. If the average core testing results are less than the specified strength, the remedial action as described in the following categories will be required:

Category A: *0 to 250 psi (0 to 1.66 MPa) below 28-day Design Strength*

No repair required, full payment as specified in Subsection 602.27.

Category B: *251 to 500 psi (1.67 to 3.33 MPa) below 28-day Design Strength*

Prorated payment as specified in Subsection 602.27.

Category C: *501 to 1000 psi (3.34 to 6.66 MPa) below 28-day Design Strength*

Prorated payment as specified in Subsection 602.27 plus the application of a protective waterproofing that is approved by the Department's Materials and Research Section. The coating shall be clear and shall only be applied to the pour area that the core represents.

Category D: *1000 psi (6.67 MPa) or greater below 28-day Design Strength*

Strengthen area of low strength concrete as approved by the Engineer at no cost to the Department.

If the difference in strength between the Department's results and the Contractor's independent test laboratory results are greater than 501 psi (3.34 MPa), the core testing results will be considered

void and the prorated payment as specified in Subsection 602.27 will be applied to the concrete in question based upon the field-cast cylinders.

602.26 Method of Measurement. The quantity of portland cement concrete will be measured as the number of cubic yards (cubic meters) of concrete placed and accepted. The volume will be computed using the dimensions shown on the Plans, or as ordered in writing. The quantity of concrete in floor slabs will be computed from the dimensions shown on the Plans with no allowance for form deflection or stay-in-place form corrugations. No deduction in the computed volume of portland cement concrete will be made for pipes with outside diameters of 12″ (300 mm) or less, conduits, anchors, bolts, and scuppers. The quantity of concrete in deck slabs will be computed from design deck thickness.

Floodlighting will not be measured.

The quantity of grooving will not be measured.

602.27 Basis of Payment.

(a) *General.* The quantity of portland cement concrete will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for furnishing all materials, forms, and falsework; for cold weather protection; for removal of bridge deck forms to allow visual inspection of areas of doubtful soundness and bonding of concrete; for construction of drainage openings and weepholes; for furnishing and placing pipes and conduits; for furnishing and placing anchors, bolts, and scuppers; for furnishing and maintaining light plants and lighting equipment; for grooving and removing all debris or for manual texturing; and for furnishing all equipment, tools, labor, and incidentals required to complete the work.

(b) *Price Adjustment for Low Strength Concrete.* Prorated payment for concrete as specified in Subsection 602.25 shall be calculated as shown in the following equation:

$$\textit{Prorated Payment} = \frac{\textit{Low Compressive Strength Concrete}}{\textit{Specified Compressive Strength}} \times (\textit{Quantity of Concrete}^{*}) \times (\textit{Bid Price}^{**})$$

* The quantity for which the low compressive strength results represent.

** Item bid price; not material cost.

SECTION 603 – BAR REINFORCEMENT

603.01 Description. This work consists of furnishing and placing bar reinforcement.

MATERIALS.

603.02 Bar Reinforcement. Bar reinforcement shall conform to the requirements of Section 824.

603.03 Working Drawings. Working drawings shall be submitted in accordance with Subsection 105.04. In addition, the Contractor shall submit complete, detailed bar lists and bending diagrams for all bar reinforcement to be furnished. The Contractor shall be responsible for checking all bar lists and details shown on the Plans for accuracy as to the quantity, size, length, and dimensions before ordering bars from its lists. Bar lists may be prepared on sheets of a size and type that are the supplier′s standard.

CONSTRUCTION METHODS.

603.04 Storage. Bar reinforcement shall be stored on wooden platforms or other hard, clean surfaces, and shall be placed under cover. The Contractor shall not permit bar reinforcement to be in direct contact with soil.

603.05 Placing. All bar reinforcement shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust. When bending is required, it shall be accurately accomplished without the use of heat. Bar reinforcement with cracks or splits at the bends will be rejected.

All bar reinforcement shall be placed in the position shown on the Plans and shall be held in position by wiring at bar intersections. The bar reinforcement shall be securely held so that it will not be displaced during the placing and consolidating of the concrete. In bridge decks, bar reinforcement shall be tied at all intersections. For all other construction, bar reinforcement shall be tied at all intersections except where bar spacing is less than 12″ (300 mm) in both directions, in which case alternate intersections shall be tied. The use of pebbles, bricks, broken stone, metal or wooden blocks, or other unapproved material for blocking is prohibited.

Chairs and metal supports in contact with the forms shall be plastic or rubber tipped. Epoxy or plastic coated chairs fabricated with turned-up legs are acceptable. Precast concrete may be used to provide the required vertical clearance between bar reinforcement and the ground in foundations.

603.06 Welding. Welding of bar reinforcement shall be performed only where detailed on the Plans or the approved working drawings, or if authorized in writing. Welding shall conform to ANSI/AWS D1.4. The workmanship shall not result in any burning or reduction in section of the bar reinforcement. The Contractor shall obtain the Engineer′s approval for all welding methods and results.

603.07 Splicing Bar Reinforcement. All bar reinforcement shall be furnished in the full lengths indicated on the Plans unless otherwise permitted. Splicing of bars, except where shown on the Plans, will not be permitted without written approval. Splices shall be staggered as far as possible. Unless otherwise shown on the Plans, bars shall be spliced in accordance with the AASHTO Standard Specifications for Highway Bridges. In lapped splices, the bars shall be placed and wired in such a manner as to maintain the minimum distance to the surface of the concrete shown on the Plans. Lapped splices shall not be used for No. 14 (No. 43) and No. 18 (No. 57) bars. Connecting bars mechanically or by welding shall be done only if detailed on the Plans or authorized in writing by the Engineer.

603.08 Method of Measurement. The quantity of bar reinforcement will be measured by determining the theoretical weight, in pounds (kilograms), of the steel placed as shown on the Plans and accepted. For the purpose of computing the theoretical weight of bar reinforcement, the following table shall be used:

Table 603-A
Deformed Metric Bar Designation Numbers and Unit Weights

Bar Size Designation US Customary (Metric)	*Unit Weight lb/ft (kg/m)*
#3 (#10)	0.376 (0.560)
#4 (#13)	0.668 (0.994)
#5 (#16)	1.043 (1.552)
#6 (#19)	1.502 (2.235)
#7 (#22)	2.044 (3.042)
#8 (#25)	2.670 (3.973)
#9 (#29)	3.400 (5.060)
#10 (#32)	4,303 (6.404)
#11 (#36)	5.313 (7.907)
#14 (#43)	7.65 (11.38)
#18 (#57)	13.60 (20.24)

603.09 Basis of Payment. The quantity of bar reinforcement will be paid for at the Contract unit price per pound (kilogram), based upon the metric designation. Price and payment will constitute full compensation for furnishing and placing all materials, including clips, wire, chairs, and other material used for fastening the bar reinforcement in place, for banding and splicing, and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 604 – BAR REINFORCEMENT, EPOXY COATED

604.01 Description. This work consists of furnishing and placing epoxy coated bar reinforcement.

MATERIALS.

604.02 Bar Reinforcement. Epoxy coated bar reinforcement shall conform to the requirements of Section 824.

604.03 Repair Material. The Contractor shall furnish a certification from the coating manufacturer that the repair material is compatible with the coating material.

604.04 Working Drawings. Working drawings shall be submitted in accordance with Subsection 603.03. In addition, the working drawings shall indicate to the fabricator and coater that the spacing between bands around bundled bars shall not exceed 13′ (4 m).

CONSTRUCTION METHODS.

604.05 Storage and Protection. Epoxy coated bar reinforcement shall be stored on wooden or padded supports that will keep the steel above the ground, well drained, and protected against deformation and abrasion.

Epoxy coated bars that have been exposed to sunlight for 90 days shall be covered. This requirement includes partially embedded bars. The cover shall be opaque to block sunlight and shall

be placed to allow air circulation around the bars.

In order to protect the coated bar reinforcement from damage during movement, the Contractor shall ensure that bands used to secure rebar in bundles are spaced no more than 13′ (4 m) apart. The Contractor shall also use padded or non-metallic slings and padded straps to handle bundled bars. Bundles of epoxy coated bars shall be lifted by spreader bars or multiple supports from a platform bridge that will prevent bar-to-bar abrasion from sags. Bundles shall not be picked up by the banding material. Bars and bundles shall not be dropped, dragged, or driven over. The Contractor may propose alternate precautionary measures for the Engineer′s approval.

604.06 Placing.

(a) *Bridge Decks.* The bottom layer of bar reinforcement in bridge decks shall be supported from the forms on continuous type bar supports placed parallel to the beams and spaced with the lines of supports, as measured between beam centers, at approximately the 1/4 and 3/4 points for beam spacing less than 9′ (2.7 m) and at approximately the 1/6, 1/2, and 5/6 points for beam spacing 9′ (2.7 m) and over. Additional individual chairs may be required outside the fascia beam to securely support the bar reinforcement along and near the fascia. The continuous type bar supports and individual chairs in contact with epoxy coated bars shall be either epoxy or plastic coated, as approved. The Contractor may propose other devices for the Engineer′s approval. Coated chairs fabricated with straight legs shall also be equipped with plastic or rubber tips. Coated chairs fabricated with turned-up legs do not require tips.

The upper layer of bar reinforcement in bridge decks shall be supported with rows of approved, continuous, steel bar supports consisting of a minimum of three longitudinal wires acting as spacers at the proper height. The longitudinal wires shall be securely tied to the structural steel, stud shear developers, or other structural components at intervals not greater than 5′ (1.5 m) along each beam or girder. Tie-downs shall consist of loops of 12 gage (2.7 mm) coated wire, or equivalent devices meeting the approval of the Engineer.

(b) *Other Structures.* The method of placement for structures other than bridge decks shall conform to the requirements of Subsection 603.05. The wire, chairs, and metal supports in contact with epoxy coated bars shall, at the Contractor′s option, be either epoxy or plastic coated. Epoxy coated bar reinforcement shall not come in contact with any materials to be embedded in the concrete which are not epoxy or plastic coated.

604.07 Splicing Reinforcement. Splicing shall conform to the requirements of Subsection 603.07.

604.08 Repair of Epoxy Coating. If, in the opinion of the Engineer, the coating on bar reinforcement has been damaged, the damaged bar will be rejected and shall be properly repaired or replaced.

Repair material shall be compatible with the coating, inert in concrete, and supplied by the epoxy resin manufacturer. The material shall be suitable for repairing areas of the coating that have been damaged and shall be applied at the point of application, fabrication, or installation, as may be required. Sheared ends and other cut or exposed areas shall be repaired promptly before detrimental oxidation occurs. These areas shall be clean and free from all surface contaminants.

The sum of the damaged areas of coating in each 1 yd (1 m) of length of bar reinforcement shall not exceed 6% of the surface area in that 1 yd (1 m) length of bar. All visible damage of the epoxy coating shall be repaired. The total bar surface area covered by patching material shall not exceed 2%.

604.09 Method of Measurement. The quantity of epoxy coated bar reinforcement will be measured according to Subsection 603.08.

604.10 Basis of Payment. The quantity of epoxy coated bar reinforcement will be paid for at the Contract unit price per pound (kilogram) based upon metric designation as shown in the Table 603-A. Price and payment will constitute full compensation for furnishing and placing all materials, including the epoxy resin, clips, wire, chairs, and other material used for fastening the bar reinforcement in place; for preparing the bar reinforcement surfaces for epoxy coating; for applying the epoxy coating; for bending, splicing, and repairing; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 605 – STEEL STRUCTURES

605.01 Description. This work consists of furnishing, field fabricating, erecting, and painting structural steel for bolted and welded construction.

This work also consists of recoating a portion of or the entire existing steel structure.

605.02 Materials. Materials for steel structures shall conform to the following Subsections:

Coatings 820.02
Structural Steel 826.02
Fasteners 826.03
Shear Connectors 826.04
Forgings and Castings 826.05
Bearing Materials 826.06
Galvanizing 826.07
Sheet Zinc 826.08

605.03 Storage of Materials. Structural material shall be stored above the ground on platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter, and shall be protected as far as practicable from corrosion.

FABRICATION.

605.04 Straightening Material. Rolled material, before being laid out or worked, must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends shall be cause for rejection of the material.

605.05 Finish. Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting, and chipping shall be done carefully and accurately and result in square and true edges.

605.06 Bolt Holes.

(a) *High Strength Bolts.* All holes for high strength bolts shall be either punched or reamed or drilled. When there are more than five layers of metal to be bolted or when any of the material is thicker than 3/4″ (19 mm) for carbon steel, or 5/8″ (16 mm) for high-strength steel, all holes shall be either subpunched or subdrilled 3/16″ (5 mm) smaller than the diameter of the bolts. After preliminary assembling, the holes shall be reamed 1/16″ (2 mm) larger or drilled from the solid to 1/16″ (2 mm) larger than the diameter of the bolts.

Material forming parts of a member composed of not more than five layers of metal may be punched 1/16″ (2 mm) larger than the diameter of the bolts whenever the thickness of the

metal is not greater than 3/4″ (19 mm) for structural steel or 5/8″ (16 mm) for high-strength steel.

(b) *Ribbed Bolts, Turned Bolts, or other Approved Bearing Type Bolts.* All holes for ribbed bolts, turned bolts, or other approved bearing type bolts shall be either subpunched or subdrilled 3/16″ (5 mm) smaller than the diameter of the bolt and reamed assembled to a steel template or, after assembling, drilled from the solid at the option of the fabricator. In any case the finished holes shall provide a driving fit as specified on the Plans or in the Special Provisions.

605.07 Punched Holes. The diameter of the die shall not exceed the diameter of the punch by more than 1/16″ (2 mm). All holes to be enlarged to admit the bolts must be reamed. Holes must be cut clean without torn or ragged edges. Poor matching of holes will be cause for rejection.

605.08 Reamed or Drilled Bolt Holes. Reamed or drilled holes shall be cylindrical and perpendicular to the member. Where practicable, reamers shall be directed by mechanical means. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. If required by the Engineer, assembled members shall be taken apart for removal of burrs caused by drilling. Connecting members requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match-marked before disassembling.

605.09 Subpunching or Subdrilling and Reaming Field Connections. Unless otherwise specified in the Special Provisions or on the Plans, holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames shall be subpunched or subdrilled and reamed while assembled to a steel template. Drilling full size holes, in lieu of assembly reaming or template reaming undersized holes, will be permitted upon approval of the procedures by the Engineer.

All holes for floor beam and stringer field end connections shall be subpunched or subdrilled and reamed to a steel template or reamed while assembled. Reaming or drilling full size field connection holes through a steel template shall be done after the template has been located with respect to position and angle and firmly bolted in place. Templates used for reaming matching members, or the opposite faces of a single member, shall be exact duplicates. Templates used for connections on like parts or members shall be located so that the parts or members are duplicates and require no match-marking.

If additional subpunching or subdrilling and reaming is required, it shall be specified in the Special Provisions or on the Plans.

605.10 Accuracy of Punched, Subpunched, and Drilled Holes. All holes punched full size, subpunched, or subdrilled shall be so accurately punched that after assembling and before any reaming is done, cylindrical pins 1/8″ (3 mm) smaller in diameter than the size of the punched, subpunched, and subdrilled holes may be entered perpendicular to the face of the member without drifting, in at least 75% of the contiguous holes in the same plane. If this requirement is not fulfilled, the members will be rejected. If any hole will not pass a pin 3/16″ (5 mm) smaller in diameter than the size of the punched hole, this will be cause for rejection.

605.11 Accuracy of Reamed and Drilled Holes. When holes are reamed or drilled, 85% of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32″ (1 mm) between adjacent thicknesses of metal.

All steel templates shall have hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. The centerlines shall be used in locating

accurately the template from the milled or scribed ends of the members.

605.12 Fitting for Bolting. Surfaces of metal in contact shall be cleaned before assembling. The members shall be assembled, well pinned, and firmly drawn together with bolts before reaming is commenced. Assembled members shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. All members shall be free from twists, bends, and other deformations.

605.13 Drifting of Holes. The drifting during assembling shall only be to bring the members into position for bolting. The drifting shall not enlarge the holes or distort the metal. All holes to be enlarged must be reamed.

605.14 Connections Using Non-High-Strength Bolts. Non-high-strength bolts shall be unfinished, turned, or ribbed bolts conforming to the requirements for Grade A bolts of ASTM A 307. Bolted connections shall be used only as indicated by the Plans or Special Provisions. Bolts shall have single, self-locking nuts or double nuts unless otherwise shown on the Plans or in the Special Provisions. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

(a) *Unfinished Bolts.* Unfinished bolts shall be furnished unless other types are specified.

(b) *Turned Bolts.* The surface finish of the body of turned bolts shall meet the ANSI B 46.1 roughness rating value of 125 (3.2 µm). Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed for the bolts furnished to provide for a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

(c) *Ribbed Bolts.* The body of ribbed bolts shall be of any approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 5/64″ (2 mm) greater than the nominal diameter specified for the bolts.

Ribbed bolts shall be furnished with round heads conforming to ANSI/ASME B18.5.2.2M unless otherwise specified. Nuts shall be hexagonal. The nuts shall be recessed or installed using washers of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such that the ribs do not mash down enough to permit the bolts to turn in the holes during tightening. If for any reason the bolt twists before drawing tight, the holes shall be carefully reamed and an oversized bolt used as a replacement.

605.15 Connections Using High Strength Bolts. This Subsection covers the assembly of structural joints using AASHTO M 164 (M 164M) high-strength carbon steel bolts and AASHTO M 253 (M 253M) quenched and tempered alloy steel bolts or equivalent fasteners, tightened to a high tension. Holes for high-strength bolt connections shall conform to the requirements of Subsections 605.06, 605.07, and 605.08.

(a) *Bolts, Nuts, and Washers.* Bolts manufactured to AASHTO M 164 (M 164M) shall be marked on the top of the head with three radial lines and the symbol **A325** (**A 325M)**.

All galvanized nuts shall be lubricated with a water soluble lubricant containing a visible dye so a visual check can be made for the lubricant at the time of field installation. Nuts shall be marked according to the requirements of ASTM A563

(A 563M).

Bolts, nuts, and washers shall be kept protected from the weather or any other adverse environments. Weathered or rusted fasteners or fasteners which have lost their lubricant or protective coating will be rejected for use.

Bolt and nut dimensions shall conform to the dimensions shown in Table 605-A.

Table 605-A
Bolt and Nut Dimensions, U.S. Customary

Heavy Hex Structural Bolts (Inches)				Heavy Hex Nuts (Inches)	
Nominal Bolt Diameter, D	**Width Across Flats, F**	**Height, H**	**Thread Length**	**Width Across Flats, W**	**Height, H**
1/2	7/8	5/16	1	7/8	31/64
5/8	1 1/6	25/64	1 1/4	1 1/6	39/64
3/4	1 1/4	15/32	1 3/8	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 13/16	1 7/64
1 1/4	2	25/32	2	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 3/8	1 15/32

Table 605-A
Bolt and Nut Dimensions Metric

Nominal Bolt Diameter and Thread Pitch [1]	*Heavy Hexagon Structural Bolt Dimensions* [1] *(mm)*						*Nut Dimensions* [2] *(mm)*			
	Body Diameter (D)		*Width Across Flats (S)*		*Head Height (K)*		*Width Across Flats (S)*		*Thickness (M)*	
	max.	*min.*	*max.*	*min.*	*max.*	*min.*	*max.*	*min.*	*max.*	*min.*
M16 × 2	16.70	15.30	27.00	26.16	10.75	9.25	27.00	26.16	17.10	16.40
M20 × 2.5	20.84	19.16	34.00	33.00	13.40	11.60	34.00	33.00	20.70	19.40
M22 × 2.5	22.84	21.16	36.00	35.00	14.90	13.10	36.00	35.00	23.60	22.30
M24 × 3	24.84	23.16	41.00	40.00	15.90	14.10	41.00	40.00	24.20	22.90
M27 × 3	27.84	26.16	46.00	45.00	17.90	16.10	46.00	45.00	27.60	26.30
M30 × 3.5	30.84	29.16	50.00	49.00	19.75	17.65	50.00	49.00	30.70	29.10
M36 × 4	37.00	35.00	60.00	58.80	23.55	21.45	60.00	58.80	36.60	35.00

Note 1: From ANSI B18.2.3.7M - 1979. Pitch = the distance in millimeters from the crest of one thread to the crest of the next thread.

Note 2: From ANSI B18.2.4.6M - 1979.

(b) *Bolted Members.* The slope of surfaces of bolted members in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Bolted members shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.

When assembled, all faying surfaces including the outside surfaces adjacent to the bolt heads, nuts, or washers shall be free of scale, except for tight mill scale. The faying surfaces shall also be free of dirt, loose scale, burrs, other foreign material, and other defects that would prevent solid seating of the members.

(c) *Surface Preparation of Contact Surfaces.* Contact surfaces of high strength bolted connections which are considered within friction-type joints shall be free of oil, paint, lacquer, rust inhibitor, or galvanizing unless specifically modified by the Plans or Special Provisions.

(d) *Bolt Tension.* During installation each fastener shall be tightened to provide a tension which is greater than 70% of the tensile strength given in AASHTO M164 for A325 (AASHTO M 164M for A 325M) bolts and between 70% of the minimum and maximum tensile strength given in AASHTO M253 for A490 (AASHTO M 253M for A 490M) bolts.

Table 605-B, US Customary
Minimum Bolt Tension[1] (pounds)

Bolt Size (in.)	AASHTO M164 (ASTM A325) Bolts	AASHTO M253 (ASTM A490) Bolts
1/2	12,050	14,900
5/8	19,200	23,700
3/4	28,400	35,100
7/8	39,250	48,500
1	51,500	63,600
1 1/8	56,450	80,100
1 1/4	71,700	101,800
1 3/8	85,450	121,300
1 1/2	104,000	147,500

Table 605-B Metric
Minimum Bolt Tension [1], kilonewtons

Nominal Bolt Diameter and Thread Pitch	*AASHTO M 164M*	*AASHTO M 253M*	
		min.	*max.*
M16 × 2	91	114	132
M20 × 2.5	142	179	206
M22 × 2.5	176	221	255
M24 × 3	205	257	297
M27 × 3	267	334	386
M30 × 3.5	326	408	471
M36 × 4	475	595	686

Note 1: Equal to 70% of specified minimum tensile strength of bolts.

Threaded bolts shall be tightened by the turn-of-nut method. If required because of bolt-entering and wrench-operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. Impact wrenches, if used, shall be of adequate capacity and supplied with sufficient air to perform the required tightening of each bolt in approximately ten seconds.

(e) *Washers.* All fasteners shall have a hardened washer under the element (nut or bolt head) turned in tightening. Hardened washers shall be used under both the head and nut regardless of the element turned when using AASHTO M253 (ASTM 490) [AASHTO M 253M (ASTM A 490M)] bolts, if the material against which it bears has a specified yield strength of less than 40,000 psi (276 MPa).

Where an outer face of the bolted members has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth, beveled washer shall be used to compensate for the lack of parallelism.

(f) *Calibrated Wrench Testing.* To check the correct calibration of a wrench, the Skidmore-Wilhelm Bolt Tension Calibrator or equivalent tension measuring device shall be furnished.

(g) *Turn-of-Nut Tightening.* When the turn-of-nut method is used to provide the bolt tension specified under (d) above, there shall first be enough bolts brought to a "snug tight" condition to ensure that all members of the connection are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a construction worker using an ordinary spud wrench. Following this initial operation, bolts shall be placed in all remaining holes in the connection and brought to snug tightness. All bolts in the connection shall then be tightened by the applicable amount of nut rotation specified in Table 605-C. Tightening shall progress systematically from the most rigid part of the connection to its free edges. During this operation there shall be no rotation of the element not turned by the wrench.

(h) *Tightening by Use of a Load Indicating Fastener System.* Tightening by this means is permitted provided it can be demonstrated, by an accurate, direct measurement procedure, that the bolt has been tightened in accordance with Table 605-C. Tightening shall be by methods and procedures approved by the Engineer.

Table 605-C
Nut Rotation from Snug Tight Condition [1]

Bolt Length, measured from underside of head to extreme end of point	*Both faces normal to bolt axis*	*One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer 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 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters [2]	2/3 turn	5/6 turn	1 turn

Note 1: Nut rotation is relative to the bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be ±30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be ±45 degrees.

Note 2: No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedures when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension device simulating the actual conditions.

(i) *Inspection.*

(1) The Engineer will determine when the requirements of (3)b. and (3)c. below are met. When the calibrated-wrench method of tightening is used, the Engineer will have full opportunity to witness the calibration tests prescribed under (f) above.

(2) The Engineer will observe the installation and tightening of bolts to determine if the selected tightening procedure is properly used and will determine when all bolts are tightened.

(3) The following inspection procedure shall be used unless a more extensive or different inspection procedure is specified:

a. Either the Engineer will or the Contractor in the presence of the Engineer, at the Engineer's option, shall perform the inspection using an inspection wrench. The inspection wrench may be either a torque wrench or a power wrench that can be accurately adjusted in accordance with the requirements under (f) above.

b. Three bolts of the same grade, size*, and condition as those under inspection shall be placed individually in a calibration device capable of indicating bolt tension. There shall be a washer under the element turned. (* Length may be any length representative of bolts used in the structure.)

c. When the inspection wrench is a torque wrench, each of the three bolts shall be tightened in the calibration device by any convenient means to the minimum tension specified for its size under (d) above. The inspection wrench shall then be applied to the tightened bolt, and the torque necessary to turn the nut or head five degrees [approximately 1″ (25 mm) at a 12″ (300 mm) radius] in the tightening direction shall be determined. The average torque measured in the tests of the three bolts shall be taken as the

job inspecting torque to be used as specified in (3)e. below.

d. When the inspection wrench is a power wrench, it shall be adjusted so that it tightens each of the three bolts to a tension at least 5% but not more than 10% greater than the minimum tension specified for its size under (d) above. This tension setting of the power wrench shall be taken as the job inspecting torque to be used in the manner specified in (3)e. below.

e. Bolts represented by the three-bolt sample that have been tightened in the structure shall be inspected by applying in the tightening direction, the inspection wrench to its job inspecting torque on 10% of the bolts, but not less than two bolts, selected at random in each connection. If no nut or bolt is turned by this application of the job inspecting torque, the connection shall be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque, this torque shall be applied to all bolts in the connection. All bolts whose nut or head is turned by the job inspecting torque shall be tightened and reinspected. Alternatively, the Contractor has the option to retighten all of the bolts in the connection and then resubmit the connection for inspection.

605.16 Plate Cut Edges.

(a) *Edge Planing.* Sheared edges of plates more than 5/8″ (16 mm) in thickness and carrying calculated stress shall be planed, milled, ground, or thermal cut to a depth of ¼″ (6 mm). Re-entrant cuts shall be filleted to a minimum radius of 3/4″ (19 mm) before cutting.

(b) *Visual Inspection and Repair of Plate Cut Edges.* In the repair and determination of limits of internal defects visually observed on sheared or flame-cut edges and caused by entrapping slag or refractory, deoxidation products, gas pockets, or blow holes, the amount of metal removed shall be the minimum necessary to remove the defect or to determine that the permissible unit is not exceeded. Plate edges may be at any angle with respect to the rolling direction. All repairs of defects made by welding shall conform to the applicable provisions of ANSI/AASHTO/AWS D1.5, *Bridge Welding Code* as modified in this Section.

The limits of acceptability and the repair of visually observed edge defects in plates 4″ (100 mm) and under in thickness shall be in accordance with Table 605-D.

Table 605-D
Required Repairs for Discontinuity

Description of Discontinuity	*Repair Required*
Any discontinuity 1″ (25 mm) in length or less and 1/8″ (3 mm) maximum depth.	None; need not be explored.
Any discontinuity over 1″ (25 mm) in length and 1/8″ (3 mm) maximum depth.	None; depth should be explored by random spot grinding
Any discontinuity over 1″ (25 mm) in length with depth over 1/8″ (3 mm) but not greater than ¼″ (6 mm) .	Remove discontinuity; need not fill area with weld material.
Any discontinuity over 1″ (25 mm) length with depth over ¼″ (6 mm) but not greater than 1″ (25 mm).	Completely remove and weld. Aggregate length of welding shall not exceed 20% of plate edge length being repaired.
Any discontinuity over 1″ (25 mm) in length with depth greater than 1″ (25 mm).	Subject to approval by the Engineer. Repair to be made in accordance with Section 3.2 of the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

Note 1: The length of defect is the visible long dimension on the plate cut edge, and the depth is the distance that the defect extends into the plate from the cut edge.
Note 2: This table does not apply to fracture critical members.

Steel plate, bar, or shapes containing any discontinuity, regardless of length or depth, will not be permitted for use in any member or component in a tension area.

605.17 Welding and Oxygen Cutting. All welding and oxygen cutting shall conform to the requirements of Subsection 826.12.

605.18 Abutting Joints. Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an even bearing. Wheel joints are not faced and the opening shall not exceed ¼″ (6 mm).

605.19 End Connection Angles. Floorbeams, stringers, and girders having end connection angles shall be built to the exact length shown on the Plans measured between the heels of the connection angles with a permissible tolerance of +0 to -1/16″ (+0 to -2 mm). Where continuity is required, end connections shall be faced. The thickness of the connection angles shall be not less than 3/8″ (10 mm) and not less than that shown on the detail drawings, after facing.

605.20 Web Plates. For girders having no cover plates and not encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than 1/8″ (3 mm) below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles.

At web splices, the clearance between the ends of the web plates shall not exceed 3/8″ (10 mm). The clearance at the top and bottom ends of the web splice plates shall not exceed ¼″ (6 mm).

605.21 Bent Plates. Cold-bent, load-carrying, rolled-steel plates shall conform to the following:

(a) They shall be taken from the stock plates so that the bend-line will be at right angles to the direction of rolling.

(b) The radius of bends shall be such that no cracking of the plate occurs. Generally accepted minimum radii, measured to the concave face of the metal, are shown in Table 605-E:

Table 605-E
Minimum Radii for Cold Bent Steel Plates
radii and t (thickness) in millimeters

All Grades of Structural Steel in this Section	Up to ½″ (13 mm)	Over ½″ (13 mm) to 1″ (25 mm)	Over 1″ (25mm) to 1½″ (38 mm)	Over 1½″ (38 mm) to 2½″ (64 mm)	Over 2½″ (64 mm)
Bend Radius	2t	2.5t	3t	3.5t	4t

Note: Low alloy steel in thickness over ½″ (13 mm) may require hot bending for small radii. If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 1150 °F (620 °C). Hot-bent plates shall conform to (a) above.

(c) Before bending, the corners of the plates shall be rounded to a radius of 1/16″ (2 mm) throughout that portion of the plates at which the bending is to occur.

605.22 Eyebars. Pin holes may be flame-cut at least 2″ (50 mm) smaller in diameter than the finished pin diameter. All eyebars that are to be placed side by side in the structure shall be securely fastened together so that they will be placed on the pin and bored at both ends while clamped. Eyebars shall be packed and match-marked for shipment and erection. All identifying marks shall be stamped with steel stencils on the edge of one head of each member after fabrication is completed so that the markings will be visible when the bars are nested in place on the structure. The eyebars shall be straight and free from twists, and the pin holes shall be accurately located on the centerline of the bar. The inclination of any bar to the plane of the truss shall not exceed 1/16″ to a foot (1 in 200 mm).

The edges of eyebars lying between the transverse centerline of their pin shall be cut simultaneously with two mechanically operated torches abreast of each other guided by a substantial template in such a manner as to prevent distortion of the plates.

605.23 Testing Requirements. Testing of fabricated structural members shall be according to Subsection 826.26.

FIELD ERECTION.

605.24 Erection of Structure. The Contractor shall set the steel according to the lines and elevations as provided in the Contract, remove the temporary construction, and do all the work required to complete the bridge or bridges as covered by the Contract, all in accordance with the Plans and this Section.

605.25 Erection Material. The Contractor shall provide the falsework and all tools, machinery, and appliances, including drift pins and fitting-up bolts, necessary to complete the work.

605.26 Handling and Storing Fabricated Materials. Stored material shall be placed on skids above the ground. It shall be kept clean and shall be properly drained. Girders and beams shall be placed

upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent permanent deflections.

605.27 Falsework. The Contractor shall engage a Professional Engineer registered in Delaware to design the falsework separately for steel structures and for necessary changes in existing steel structures on the Project. The Professional Engineer's signature and seal shall be affixed to the working drawings. Working falsework drawings shall be submitted in accordance with Subsection 105.04. The falsework shall be properly designed, constructed, and maintained for the loads that it will carry. It is the Contractor's responsibility to obtain approval of the working drawings from the Department prior to the construction of the falsework. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility. After placement of the falsework, the Contractor's Professional Engineer shall certify that the falsework system has been assembled according to the approved falsework drawing prior to placing loads on the falsework.

605.28 Methods and Equipment. Before starting the work of erection, the Contractor shall inform the Engineer as to the method of erection it proposes to follow and the number and type of equipment it proposes to use. The Contractor's methods and equipment shall be subject to the approval of the Engineer. The Engineer's approval does not relieve the Contractor of its responsibility for the safe performance of the work or from carrying out the work in full accordance with the Plans and the requirements of this Section. No work shall be done until the Engineer's approval has been obtained.

605.29 Bearings and Anchorages.

(a) *Bearings.* Bridge bearings shall be set level in the exact position indicated and shall have full and even bearing on the masonry. Prior to assembly in place, the steel surface bearing on the self-lubricating bearing plate shall be thoroughly lubricated with additional antioxidant lubricant furnished by the manufacturer.

The sliding surface shall be planed parallel to the movement of the spans.

(b) *Anchor Bolts.* Anchor bolts, when required, including hex nuts and washers, shall conform to the requirements of AASHTO M 314 unless otherwise specified on the Plans. The exposed portion of the anchor bolt shall be either galvanized or painted, unless otherwise specified.

When the anchor bolt passes through the sole plate, the nut is to be ¼″ (6 mm) clear. The threads shall be burred at face of nut. Anchor bolts shall be swedged and may be cast-in-place or grouted in preformed (sleeved or drilled) holes. If the Contractor elects to drill, it shall not cut through the bar reinforcement in the masonry. All slots and holes in the masonry plates surrounding the anchor bolts shall be filled with an approved, non-hardening caulking compound or elastic joint sealer.

605.30 Straightening Bent Material. The straightening of plates, angles, other shapes, and built-up members, when permitted by the Engineer, shall be done by methods that will not produce fractures or other injuries. Distorted members shall be straightened using mechanical means or, if approved by the Engineer, using a limited amount of localized heat. The temperature of the heated area shall not exceed 1150 °F (620 °C) (a dull red) as monitored by temperature indicating crayons, liquids, or bimetal thermometers. Members to be heat-straightened shall be substantially free of stress and external forces, except stresses resulting from the mechanical means used in conjunction with the application of heat.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

605.31 Assembling Steel. The members shall be accurately assembled as shown on the Plans and all match-marks shall be followed. The material shall be carefully handled so that no members are bent, broken, or otherwise damaged. Hammering which injures or distorts the members shall not be done. Bearing surfaces and surfaces in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully bolted and all other truss connections are pinned and bolted. Permanent bolts in splices of butt joints of compression members and permanent bolts in railings shall not be tightened until the span has been swung. One-half of the holes in splices and field connections shall be filled with bolts and cylindrical erection pins (half bolts and half pins) before bolting with high-strength bolts. All splices and connections during erection shall have three-fourths of the holes filled.

Filling-up bolts shall be of the same nominal diameter as the high strength bolts. Cylindrical erection pins shall be 1/32″ (1 mm) larger.

605.32 Pin Connections. Pilot and driving nuts shall be used for driving pins. They shall be furnished by the Contractor. Pins shall be driven so that the members take full bearing on them. Pin nuts shall be securely fastened, and the threads shall be burred at the face of the nut using a pointed tool.

605.33 Misfits. The correction of minor misfits involving harmless amounts of reaming, cutting, and chipping will be considered a legitimate part of the erection. However, all errors in the shop fabrication, or deformations resulting from handling and transportation, that prevent the proper assembly and fitting up of members by the moderate use of drift pins, or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the inspector to obtain approval of the proposed correction method. All corrections shall be made in the inspector′s presence.

605.34 Cleaning and Restoration. Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish, and temporary buildings. The Contractor shall also replace or renew any damaged fences, restore in an acceptable manner all property, both public and private, damaged during the prosecution of this work, and leave the structure site and adjacent highway in a neat and presentable condition satisfactory to the Engineer. All excavated material or falsework placed in the stream channel during construction shall be removed by the Contractor before final acceptance.

FIELD PAINTING.

605.35 Field Painting. All structural steel members, railings, fascia, downspouts, and other miscellaneous steel items that have been previously painted shall be cleaned, and primed and painted by applying two full coats of paint, the intermediate coat and the finish coat. The coating system to be used shall meet the requirements of moisture-cured urethane system as specified in Subsection 820.02.

605.36 Surface Preparation. Surfaces identified to be painted shall be cleaned in the following manner:

(1) Surfaces specified to be recoated shall be cleaned to bare metal in accordance with SSPC-SP 11.

The perimeter or edge of intact paint adjoining the cleaned surface shall be feathered back, and the adjoining paint shall be tightly adhered. Ragged edges on intact paint will not be allowed. Adherence will only be considered satisfactory if the adjoining

remaining paint is smoothly feathered back and cannot be removed by lifting with a dull putty knife. After power tool cleaning operations are completed, all residue generated by the cleaning work shall be removed by vacuuming using HEPA filtered vacuums.

Surfaces shall be accepted by visual comparison to a prepared Project standard. The Contractor shall prepare the Project standard by power tool cleaning a representative area on the structure that is being prepared for painting. The prepared standard shall generally conform to SSPC-Vis 3, E SP 11, F SP 11, and G SP 11, as applicable, and shall be approved by the Engineer before the start of general cleaning work. At least one standard shall be prepared for each structure that is being specified for cleaning. More than one standard may be necessary if the cleaned steel differs significantly from the photographic standards due to surface conditions or other factors. Each standard shall be at least 12 by 12″ (300 by 300 mm) in size and shall be located in an area of the structure that is accessible to and approved by the Engineer.

The Contractor shall protect the Project standard from corrosion and contamination throughout the duration of work. Protection shall be by applying a clear coat of polyurethane, or other means. At the completion of cleaning work, the Project standard shall be recleaned and painted in accordance with this Section. If in the opinion of the Engineer the Project standard becomes deteriorated, or otherwise ineffective, it shall be re-established in accordance with this Subsection.

(2) Surfaces specified to be overcoated shall be solvent cleaned after water blasting.

605.37 Painting.

(a) *Manufacturer's Instructions.* At least five working days prior to the start of work, the Contractor shall provide the Engineer with one copy of the paint manufacturer's current Technical Data and Material Safety Data Sheets for the paint materials being furnished. Instructions, suggestions, and precautions contained in the data sheets shall be followed to the extent that they do not contradict the provisions of this Section. In the case of a contradiction, the more stringent requirements shall be followed.

(b) *Specifications and Inspection Equipment.* Prior to the start of and throughout the duration of work, the Contractor shall supply the Engineer with the following:

(1) One bound copy each of the SSPC surface preparation specifications, SSPC-SP 1 and SSPC-SP 11;
(2) One bound copy of the SSPC pictorial standard, SSPC-Vis 3;
(3) One bound copy of the SSPC paint application specification, SSPC-PA 2;
(4) One air thermometer, pocket type, ranging from 0 to 200 °F (-17 to 93 °C);
(5) One surface thermometer, ranging from 0 to 300 °F (-18 to 149 °C); and
(6) One magnetic dry film thickness gage, Type 2 (fixed probe);

(c) *Atmospheric Conditions.* Painting shall not be performed unless all of the following conditions are met:

(1) The receiving surface is clean and free of rust back, condensation, and visible moisture. Rustback occurs when freshly exposed bare steel is exposed to conditions of high humidity, moisture, or a corrosive atmosphere. The time interval from blast cleaning to rust back varies from minutes to weeks depending on the environment.
(2) The receiving surface and ambient air temperature are as recommended by the paint manufacturer, except that in no case shall painting work be performed when the surface and ambient temperatures are less than 36 or greater than 100 °F (2 or greater than 38 °C).

(d) *Mixing Paint.* All paints shall be thoroughly mixed with mechanical mixers in accordance with the manufacturer's recommendations.

(e) *Solvent Restrictions.* The Contractor may thin the paint only with approved manufacturer's thinner. Thinning will be allowed only in strict accordance with manufacturer's recommendations and State VOC regulations. Unauthorized use of solvents shall result in recleaning and repainting of the surface in accordance with this Section.

(f) *Paint Application.* Paint coatings may be applied using brush, roller, or spray methods unless prohibited by the Contract. When spray painting is prohibited, paint shall be applied using brushes or rollers only.

Stripe painting with primer will be required on the following surfaces cleaned to bare metal. All welds, rivets, bolts, nuts, and edges of plates, angles, lattice, pieces, or other shapes, and corners and crevices shall be "striped" with primer before the general prime coat is applied. All stripe painting shall be performed using a brush only. No other method of paint application will be allowed for stripe painting.

Complete protection against paint spatter, spillage, overspray, wind blown paint, or similar releases of paint shall be provided. Covers, tarps, mesh, and similar materials shall be placed around the work area to protect public and private property; pedestrian, vehicular, marine, or other traffic; all portions of the bridge, highway appurtenances, waterways, and similar surrounding areas; and property upon, beneath, or adjacent to the structure.

(g) *Number of Coats.* Areas cleaned to bare metal and specified to be recoated shall be painted with one coat of primer. After the primer has dried, all surfaces shall be painted with two full coats of paint: the intermediate coat and the finish coat.

(h) *Film Thickness.* Paint shall be applied in sufficient quantity to produce the minimum dry film thickness specified in Section 820 for the type of paint specified.

(i) *Painting Schedule.* Primer shall be applied on the same day of the cleaning operation and before rust back occurs. Failure to apply primer to a cleaned surface within eight hours shall result in recleaning the surface in accordance with this Section.

The intermediate coat of paint shall be applied to the receiving surface within 14 days of the application of the previous coating (primer), or within the manufacturer's recommended schedule for recoating, whichever is less.

The finish coat of paint shall be applied to the receiving surface within 14 days of the application of the previous (intermediate) coating, or within the manufacturer's recommended schedule for recoating, whichever is less.

Areas failing to meet the specified minimum dry film thickness shall be recoated with the same type of paint to produce at least the total dry film thickness required. Paint applied containing thinners, paint applied to contaminated surfaces, and paint applied contrary to this Section shall result in recleaning and repainting the surface. The work of recleaning and repainting, if required, shall be done by the Contractor to the satisfaction of the Engineer.

(j) *Material Storage.* Paint in storage shall be protected from damage and maintained between 40 and 85 °F (5 and 29 °C). Paint not used before the expiration shall be immediately removed from the Project.

605.38 Painting of Galvanized Steel. All galvanized surfaces (downspouts, etc.) shall be painted with a moisture-cured aluminum paint that is designed to adhere to galvanized steel surfaces.

605.39 Stenciling Requirement. At the completion of the painting work, the completion date (month and year) and the bridge number, shall be stenciled on the structure in 3″ (75 mm) high numbers. The

paint used for this marking shall be the same as the topcoat except the color shall be black. The numbers shall be stenciled on the outside of each fascia beam at the approaching traffic end of the structure, on a location designated by the Engineer. The Contractor shall paint the month and year of the existing stenciling after the existing stenciling area is cleaned and painted if so required in case of partial painting of the structure.

605.40 Method of Measurement. The quantity of steel structures will not be measured if payment is on a lump sum basis. If payment is based on the Contract unit price per pound (kilogram), then the quantity of steel structures will be measured in pounds (kilograms). Unless measurement by the scale weight is specified, the quantity of steel will be computed on the following basis:

(a) Unit weights, lb/ft^3 (kg/m^3)

Aluminum, cast or wrought	173 (2770)
Bronze, cast	536 (8590)
Copper-alloy	536 (8590)
Copper sheet	558 (8940)
Iron, cast	445 (7130)
Iron, malleable	470 (7530)
Iron, wrought	487 (7800)
Lead, sheet	707 (11 330)
Steel, rolled, cast, copper bearings, silicon, nickel, and stainless	490 (7850)
Zinc	450 (7210)

(b) The weights of rolled shapes shall be computed on the basis of their nominal weights per foot (meter) as shown on the drawings, or listed in the AISC Manual of Steel Construction.

The weights of plates shall be computed on the basis of the nominal weight of their width and thickness, as shown in the drawings, plus an estimated over-run computed as one-half the permissible variation in thickness and weight as tabulated in AASHTO M 160/M 160M.

(c) The weight of castings shall be computed from the dimensions shown on the approved shop drawings, deducting for open holes. To this weight shall be added 5% allowance for fillets and overruns. Scale weights may be substituted for computed weights in the case of castings or of small complex parts for which accurate computations of weight would be difficult.

(d) The weight of temporary erection bolts; shop and field paint; boxes, crates, and other containers used for shipping; and materials used for supporting members during transportation and erection shall not be included.

(e) When computing the pay weight on the basis of computed net weight the following stipulations in addition to those in (a) through (d) above shall apply:

(1) The weight shall be computed on the basis of the net finished dimensions of the members as shown on the approved shop drawings, deducting for copes, cuts, clips, and all open holes.

(2) The aggregate weight of heads, nuts, single washers, and the threaded stick-through of all high strength shop bolts shall be included on the basis of the following weights:

Table 605F
U.S. Customary

Diameter of Bolt Inches	Weights per 100 Bolts, pounds
1/2	19.7
5/8	31.7
3/4	52.4
7/8	80.4
1	116.7
1 1/8	165.1
1 1/4	212.0
1 3/8	280.0
1 1/2	340.0

Table 605-F
Weights of Metric High-Strength Structural Bolts [1]
approximate weight of 100 steel bolts in kilograms

Bolt Length (mm)	*Nominal Bolt Diameter and Thread Pitch*						
	M16 × 2	*M20 × 2.5*	*M22 × 2.5*	*M24 × 3*	*M27 × 3*	*M30 × 3.5*	*M36 × 4*
45	10.8	---	---	---	---	---	---
50	11.6	19.8	---	---	---	---	---
55	12.3	21.0	26.0	---	---	---	---
60	13.1	22.3	27.5	35.4	---	---	---
65	13.9	23.5	29.0	37.1	50.5	---	---
70	14.7	24.7	30.5	38.9	52.7	64.0	---
75	15.5	26.0	32.0	40.7	55.0	66.8	---
80	16.3	27.2	33.5	42.4	57.2	69.6	108
85	17.1	28.4	34.9	44.2	59.5	72.4	112
90	17.9	29.7	36.4	46.0	61.7	75.1	116
95	18.6	30.9	37.9	47.8	63.9	77.9	120
100	19.4	32.1	39.4	49.5	66.2	80.1	124
110	20.8	34.3	42.1	52.7	70.4	85.6	132
120	22.4	36.8	45.0	56.2	74.9	91.1	140
130	24.0	39.2	48.0	59.7	79.4	96.7	148
140	25.6	41.7	51.0	63.3	83.9	102	155
150	27.1	44.1	54.0	66.8	88.4	108	163
160	28.7	46.6	57.0	70.4	92.8	113	171
170	30.3	49.1	59.9	73.9	97.3	119	179
180	31.8	51.5	62.9	77.5	102	124	187
190	33.4	54.0	65.9	81.0	106	130	195
200	35.0	56.4	68.9	84.6	111	135	203
210	36.6	58.9	71.8	88.1	115	141	211
220	38.2	61.4	74.8	91.6	120	146	219
230	39.7	63.8	77.8	95.2	124	152	227
240	41.3	66.2	80.8	98.7	129	158	235
250	42.9	68.7	83.8	102	133	163	243
260	44.5	71.2	86.7	106	138	169	251
270	46.0	73.7	89.7	109	142	174	259
280	47.6	76.1	92.7	113	147	180	267
290	49.2	78.6	95.7	116	151	185	275
300	50.8	81.1	98.6	120	156	191	283

Note 1: From ANSI B18.2.3.7M, Table 3.

(3) The weight of weld metal shall be computed on the basis of the theoretical volume from dimensions of the welds.

(f) When computing the pay weight on the basis of scale weight, the pay quantity of structural steel will be the shop scale weight of the fabricated members, weighed on

satisfactory scales in the presence of the inspector. If the shop paint has been applied to the completed member when weighed, 0.4% of the weight of the member shall be deducted from the scale weight to compensate for the weight of shop paint.

The quantity of recoating will either be measured by the square foot (square meter) of area recoated or will not be measured.

605.41 Basis of Payment.

(a) *Steel.* The quantity of steel structures will be paid for either at the Contract unit price per pound (kilogram) or on a lump sum basis. Price and payment will constitute full compensation for all labor, materials, equipment, and transportation required for furnishing, fabricating, transporting, erecting, and shop and field painting to complete the work. The quantity of recoating will be paid for either at the Contract unit price per square foot (square meter) or at the Contract lump sum price.

The Contract price for steel structures shall also include, when applicable, taking field elevations along the tops of the existing beams; removal of existing blast plates; and modifications to existing beams for widening except those specifically paid for under the applicable Section. Also included are all additional costs for stage construction for all the work on the Project. The cost of painting of all new structural steel includes all material, labor, tools and equipment, and surface preparation, spatter protection, and cleanup.

When tests of fabricated members are required by the Contract, the cost of testing, including equipment, handling, supervision, and incidentals including but not limited to temperature indicating crayons, liquids, or bimetal thermometers for making the test, will be included in the Contract unit price per pound (kilogram) of structural steel, unless otherwise specified.

All metal parts such as anchor bolts and nuts, shoes, rockers, rollers, bearing and slab plates, pins and pilot and driving nuts, expansion dams, roadway drains and scuppers, weld metal, bolts embedded in concrete, cradles and brackets, blast plates, and waterstops shall be paid for as structural steel unless otherwise stipulated. Steel reinforcement for concrete is not included in this Section and will be paid separately under the appropriate Section.

Payment will be made on a lump sum or price per pound (kilogram) basis as required by the terms of the Contract. When payment is to be based on price per pound (kilogram), the finished work shall be weighed in the presence of the inspector, if practicable. The Contractor shall supply satisfactory scales and shall perform all work involved in handling and weighing the various members.

If payment is made on a lump sum basis the Contractor should note that the approximate weight of structural steel is stated in the proposal. It shall be the responsibility of the Contractor, however, to estimate and determine for itself the amount of metal work required as the quantity given is not guaranteed to be absolutely correct.

If payment is made on a price per pound (kilogram) basis, the payment shall be based on the computed net weight of metal in the fabricated and erected structures unless the Contract provides that payment shall be based on the scale weight. No payment will be made for any weight in excess of 1.5% above the computed net weight of the whole item.

(b) *Painting.* The quantity of recoating all existing structural steel, unless specified elsewhere, will be paid for at the Contract unit price per square foot (square meter) or lump sum price. Price and payment will constitute full compensation for all material, labor, tools and equipment, surface preparation, spatter protection, and cleanup.

Price and payment for the moisture-cured urethane paint system will constitute full

compensation for furnishing all materials; for providing protection against damage during paint application; for re-establishing Project standards, if necessary; for recleaning when primer is not applied within eight hours of initial cleaning; for recleaning and repainting surfaces when unauthorized solvents are used, when paint containing thinners is applied, when paint is applied to contaminated surfaces, and when paint is applied contrary to the requirements of this Section; and for all labor, equipment, tools, and incidentals required to complete the work.

Progress payments will be made based on the percentage of the structure primed and painted with two full coats of paint in accordance with the specification. The percentage will be computed as the ratio of the length of structure primed to the total length of structure. The percentage of payments to be paid to the Contractor will be 25%, 50%, 75%, and 100% after the completion of the work.

SECTION 606 – METAL BRIDGE RAILING

606.01 Description. This work consists of furnishing, fabricating, and erecting either aluminum bridge railing or galvanized steel bridge railing.

606.02 Materials. Materials shall be as specified on the Plans. If galvanized steel is used, it shall be galvanized after fabrication.

606.03 Construction Methods. The type of rail and details shall be as shown on the Plans. Each post base shall be set on a preformed elastomeric pad, conforming to the requirements of Subsection 826.06. The outline of the pad shall conform to the base of the post or base plate. All posts shall be set normal to grade, and all rails shall be set parallel to grade. Anchor bolts shall be set prior to pouring the concrete and shall be firmly held in place by a template. The portions of anchor bolts exposed above the concrete shall be given a protective coating of grease or oil before the concrete is poured.

All rough or sharp corners which, in the opinion of the Engineer, would endanger pedestrians shall be ground smooth either during fabrication or after erection. All anchor bolts and other connecting bolts and fasteners shall be burred to prevent loosening after erection is completed.

No paint will be required on the completed installation except for any touch up of damaged coating. Such damaged areas shall be coated with a material acceptable to the Engineer. Before acceptance of the installation, the railing shall be thoroughly cleaned of all dirt, grime, and stains. Cleaning methods and agents shall be used in accordance with the recommendations of the rail manufacturer.

606.04 Method of Measurement. The quantity of metal bridge railing will be measured as the actual number of linear feet (linear meters) of railing sections, installed and accepted.

606.05 Basis of Payment. The quantity of metal bridge railing will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for furnishing, fabricating, and installing all materials; for touch up of damaged coatings; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 607 – REMOVAL OF EXISTING CONCRETE AND MASONRY

607.01 Description. This work consists of the removal and acceptable disposal of existing rubble, concrete, and masonry that interferes with the completion of new construction except such objects as are designated to remain or are to be removed in accordance with other Sections of these Specifications.

607.02 Construction Methods. Care shall be used during the removal of existing concrete and masonry to avoid damage to existing concrete and masonry construction that is to remain in place.

607.03 Method of Measurement. The quantity of existing concrete and masonry removed will be measured by the cubic yard (cubic meter) based on computations using field measurements of the concrete and masonry in place prior to removal.

607.04 Basis of Payment. The quantity of existing concrete and masonry removed will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for the removal and disposal of the existing rubble, concrete, and masonry and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 608 – COARSE AGGREGATE FOR FOUNDATION STABILIZATION AND SUBFOUNDATION BACKFILL

608.01 Description. This work consists of furnishing and placing coarse aggregate for foundation stabilization and subfoundation backfill. This Section is to be used only when specified and authorized by the Engineer.

608.02 Materials. Coarse aggregate shall conform to the provisions of Section 805 and to the grading requirements of Section 813, Delaware No. 57.

608.03 Construction Methods. The bedding areas on which the coarse aggregate is to be placed will be approved by the Engineer.

Coarse aggregate shall be carefully placed and tamped to form a solid, unyielding mass with the exposed surface conforming to the form and dimensions shown on the Plans. Coarse aggregate shall be placed in locations where the exposed soil conditions are of such a nature and composition as to require the use of this material to achieve a satisfactory load-bearing condition.

608.04 Method of Measurement. The quantity of coarse aggregate will be measured as the actual weight placed and accepted. The weight will be calculated as specified in Subsection 109.01.

608.05 Basis of Payment. The quantity of coarse aggregate will be paid for at the Contract unit price per ton (metric ton). Price and payment will constitute full compensation for furnishing, hauling, and placing the material and for all equipment, tools, labor, and incidentals required to complete the work.

SECTION 609 – SUBFOUNDATION CONCRETE

609.01 Description. This work consists of placing portland cement concrete to level rock foundations, seal rock fissures, and for other similar purposes. This Section is to be used only when specified and authorized by the Engineer.

609.02 Materials. Portland cement concrete shall conform to the requirements of Section 812, Class C.

609.03 Construction Methods. Subfoundation concrete shall not be reinforced and need not be vibrated.

Unless otherwise ordered, curing requirements for subfoundation concrete may be reduced to three days.

609.04 Method of Measurement. The quantity of subfoundation concrete will be measured as the number of cubic yards (cubic meters) of subfoundation concrete placed and accepted. When limits are shown on the Plans, they shall govern for payment purposes. All costs for required forming will be included under this work. When the limits are not shown on the Plans, prior to the work the Engineer will take cross-sections of the spaces to be filled with subfoundation concrete and will compute the volume by the average end area method.

609.05 Basis of Payment. The quantity of subfoundation concrete will be paid for at the Contract unit price per cubic yard (cubic meter). Price and payment will constitute full compensation for furnishing and placing all materials; for required forming; and for all labor, tools, equipment, and incidentals required to complete the work.

SECTION 610 – STONE MASONRY

610.01 Description. This work consists of furnishing all materials for and constructing stone masonry.

MATERIALS.

610.02 Portland Cement. Portland cement shall conform to the requirements of Section 801.

610.03 Fine Aggregate. Fine aggregate shall conform to the requirements of Section 818.

610.04 Water. Water shall conform to the requirements of Section 803.

610.05 Hydrated Lime. Hydrated lime shall conform to the requirements of Section 802.

610.06 Stone. Stone shall be of the dimensions and type as detailed and specified on the Plans. The Contractor shall submit samples of stone for approval prior to starting in case of new masonry work. Materials for masonry repair/replacement shall match the existing stone and patterns.

610.07 Steel Wall Ties. All steel wall ties shall be hot-dipped galvanized.

CONSTRUCTION METHODS.

610.08 Excavation. Excavation shall be made to the required depth when necessary, to expose the foundation on which stone masonry is to be placed.

610.09 Mixing Mortar. Portland cement mortar shall be mixed in the proportion of one part portland cement to three parts fine aggregate, to which shall be added hydrated lime not to exceed 10% of the cement by weight. The fine aggregate, portland cement, and lime shall first be mixed dry in an approved manner until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains such consistency as can be easily handled and spread with a trowel. The mortar shall be so placed to form a firm bond. Mortar which is not used within 30 minutes after water has been added shall be wasted. Retempering of mortar will not be permitted.

610.10 Placing Stone. All masonry work shall be constructed by experienced stone masons. The stone shall be laid to the wall to form the pattern shown on the Plans, and shall be thoroughly wetted before laying in mortar. All joints shall be completely filled with mortar and shall be finished properly as work progresses. Mortar joints shall be 1″ (25 mm) to 1½″ (38 mm) thick.

No masonry shall be laid in freezing weather.

610.11 Cleaning. After constructing the stone masonry, the entire area shall be thoroughly cleaned of all mortar, scars, or spots. Efflorescence may be partly removed by water, but where special treatment is necessary, the area shall be first washed down with water, then treated with a solution of three parts hydrochloric acid to 100 parts of water following washing with water again. The Contractor shall be watchful to notice for any deteriorating reaction to the stone masonry, and in such case the treatment shall stop, and the treated area shall be thoroughly washed down with water. However, it shall be the responsibility of the Contractor to clean the constructed masonry as to present a natural color.

610.12 Backfilling. The excavated areas which are not occupied by the stone masonry shall be backfilled to the required elevation with suitable material which shall be tamped in layers of not more than 6″ (150 mm), until firm and solid. No backfill shall be made prior to approval.

610.13 Method of Measurement. The quantity of stone masonry placed and accepted will be measured by the square foot (square meter).

610.14 Basis of Payment. The quantity of stone masonry will be paid for at the Contract unit price per square foot (square meter). Price and payment will constitute full compensation for excavating and backfilling; for furnishing and placing all materials; for the disposal of surplus materials, and for all labor, equipment, tools, and incidentals required to complete the work, including cleaning.

SECTION 611 – BRICK MASONRY

611.01 Description. This work consists of constructing brick masonry.

MATERIALS.

611.02 Portland Cement. Portland cement shall conform to the requirements of Section 801.

611.03 Fine Aggregate. Fine aggregate shall conform to the requirements of Section 818.

611.04 Water. Water shall conform to the requirements of Section 803.

611.05 Hydrated Lime. Hydrated lime shall conform to the requirements of Section 802.

611.06 Brick. Brick shall be new, whole brick of best quality, of uniform and dense structure, free from lumps of lime, laminations, cracks, checks, soluble salt, or other defects that in any way impair their strength, durability, appearance, or usefulness for the purpose intended. All brick shall conform to requirements of AASHTO M 114 for Grade SW brick. The Contractor must submit samples for approval when the masonry is exposed to general view.

CONSTRUCTION METHODS.

611.07 Excavation. Excavation shall be made to the required depth when necessary, to expose the existing foundation on which the brick masonry is to be placed.

611.08 Mixing Mortar. Portland cement mortar shall be mixed in the proportion of one part portland cement to three parts fine aggregate, to which shall be added hydrated lime not to exceed 10% of the cement by weight. The fine aggregate, portland cement, and lime shall first be mixed dry in an approved manner until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains such consistency as can be easily handled and spread with a trowel. The mortar shall be so placed to form a firm bond. Mortar that is not used within 30 minutes after water has been added shall be wasted. Retempering of mortar will not be permitted.

611.09 Placing Bricks. Bricks shall be laid by means of the shove-joint method so as to thoroughly bed them into the mortar. Buttered or plastered joints will not be permitted. All brick headers and stretchers shall be so arranged as to thoroughly bond the mass with alternate courses breaking joints. All joints shall be completely filled with mortar and shall be finished properly as the work progresses. Joints shall be not less than ¼″ (6 mm) and not more than ½″ (13 mm) in thickness. No spalls or bats shall be used except for shaping irregular openings or when unavoidable to finish out a course, in which case, full bricks shall be placed at the corners and bats shall be placed in the interior of the course. Competent bricklayers shall be employed on work of this class.

611.10 Cleaning. Brick masonry which is to be exposed after completion of the structure, shall be thoroughly cleaned of all mortar, scars, or spots, and shall present a surface showing the natural color of the bricks. Efflorescence may be partly removed by water. The wall shall be first washed down with water, then treated with a solution of three parts hydrochloric acid to 100 parts of water, and finally washed thoroughly again with water.

611.11 Backfilling. The excavated areas which are not occupied by the brick masonry shall be backfilled to the required elevation with suitable material which shall be tamped in layers of not more than 6″ (150 mm), until firm and solid. No backfill shall be made prior to approval.

611.12 Method of Measurement. The quantity of brick masonry placed and accepted will be measured by the square foot (square meter).

611.13 Basis of Payment. The quantity of brick masonry will be paid for at the Contract per square foot (square meter). Price and payment will constitute full compensation for excavating and backfilling; for furnishing and placing all materials; for the disposal of surplus materials; and for all labor, equipment, tools, and incidentals required to complete the work, including cleaning.

SECTION 612 – REINFORCED CONCRETE PIPE

612.01 Description. This work consists of furnishing and installing reinforced concrete round or elliptical pipe. This work also includes the construction of connections to existing drainage inlets and manholes as may be required to complete the work.

MATERIALS.

612.02 Reinforced Concrete Pipe.

(a) *Round Pipe.* Reinforced concrete round pipe shall conform to the requirements of AASHTO M170 (M 170M) and shall be Class III unless otherwise noted.

(b) *Elliptical Pipe.* Pipe designed for placement with the major axis horizontal shall be designated as horizontal elliptical pipe (HE). Pipe designed for placement with the major axis vertical shall be designated as vertical elliptical pipe (VE).

Reinforced concrete elliptical pipe shall conform to the requirements of AASHTO M207 (M 207M) and the following:

(1) Standard strength reinforcement concrete elliptical pipe (HE or VE) shall be Class III.

(2) Extra strength reinforced concrete elliptical pipe (HE or VE) shall be Class IV.

No pipe shall be shipped from the plant to the Project until the requirements of AASHTO M170 (M 170M) or M207 (M 207M) are met and the pipe is marked with the Department's inspection stamp. The manufacturer shall have clearly marked on the pipe the following information before inspection is made:

(1) Pipe class

(2) Pipe type, HE or VE, for elliptical pipe only

(3) Date of manufacture

(4) Name or trademark of the manufacturer

(5) One end of each section of elliptical pipe shall be clearly marked, during the process of manufacture or immediately thereafter, on the inside and the outside of the opposite walls along the minor axis.

All pipe inspected and approved at the manufacturing plant shall be subject to inspection at the site of the work, and no previous stamp or approval shall bar rejection if the pipe is found to be defective or damaged.

612.03 Joint Material. A rubber gasket conforming to the requirements of AASHTO M 315 (M 315 M) shall be used to seal the joints between successive sections of pipe.

612.04 Backfill Material. Backfill material shall conform to the requirements of Subsection 209.04, Borrow Type C. If the existing material meets these requirements, it shall be used for pipe backfill.

CONSTRUCTION METHODS.

612.05 Excavation. The trench in which the pipe is laid shall be excavated in accordance with Section 208 to the required depth. The bottom of the trench shall be shaped to provide the required class of bedding. Where rock is encountered, the trench shall be excavated in depth to the bottom of the earth cushion as shown on the Standard Construction Details for bedding in rock, and for a width of 12″ (300 mm) on each side of the pipe. This depth and width shall be backfilled with approved material and thoroughly tamped.

612.06 Bedding of Pipe. Unless noted otherwise, all pipes shall receive a Class C bedding. Class C bedding shall consist of bedding the pipe in a trench carefully shaped to conform to the outside circumference of the pipe for a depth not less than 10% of the outside diameter of the pipe. Shaping of the bed to conform to the shape of the pipe at joints shall also be required.

612.07 Joints. Before laying the pipe in the trench, the rubber gasket shall be attached to the spigot end of each pipe joint and set firmly against the shoulder around the entire circumference of the pipe joint. A lubricant, specified by the gasket manufacturer, may be applied to the gasket for ease of installation.

Pipe handling after the gasket has been affixed shall be carefully controlled to avoid bumping the gasket and thus displacing it or covering it with dirt or other foreign material. Any gasket so disturbed shall be removed, replaced if damaged, and repositioned if displaced. Sufficient pressure shall be applied in making the joint to ensure that the joint is tight.

612.08 Laying Pipe. All pipe shall be laid in an upgrade direction unless otherwise directed. The pipe shall be laid with the lowest point of the inside diameter conforming with the flow line shown on the Plans.

All pipe shall be carefully laid with the bell ends upgrade, with the spigot ends fully entered into the adjoining bell, and true to the lines and grades shown on the Plans, or as directed.

Any pipe which is not in true alignment, or which shows any settlement after laying, shall be taken up and relaid. Unsuitable material encountered below the flow line of pipe shall be removed to a depth and replaced, as directed.

612.09 Backfill. Placement of backfill shall conform to Section 208. Where heavy construction equipment travels over the pipe, a cover of material shall be placed to a minimum depth of 4′ (1.2 m).

612.10 Method of Measurement. The quantity of reinforced concrete round or elliptical pipe will be measured as the actual number of linear feet (linear meters) of each type of pipe placed and accepted, measured from end to end of pipe, including structure wall thickness, but excluding structure interior.

612.11 Basis of Payment. The quantity of reinforced concrete round or elliptical pipe will be paid for at the Contract unit price per linear foot (linear meter) for each type of pipe. Price and payment will constitute full compensation for furnishing, hauling, and installing pipe; for all cribbing or foundation treatment necessary to prevent settlement; for all shoring and sheeting; for the replacement of any pipe which is not true in alignment or which shows any settlement after laying; and for all material, labor, equipment, tools, and incidentals required to complete the work.

For round pipe under 24″ (600 mm) nominal inside diameter, and elliptical pipe under 24″ (600 mm) nominal inside horizontal dimension, the excavation (excluding rock), backfill, and backfilling will

be included in the price for this work. For pipe of nominal inside diameter or horizontal dimension of 24″ (600 mm) and over, payment for excavation and backfill will be in accordance with Section 208. Furnishing of Borrow Type C for pipe of nominal inside diameter or horizontal dimension of 24″ (600 mm) and over, will be paid for under Section 210.

Payment for excavation and replacement of unsuitable material encountered below the flow line of pipe will be provided for under Section 208.

SECTION 613 – RESERVED

SECTION 614 – CORRUGATED PIPE

614.01 Description. This work consists of furnishing and installing corrugated steel or corrugated aluminum pipe. This work also includes the furnishing and construction of joints and connections to existing pipes, drainage inlets, and endwalls, as may be required to complete the work as indicated on the Plans, or as directed.

MATERIALS.

614.02 Pipe.

(a) *Corrugated Steel Pipe.* Corrugated steel pipe shall conform to the requirements of AASHTO M 36/M 36M.
   (1) Zinc-coated (galvanized) corrugated steel pipe shall conform to AASHTO M 218.
   (2) Aluminum-coated (Type 2) corrugated steel pipe shall conform to AASHTO M 274.

(b) *Corrugated Aluminum Pipe.* Corrugated aluminum pipe shall conform to the requirements of AASHTO M 196/M 196M.

(c) *Spiral Rib Pipe.* Spiral rib pipe (Type 1R) shall conform to the requirements of AASHTO M 36/M 36M for steel spiral rib and to AASHTO M 196/M 196M for aluminum spiral rib pipe.

614.03 Bituminous Coating. When bituminous coating is called for, it shall conform to the requirements of AASHTO M 190.

614.04 Bands. All corrugated steel or corrugated aluminum pipe shall be furnished in lengths specified on the Plans. If any specified length of pipe is divided into shorter sections for convenience, approved connecting bands shall be furnished for field joints. The coupling bands shall conform to AASHTO M 36/M 36M.

Bands shall be constructed so as to lap an equal portion of each of the pipe sections to be connected. Bands shall be fastened at the ends by galvanized angles having minimum dimensions of 2 by 2 by 3/16″ (50 by 50 by 4.75 mm). Other equally effective methods of fastening the bands may be used if approved. All bands shall include an approved rubber gasket to ensure a watertight joint.

Connecting bands used under this Section shall not be bituminous coated.

614.05 Defects. The following defects in corrugated steel or corrugated aluminum pipe constitute poor workmanship, and the presence of any of them in any individual pipe shall be sufficient cause for rejection:

(a) Uneven laps
(b) Elliptical shaping (circular pipe only)
(c) Variation from a straight centerline
(d) Ragged or diagonal sheared edges
(e) Loose, unevenly lined or spaced rivets
(f) Imperfectly formed rivet heads
(g) Unfinished ends
(h) Illegible brand
(i) Lack of rigidity
(j) Bruised, scaled, or broken protective coating
(k) Dents or bends in the metal

614.06 Field Inspection. Field inspections will be made and will include an examination of the pipe for deficiencies in lengths of sheet used, thickness of metal, nominal inside diameter, net length of finished pipe, and any evidence of poor workmanship as outlined in this Section. The inspection may include the taking of samples for chemical analysis and determination of coating thickness and quality.

614.07 Backfill Material. Backfill material shall conform to the requirements of Subsection 209.04, Borrow Type C. If the existing material meets these requirements, it shall be used for pipe backfill.

CONSTRUCTION METHODS.

614.08 Pipe Installation. All pipe shall be carefully handled during unloading and placing in position. Dragging the pipe over the ground or over timbers or planks will not be permitted. Utmost care shall be taken to prevent damage to the bituminous coating. Any exposed metal or damaged coating not exceeding 60 in² (40 000 mm^2) shall be covered with an approved bituminous material properly built up, before placing the backfill. Pipe with damaged areas exceeding 60 in² (40 000 mm^2) may be rejected.

The pipe shall be bedded according to Section 612.

Pipes of large diameter shall be strutted if shown on the Plans. The struts shall be placed before the embankment is placed and shall be removed when ordered.

Where the pipe sections are joined on the Project, the ends shall be joined with a standard band, bolted firmly in place.

Any pipe which is not in true alignment or which shows any detrimental settlement after laying, shall be taken up and relaid.

614.09 Backfill. Placement of backfill shall conform to Section 208. Care shall be taken to avoid striking the pipe with tamping tools.

614.10 Method of Measurement. The quantity of corrugated steel or corrugated aluminum pipe will be measured as the number of linear feet (linear meters) of each type of pipe placed and accepted, measured from end to end of pipe, including structure wall thickness, but excluding structure interior.

In measuring lengths of special manufactured connections, exclusive of coupling bands, each actual linear foot (linear meter) placed will be doubled.

614.11 Basis of Payment. The quantity of corrugated steel or corrugated aluminum pipe will be paid for at the Contract unit price per linear foot (linear meter) for each type of pipe. Price and payment will

constitute full compensation for furnishing, hauling, and installing pipe; for all cribbing or foundation treatment necessary to prevent settlement; for all shoring and sheeting; for the replacement of any pipe which is not in true alignment or which shows any detrimental settlement after laying; for coating if required; and for all material, labor, equipment, tools, and incidentals required to complete the work.

For pipe under 24″ (600 mm) nominal inside diameter and arch pipe under 24″ (600 mm) nominal inside horizontal dimension, the excavation (excluding rock), backfill, and backfilling will be included in the price for this work. For pipe of nominal inside diameter or horizontal dimension 24″ (600 mm) and over, payment for excavation and backfill will be in accordance with Section 208. Furnishing of Borrow Type C for pipe of nominal inside diameter or horizontal dimension of 24″ (600 mm) and over, will be paid for under Section 210.

Payment for excavation and replacement of unsuitable material encountered below the flow line of pipe will be provided for under Section 208.

SECTIONS 615 and 616 – RESERVED

SECTION 617 – FLARED END SECTION

617.01 Description. This work consists of furnishing and placing corrugated metal pipe and reinforced concrete flared end sections.

617.02 Materials. Materials shall conform to the requirements of Sections 612 and 614, as applicable.

617.03 Construction Methods. Flared end sections shall be placed in conformance with the details, dimensions, and notes shown on the standard sheet and at the locations shown on the Plans.

617.04 Method of Measurement. The quantity of flared end sections will be measured as the actual number placed and accepted.

617.05 Basis of Payment. The quantity of flared end sections will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing, hauling, and installing materials, including bar reinforcement; for excavating, backfilling, and compacting; for cribbing, shoring, sheeting, coating, and paving; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 618 – PILE MATERIALS

618.01 Description. This work consists of furnishing treated and untreated timber piles and test piles, cast-in-place concrete piles and test piles, steel H pile and test piles, and precast, prestressed concrete piles and test piles.

TIMBER PILE MATERIALS.

618.02 Classification. Untreated timber piles that will be below water level at all times, may be of any species of wood that satisfactorily withstands driving.

Untreated timber piles for use in exposed work shall have a diameter of heartwood at the butt not less than 80% of the required diameter of the pile.

Treated timber piles shall be of southern yellow pine or Douglas fir, unless otherwise specified.

618.03 Requirements. The following requirements shall apply to both untreated and treated timber piles except that piles intended for treating shall be cleaned of all bark and shall be otherwise conditioned as outlined in Subsection 618.04.

All piling shall be cut from sound, live timber and shall contain no unsound knots. Sound knots will be allowed provided the diameter of the knot does not exceed the lesser of 4″ (100 mm) or one-third the diameter of the pile at the point where the knot occurs. Any defect or combination of defects, which impairs the strength of the pile more than that of the maximum allowable knot, shall not be permitted. The butts shall be sawed square, and the tips shall be sawed square or tapered to a point not less than 4″ (100 mm) square where soil conditions warrant pointing the tip. The slope of the spiral grain, if present, shall not exceed 1″ (25 mm) in height for 12″ (300 mm) in length.

Piles shall have a uniform taper from butt to tip. A line drawn from the center of the butt to the center of the tip shall not fall outside the center of the pile at any point more than 0.5% of the length of the pile. Bends which cause difficulty in driving are sufficient cause for rejection of the piling.

The piles shall be free from season checks which penetrate more than one-sixth of the diameter of the pile or are more than ¼″ (6 mm) in width. A check is defined as a lengthwise separation of the wood across the rings of normal growth, extending from the surface toward the pith, but not extending through the piece. Piles must meet the requirements of AASHTO M 168.

618.04 Preparation. Untreated piles shall have the outer bark removed.

Treated piles shall be peeled by removing all the outer bark and at least 80% of the inner bark. No strip of inner bark remaining on the pile shall be over 3/4″ (20 mm) wide or over 8″ (200 mm) long, and there shall be at least 1″ (25 mm) of clean wood surface between any two such strips.

618.05 Dimensions. The diameter that designates the size of piles shall be measured 3′ (900 mm) from the butt. The minimum tip diameter of piles shall be 8″ (200 mm) for piles under 40′ (12 m) in length and 7″ (175 mm) for 40′ (12 m) and longer piles. All measurements shall be made under the bark. The maximum diameter at butt of any pile shall not exceed 20″ (500 mm).

618.06 Preservation Treatment. Treated piles shall receive preservative treatment in accordance with AASHTO M 133 and the AWPA preservation standards specified therein. Unless otherwise specified, the preservative shall be either creosote oil-tar or CCA. The treatment shall be in accordance Table 618-A.

Table 618-A
Preservation Treatment of Timber Piles

Preservative	*Process*	*Retention Rate, lb/ft³ (kg/m³) (land, freshwater, and foundation piles)* *Southern Pine*	*Douglas Fir*
Creosote Oil-Tar	empty-cell	12 (190)	17 (270)
CCA	full-cell or modified full-cell	0.8 (13)	1.0 (16)
Preservative	*Process*	*Retention Rate, lb/ft³ (kg/m³) (marine piles)* *Southern Pine*	*Douglas Fir*
Creosote Oil-Tar	empty-cell	20 (320)	20 (320)
CCA	full-cell or modified full-cell	2.5 (40)	NR

NR - not recommended

618.07 Inspection. The timber, and the operation of treatment, will be inspected at the treating plant, both before and after treating, and all acceptable timber will be marked with the Department's standard hammer mark. All timber piles shall also be subject to inspection at the site of the work. If the pile is found defective, it shall be subject to rejection.

618.08 Storing and Handling. The methods of storing and handling shall be such as to avoid injury to the piles and shall be approved. Special care shall be taken to avoid breaking the surface of treated piles; canthooks, dogs, or pikepoles shall not be used. All cuts, holes, and injuries of the surface of treated material shall be field-protected by brushing, spraying, dipping, soaking, or coating. Care shall be taken to ensure that all injuries, such as abrasions and nail and spike holes, are thoroughly saturated with the field-treating solution. Treated piles shall not be cut or trimmed in any manner after they are driven other than to saw off the tops as hereinafter specified.

Holes bored in pressure treated material shall be poured full of preservative. Horizontal holes, such as those for sway brace bolts, may be filled by pouring the preservative into them with a bent funnel. All holes made for determining penetration and retention of preservatives shall be filled with tight fitting treated cylindrical plugs.

CAST-IN-PLACE CONCRETE PILE MATERIALS.

618.09 Shells (Steel Casings). The Contractor shall use fluted steel pile shells for cast-in-place concrete piles, unless steel pipe pile shells are specified on the Plans.

If steel pipe piles are used, the steel pipe pile shell shall conform to the requirements of ASTM A 252, Grade 2 with a minimum wall thickness of ¼″ (6 mm). For welded pipe piles, all seams shall be straight or spiral-butt welded having full strength welded joints. Seamless steel pipe piles are also acceptable. All piles shall be equipped with cast steel, inside-flange, extra strong, ribbed 60 degree conical points. These conical points shall be securely fitted to the bottom of the pile shells by welding with a 30 degree beveled groove weld all around and in such a manner to minimize any extrusion

beyond the outside surface of the steel casings. A maximum protrusion of ¼″ (6 mm) is permissible. If the protrusion exceeds ¼″ (6 mm), the Contractor shall grind the protruding weld flush with the outside surface of the pile shell.

If fluted steel pile shells are used, the tapered section shall have a tip diameter of 8″ (200 mm) with a closed conical point and tapering at the rate of 0.4″/ft (33 mm/m). The fluted steel pile shall be closed or open ended as specified on the Plans. The Contractor shall accomplish splices by cutting the walls in a serrated pattern, inserting the added section, crimping back, and welding along the entire perimeter with a continuous 3/8″ (10 mm) fillet weld. All welding shall be performed by AWS certified welders approved by the Department. Welding certifications shall be current and must show passing qualifications for the type of welding to be performed. The steel for the shells shall conform to SAE 1010 or 1015 and have a minimum yield point of 50,000 psi (345 MPa) and a minimum thickness of 7 gage (4.55 mm).

All field splices shall have the full strength of the sections they connect and require approval of the Engineer. Generally the minimum distance between field splices on the pile shall be 40′ (12 m).

618.10 Protective Coating. When indicated on the Plans, the pile shells (steel casings) shall be protected with a coating consisting of either coal tar epoxy or fusion bonded epoxy.

If coal tar epoxy coating is specified, two coats of dark red coal tar epoxy shall be applied. The pile shell shall be thoroughly dry and commercially blast cleaned according to SSPC-SP 6 before coating. The two coat application, final drying time, touch-up, and inspection shall conform to the specifications of the SSPC. The dry film thickness of each coat shall be 8 mils (200 µm) minimum and 16 mils (400 µm) for the two-coat system.

If fusion bonded epoxy coating is specified, it shall be a one-part, heat curable, thermosetting powder coating meeting the following requirements:

Property	***Test Method***	***Value***
Gloss 60 degrees	ASTM D 523	25 to 90%
Impact (5/8″ Top) [16 mm Top]	ASTM G 14	80-160 Inch Pounds (9 to 18 J)
Taber Abrasion*	ASTM D 4060	70 mg/1000 cycles
Chemical Resistance	ASTM D 1308	10% CaCl No Effect 10% NaOH No Effect Sat $Ca(OH)_2$ No Effect
Color	Red Standard (For other colors, consult coater.)	

* Taber Abrasion run CF 10 wheel, 1000 g load, 1000 cycles

The fusion bonded epoxy coating shall be applied in an environmentally controlled plant that is fully enclosed. The blast cleaning apparatus and the coating application system shall be approved and prequalified by the Department. All surfaces to be coated shall be blast cleaned according to SSPC-SP 5 "White Metal Blast Cleaning" standards. The blast profile shall be 2 to 3 mils (50 to 75 µm). The coating shall be applied within eight hours after blast cleaning. The coating shall be applied as an electrostatically charged dry powder sprayed onto the grounded pile. The coating shall be heated and cured in accordance with the manufacturer's recommended procedures to provide a fully cured finish. The coating shall be applied to a cured thickness of 25±2 mils (635 ± 50 µm) as tested in accordance with ASTM G 12.

For both the coal tar and fusion bonded epoxy coatings, a compatible touch-up compound shall be provided for repairing areas damaged during driving. The touch-up compound shall be applied by the Contractor to all visible open areas in accordance with the manufacturer's recommended procedures.

The length of each pile to be coated shall be in accordance with the requirements noted on the Plans. Test piles shall also be coated if a protective coating is specified for the production piles in the group.

618.11 Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 812, Class B.

618.12 Bar Reinforcement. Bar reinforcement shall conform to the requirements of Section 824.

618.13 Storage and Handling. The pile casings or shells shall be carefully stored and protected to avoid dents, abrasions, and other injuries and shall be picked up in a manner that will avoid bending and distortion. If the pile shells are damaged due to improper storage or handling, they shall be rejected.

618.14 Inspection. Shells (steel casings) will be inspected by the Department at the point of shipment prior to applying any protective coating. If a protective coating is required, the application of the protective coating will be inspected at the plant. The pile shells shall also be subject to inspection at the Project site prior to driving. All defective piles will be rejected.

STEEL H PILE MATERIALS.

618.15 Materials. Unless otherwise indicated, all steel H piles shall conform to the requirements of AASHTO M 183/M 183M. Materials for splices or reinforced tips shall be the same as the H pile except that cast steel may be used for tips. All welding and welding materials shall be as specified under Subsection 826.12. Steel shall be straight and true with the camber and sweep within the permissible mill tolerances.

PRECAST, PRESTRESSED CONCRETE PILE MATERIALS.

618.16 Portland Cement Concrete. Portland cement concrete for square prestressed concrete piles shall conform to the requirements of Sections 623 and 812 as amended herein, and f'_c shall be 6,000 psi (40 MPa), unless noted otherwise on the Plans. The Contractor shall develop its own concrete mix design, according to the requirements of ACI 211.1, which shall be submitted to the Engineer for approval. The cement content shall not be less than 658 lb/yd³ (390 kg/m^3). Portland cement shall conform to the requirements of AASHTO M 85, Type II.

With the approval of the Engineer, a blend of Type I cement conforming to the requirements of AASHTO M 85 and ground granulated blast-furnace slag cement conforming to the requirements of ASTM C 989, Grade 120 may be used in lieu of the specified minimum amount of Type II cement. The slag cement percentage shall be not less than 35% nor greater than 50% of the Type I-slag cement blend by weight.

618.17 Prestressing Strands. Prestressing strands shall be seven-wire stress relieved, strands conforming to the requirements of AASHTO M 203/M 203M, Grade 270, unless noted otherwise on the Plans. The prestressing strands shall be arranged and stressed as shown on the Plans.

618.18 Spiral Reinforcing. Spiral reinforcing shall conform to the requirements of AASHTO M 32/M 32M.

618.19 Bar Reinforcement. Bar reinforcement, if required, shall conform to the requirements of Section 824, Grade 60 (Grade 420).

618.20 Fabrication. The prestressed concrete piles shall be manufactured in accordance with the requirements of Section 623.

Working drawings of the pile fabrication details shall be submitted in accordance with Subsection 105.04. Piles shall be furnished with flat tips as shown on the Plans. Pointed pile tips shall not be used, unless specifically called for on the Plans.

Tolerance for prestressed concrete piles shall be as follows:

Width:	-¼″ (-6 mm) to +1″ (25 mm)
Head Out of Square:	¼″ (6 mm) per 12′ (300 mm) of width, measured diagonally
Horizontal Alignment: (Deviation from straight line parallel to centerline of pile)	1/8″ (3 mm) per 10′ (3 m) of pile
Position of Stirrup Bars and Spirals:	+3/4″ (+19 mm), maintain specified clearance
Position of Tendons:	±¼″ (±6 mm)
Position of Handling Devices:	±6″ (±150 mm)

618.21 Storage and Handling. The piles shall be stored, protected, and handled properly to avoid damage. Slings or other appropriate rigging shall be used at the designated pick up points to avoid damage to the piles. If the piles are damaged due to improper storage or handling by the Contractor, the piles will be rejected and shall be replaced by the Contractor.

The Contractor shall submit working drawings to the Engineer for review showing the procedures for picking up, transporting, and handling the piles prior to handling the piles. Piles may be moved after transfer of the prestressing force. Piles may be driven after the concrete has aged at least seven days and the concrete compressive strength is equal to or greater than the specified 28-day compressive strength.

618.22 Method of Measurement. The quantity of permanent timber, cast-in-place concrete, steel H, and precast, prestressed concrete piles will be field measured as the total number of linear feet (linear meters) of material ordered as determined by the Department based on test pile driving. The quantity of timber, cast-in-place concrete, steel H, and precast, prestressed concrete test piles will be field measured as the total number of linear feet (linear meters) ordered by the Contractor after approval by the Engineer for each type of test pile. The quantity of pile material used in pile splices of all types of piles will be field measured as the total number of linear feet (linear meters) of material furnished to the site as agreed by the Department. Pay measurements will be taken, in every case, before actual driving has begun. The additional length of pile formed and constructed for the purposes of a pile build up for a Precast, Prestressed Concrete Pile will be field measured as the total number of linear feet (linear meters) formed and poured.

618.23 Basis of Payment. The quantity of permanent timber, cast-in-place concrete, steel H, and precast, prestressed concrete piles will be paid for at the Contract unit price per linear foot (linear meter) for each type of pile. The quantity of timber, cast-in-place concrete, steel H, and precast, prestressed

concrete test piles will be paid for at the Contract unit price per linear foot (linear meter) for each type of test pile. The quantity of pile material used for pile splices will be paid for at the Contract unit price per linear foot (linear meter) for each type of pile. The quantity of pile build ups constructed will be paid at the Contract unit price per linear foot (linear meter) for precast, prestressed concrete piles.

Price and payment will constitute full compensation for furnishing all pile and test pile materials, including pile tip, preservatives for timber piles, metal pile shells, protective coating for piles, bar and spiral reinforcement, prestressing strands, dowels for precast piles, portland cement concrete for cast-in-place piles, costs associated with construction of pile build ups, and for all labor, equipment, tools, and incidentals required to complete the work.

All piles that are damaged due to improper storage or handling by the Contractor shall be replaced by the Contractor at no expense to the Department.

No payment will be made for production piles and test piles not accepted, production piles and test piles improperly driven, or production piles and test piles damaged during driving.

The installation of timber, cast-in-place, steel H, and precast, prestressed concrete piles and test piles will be paid for under Section 619.

Labor costs associated with splicing precast, prestressed concrete piles to obtain proper length will be paid for under Section 619.

SECTION 619 – INSTALLATION OF PILES

619.01 Description. This work consists of installing four types of production and test piles. The four types of piles are timber, cast-in-place concrete, steel H, and precast, prestressed concrete. This work also consists of extracting, removing, and disposing of any test pile where required.

619.02 General. All materials used in the installation of any production or test pile shall conform to the requirements of Section 618. The location of production and test piles shall be as shown on the Plans or as directed by the Engineer.

No piles shall be driven until all excavating and backfilling necessary at any structural unit have been completed. No production piles shall be driven until the test pile or piles have been driven and the results have been evaluated by the Engineer.

Production and test piles shall be driven to one or a combination of the following criteria as directed by the Engineer:

Driven Bearing
Tip Elevation
Practical Refusal
Bearing Achieved by Freeze

EQUIPMENT.

619.03 Driving Hammers. All piles shall be driven with a steam, air, or diesel hammer. The minimum rated energy of the pile driving hammer per blow shall meet the following requirements:

Timber production and test piles . . . . . 12,000 ft.lb (16.3 kJ)
Cast-in-place concrete production and test piles . . . . . 16,000 ft.lb (21.7 kJ)
Precast, prestressed concrete production and test piles . . . . . 29,500 ft.lb (40.0 kJ)
Steel H production and test piles . . . . . 22,400 ft.lb (30.4 kJ)

For steel H production and test piles, a driving head, grooved to the cross-section of the pile,

shall be used to prevent damage to the tops of piles.

For production and test piles, pile hammers shall be sized to ensure that stresses associated with hammer impact do not exceed allowable driving stresses specified in Subsection 619.09. In the case of batter piles, the wave equation analysis shall also consider the decrease in energy due to the inclination of the pile driving hammer.

The pile hammer shall be maintained in proper adjustment consistent with the manufacturer's recommendations. The pile hammer shall be operated at the manufacturer's rated number of blows per minute and at the rated steam or air pressure for steam and air hammers. For steam or air hammers, the Contractor shall furnish a boiler or air compressor with a capacity at least equal to that specified by the manufacturer of the hammer to be used, and the Contractor shall equip the boiler or compressor with an accurate pressure gage. Double acting diesel hammers shall be equipped with either a pressure gage or other device calibrated in a manner that enables the Engineer to determine hammer energy. The device and calibration curves shall be as recommended by the hammer manufacturer and shall be submitted to the Engineer for review and approval. Single acting hammers of all types shall be equipped to allow accurate visual monitoring of the stroke height by the Engineer. The mechanism providing such stroke height monitoring shall be submitted to the Engineer for review and approved prior to driving the initial test pile on the Project.

The Contractor shall furnish to the Engineer for approval information regarding the proposed pile driving system on the form, "Pile and Pile Driving Equipment Data".

Pile and Pile Driving Equipment Data

Contract No.: _____ County: _____
Project: _____
Structure Name and/or No.: _____
_____
Pile Driving Contractor or Subcontractor: _____
_____
(Piles driven by)

Hammer
Manufacturer: _____
Model: _____
Type: _____
Serial No.: _____
Rated Energy: _____
@ _____ Length of Stroke
Modifications: _____
_____

Capblock
Material: _____
Thickness: _____
Area: _____
Modulus of Elasticity - E: _____ psi (MPa)
Coefficient of Restitution - e: _____

Pile Cap
Helmet
Bonnet - Weight: _____
Anvil Block
Drivehead

Cushion
Cushion Material: _____
Thickness: _____
Area: _____
Modulus of Elasticity - E: _____ psi (MPa)
Coefficient of Restitution - e: _____

Pile
Pile Type: _____
Length (in Leads): _____
Weight/meter: _____
Wall Thickness: _____
Taper: _____
Cross-Sectional Area: _____ in^2 (mm^2)
Design Pile Capacity: _____ tons (metric tons)
Description of Splice: _____
_____
Tip Treatment Description: _____
_____
_____

Submitted By: _____ Date: _____

Pile driving equipment shall not be transported to the Project site until such approval is granted.

The hammer, hammer cushion, and pile cushion used to drive the production and test piles shall be the same type and size as those used in the wave equation analysis. No modifications or substitutions will be permitted without the approval of the Engineer.

Approval of a pile hammer shall not relieve the Contractor of responsibility for achieving the required bearing, piles damaged because of misalignment of the leads, failure of capblock or cushion material, failure of splices, malfunctioning of the pile hammer, or other improper construction methods. Piles damaged for such reasons will be rejected and shall be replaced by the Contractor if the Engineer determines that the damage impairs the strength or the serviceability of the pile.

619.04 Driving Helmet and Pile Cushion. A driving helmet, including a pile cushion for concrete piles, shall be used between the top of the pile and the ram to prevent impact damage to the piles. The driving helmet, and pile cushion for concrete piles, shall be capable of protecting the head of the pile, minimizing energy absorption and dissipation, and transferring hammer energy uniformly over the top of the pile. The driving helmet shall fit loosely around the top of the pile, so that the pile is not restrained by the driving helmet if the pile tends to rotate during driving. The pile cushion may be of solid wood or of laminated construction, shall completely cover the top surface of the pile, and shall be retained by the driving helmet. The minimum thickness of the pile cushion shall be 6″ (150 mm), and the thickness shall be increased so as to be suitable for the size and length of pile, character of subsurface materials to be encountered, and hammer characteristics. The exact size and characteristics of the pile cushion shall be determined from the wave equation analysis. Timber or timber product pile cushion if used shall be replaced if it becomes compressed to 50% of its original thickness, if it becomes charred or burned, or if it becomes deteriorated in any manner during driving. If the Contractor opts to use another type of pile cushion, its properties and replacement criteria shall be submitted for approval with the wave equation analysis.

619.05 Leads. All piles shall be supported in line and position with leads while being driven. Pile driver leads shall be constructed in a manner that affords freedom of movement of the hammer, while maintaining alignment of the hammer and the pile to ensure concentric impact for each blow. Leads may be either fixed or swing type. Swinging leads, when used, shall be fitted with a pile gate at the bottom of the lead, and in the case of batter piles, a horizontal brace shall be required between the crane and the leads. The leads shall be adequately embedded in the ground. Alternatively, for battered piles, the pile shall be constrained and the leads anchored in a structural frame such as a template, as approved by the Engineer, to maintain batter and alignment of the driven piles. The leads shall be of sufficient length to make the use of a follower unnecessary and shall be so designed as to permit proper placement of batter piles. The leads and crane shall have the ability to handle, as a minimum, piles of the length indicated on the Plans plus 10′ (3 m).

619.06 Followers. Followers shall only be used when approved in writing by the Engineer, or when specifically stated in the Contract. In cases where a follower is permitted, the first pile in each bent and every tenth pile driven thereafter shall be driven full length without the use of a follower to determine that the desired bearing capacity is being attained. The follower and pile shall be held and maintained in equal and proper alignment during driving. The follower shall be of such material and dimensions to permit the piles to be driven to the length determined necessary from the driving of the full length piles. The final position and alignment of the first two piles installed with followers in each substructure unit shall be verified to be in accordance with specified location tolerances before additional piles are installed.

619.07 Water Jets. Water jets will not be permitted unless approved in writing by the Engineer or when specifically stated in the Contract. Water jets will not be permitted when installing any steel H piles. The number of jets and the nozzle volume and pressure shall be sufficient to freely erode the material adjacent to the piling. The plant shall have sufficient capacity to deliver at all times a pressure equivalent to at least 100 psi (700 kPa) at two 3/4″ (19 mm) jet nozzles. To determine driving resistance, all piles shall be driven the last 3 feet (meter) without the aid of jets. The type and configuration of water jets shall be submitted and approved prior to driving the initial test pile on the Contract.

CONSTRUCTION METHODS.

619.08 Preparation for Driving. The heads of the timber production and test piles, when the nature of the driving is such as to injure them unduly, shall be protected by caps of approved design. Collars or bands to protect them against splitting or brooming shall be provided where necessary.

Steel H production and test piles shall be driven in unspliced lengths whenever possible. Splices will only be permitted when specifically approved by the Engineer and shall be held to the absolute minimum. Splicing together short pile cut-offs to form a pile will not be permitted. Splice details will be as shown on the Plans or as approved by the Engineer. When reinforced pile tips are required, they shall be as detailed on the Plans or as approved by the Engineer.

619.09 Bearing Values. The Engineer will determine the driving resistances, tip elevations, and safe bearing capacity as described in this Subsection.

Wave equation analysis will be required for all types of piles discussed in this Section, unless otherwise shown in the Contract.

The Contractor shall be responsible for performing the wave equation analysis, unless otherwise specified, to obtain the relationship between blow count and estimated ultimate capacity. As determined by the Schedule of Work, but no less than 30 calendar days prior to driving the initial test pile, the Contractor shall submit the wave equation analysis, certified by a Professional Engineer registered in Delaware, to the Engineer for review and approval. The wave equation analysis will be used to verify the adequacy of the pile driving system and to establish the necessary blow counts, stroke heights, pile cushions, and any other applicable information for use in driving initial test piles to the required bearing capacity and tip elevation. This criteria may be reevaluated during test pile driving and may or may not be revised for production pile driving.

Along with the wave equation analysis, the Contractor shall submit to the Engineer the necessary pile driving equipment information on the "Pile and Pile Driving Equipment Data" form shown in Subsection 619.03.

Included in the submittal shall be computer input and output sheets and suitable data plots displaying the Contractor's wave equation analysis for the pile driving throughout the various subsurface conditions of the site. The plots shall show ultimate resistance versus blow count as well as maximum tension and compression stresses versus ultimate resistance. Unless otherwise specified on the Plans, a safety factor of 2.5 shall be used to calculate the allowable bearing capacity and a safety factor of 2 shall be used for bridges with pile load tests.

The information relating to the pile driving equipment proposed by the Contractor for the Project must be used as input to perform the wave equation analysis. If the wave equation analysis shows that the pile may be damaged at any time during driving, or if it is not possible to drive the pile to the desired ultimate capacity due to the proposed equipment or methods, the Contractor shall modify its proposed methods or equipment until a subsequent wave equation analysis indicates that the piles can

be driven to the desired ultimate capacity, without damage.

During pile driving operations, the Contractor must use the approved equipment. No variations in the driving system will be allowed, unless the Contractor performs a revised wave equation analysis which is approved in writing by the Engineer.

A wave equation analysis must be performed for test piles at each abutment and pier location unless otherwise specified on the Plans. The wave equation analysis should evaluate drivability of the pile to various depths of penetration using the proposed driving system. As a minimum, the driving conditions for 5% penetrations (or an alternate depth of penetration as determined by the Engineer), 70% penetration, 90% penetration, 100% penetration, and 110% penetration of the pile during initial driving and after set-up condition should be evaluated. One hundred percent penetration refers to penetration to the plan estimated tip elevation to achieve the designated ultimate driven capacity. If the Contractor's estimate of tip elevation for the ultimate driven capacity differs from the plan estimate by more than 10%, then the Contractor's estimate of penetration shall be used for 100% penetration in the wave equation analysis. If the Contractor's estimate is chosen as 100% penetration, then driving conditions for plan estimated depth shall also be shown in the analysis.

In the drivability analysis, the estimated friction and end bearing values obtained by static soil analysis along with soil layer specific quake and damping values and friction parameters for each level of penetration shall be used. Analysis output shall include, as a minimum, ultimate capacities, blow counts, compressive and tensile stresses, and transferred energy plotted as a function of depth of penetration. The static soil analysis must be submitted with the wave equation analysis.

If the Contractor's driving equipment consists of a varying energy or varying stroke type hammer, such as an open-ended diesel hammer, then an additional analysis that plots blow count versus stroke and/or energy for a fixed capacity equal to the ultimate driven capacity shall be performed.

The Contractor shall select a hammer that drives the pile to its required penetration to achieve required bearing or minimum tip elevation with a driving resistance not exceeding 120 blows per 12″ (300 mm). In no case shall the driving resistance exceed 20 blows per 1″ (25 mm) in the last 6″ (150 mm) of penetration

Unless buckling governs or unless otherwise noted in the Plans or Special Provisions, pile driving stress, due to hammer impact only, shall be limited to the values, in megapascals, specified below:

(1)	*Timber Piles:*	
	Tension or Compression	$3\sigma_a$ (where σ_a = AASHTO allowable working stress for round timber piles)
(2)	*Steel H Piles, Steel Pipe Piles, and Steel Shell Piles (Cast-In-Place Concrete Piles):*	
	Tension or Compression	$0.9\ f_y$
(3)	*Precast, Prestressed Concrete Piles:*	
	Tension	0.25 (square root of f'_c) + effective prestress
	Compression	$0.85\ f'_c$ - effective prestress

If the test pile driving data or pile load test results indicate that a higher pile load capacity is possible, the Department reserves the right to redesign the pile layout, and footing if necessary, for the higher pile capacity as long as the capacity can be obtained by use of the same hammer.

For batter piles, the safe bearing capacity of the pile along its axis shall be equal to "U" times "P". The value of "U" for steam or air hammers and diesel hammers shall be determined as follows:

$$U = \frac{0.1(10 - m)}{\sqrt{1 + m^2}}$$

where: U =
A coefficient, less than unity.

P = Safe allowable bearing capacity of piles, in pounds (kilograms), when driven vertically.

m = Tangent of the angle of batter.

If required by the Contract, the Engineer will perform dynamic monitoring of the driving of piles. This monitoring will provide information for determining the necessary production pile driving guidelines.

619.10 Pile Load Test. When required in the Special Provisions or when directed by the Engineer, safe bearing capacities of piles shall be determined by actual load tests. All requirements shall be in accordance with the Special Provision items indicated on the Plans.

619.11 Test Piles. When driving test piles, the following step-by-step procedures shall be followed:

(a) *Driving Test Piles to Bearing, Tip Elevation, Practical Refusal, or a Combination of These.*

(1) Perform the wave equation analysis based on the procedure outlined in Subsection 619.09.

(2) Ensure that test piles are the initial piles driven, are in general plumb piles, and that they meet the following requirements:

a. *Timber Test Piles.* Timber test piles shall be of the same material and size as the production piles, except that if treated timber production piles are specified, untreated test piles may be used if the Engineer gives written permission and if test piles are not to be driven in a permanent location or within any footing area.

Test piles driven outside permanent foundation locations shall, upon satisfactory completion of test driving, be either completely extracted and removed from their present locations or cut off in accordance with the requirements of Subsection 619.16.

b. *Cast-In-Place Concrete; Steel H; and Precast, Prestressed Concrete Test Piles.* Test piles shall be of the same material and size as that specified for production piles. The test piles shall be installed at locations indicated on the Plans. The test piles shall be driven in production pile locations so they can be used in the permanent structure if found satisfactory after testing. Bar reinforcement and concrete fill shall not be placed until conclusion of the testing and acceptance of the test pile for use as a production pile.

The Contractor shall furnish the Engineer with schedules of the proposed driving sequence. Driving of test piles shall not be started at any location until the schedule for that location has been approved by the Engineer. Departures from these schedules shall not be made without the Engineer's approval.

The Contractor shall at all times conduct the test pile driving operations in close cooperation with the Engineer or the Engineer's representative. The Engineer or the Engineer's representative, without relieving the Contractor of any responsibility whatsoever, will be present when the test pile driving work is in progress. A complete driving log will be recorded by the Engineer or the Engineer's representative for each test

pile driven. The driving log will list all data which is essential for the determination of correct bearing capacity. The Contractor shall conduct test pile driving operations so that all essential measurements and data can be accurately obtained.

(3) If one or more static load test is required, the Contractor shall perform at least one of the load tests in the first series of test piles driven.

(4) Lengths of test piles shall be as indicated on the Plans. However, should the Contractor's static analysis predict a need for alternate test pile lengths, then the lengths of test piles shall be clearly indicated in the wave equation analysis submittal. After evaluating the wave equation analysis, the Engineer will then issue an order length for test piles. A letter to the Contractor from the Engineer confirming test pile lengths must be received prior to the Contractor ordering any test piles.

(5) Furnish test piles in one length, and drive them continuously to the required bearing capacity and/or tip elevation.

(6) Assist the Engineer with dynamic pile testing in accordance with Special Provision 621502.

(7) The Engineer will advise the Contractor when test pile driving shall cease. However, in no case shall the pile be driven to exceed 240 blows per 12″ (300 mm) or 20 blows per 1″ (25 mm) of driving for a minimum of 3″ (75 mm).

(8) Any pile damaged by reason of internal defects or improper driving and any pile, as indicated below, driven out of its proper location or alignment shall be removed and replaced. Any driven timber pile that shows evidence of splitting, splintering, or brooming shall be removed and replaced. Any driven shell or casing that shows bends, kinks, or other deformations which are detrimental to its use as a production pile shall be removed and replaced. As an option, a second pile may be driven adjacent to the damaged or mislocated pile if the second pile can be driven without detriment to the structure and if approved by the Engineer.

The Contractor shall provide all facilities so that the required records will be kept of the pile lengths, hammer speeds, blows per foot (meter), tip elevations, and other pertinent data for all piles driven. The Contractor shall also clearly mark the pile in 12″ (300 mm) increments to assist in evaluating the driving. The mark shall be visible from a 55′ (17 m) distance.

Piles shall be driven within an allowed variation of 1/8″ (3 mm) per 12″ (300 mm) of pile length from the vertical or batter shown on the Plans. The maximum allowable variation at the top of the pile shall be 3″ (75 mm) in any direction from the location shown on the Plans.

No side pressure will be permitted for driving piles into the correct position.

(9) Following the driving of the test pile or series of initial test piles as agreed in the approved sequence of driving, the Engineer will review the driving records and make one of the following recommendations:

a. If load tests are not required, the Engineer will issue, within five working days after completion of the test pile driving, a list of production pile lengths to the Contractor for those piles governed by the test pile or group of test piles.

b. If the data and information obtained from driving any original test pile is conflicting, inconclusive, or unsatisfactory in any way, the Engineer will order, within two working days after completion of the initial driving, another test pile to be driven for additional information.

c. The Engineer will order, within two working days after completion of the initial

driving, a test pile restrike to be performed in accordance with Subsection 619.14.

d. The Engineer will order, within two working days after completion of the initial driving, a driving splice to be made on the test pile. The driving splice shall be made in accordance with the driving splice details shown on the Plans. After splicing is successfully completed, driving of the spliced pile shall be continued. When the driving of the spliced pile is completed, the Engineer will review the new driving records and make one of the recommendations listed under Step (9) above.

e. On jobs requiring static load testing, the Engineer may approve the driven test pile for load testing.

Recommendation (9)b., (9)c., or (9)d. above may be chosen prior to authorizing a load test to be performed. Also, recommendation (9)b., (9)c., or (9)d. above may be chosen if a load test is performed and found to be unsatisfactory. After a load test has been successfully completed, the Engineer will issue, within three working days after receipt of the Contractor's load test report, a list of production pile lengths to the Contractor for those piles governed by the test pile or group of test piles.

(10) On jobs requiring minimum tip elevation, the Engineer will evaluate the driving records, and in addition to recommendations (9)b. through (9)e. above, the Engineer may direct a revised tip elevation based on the test pile driving record. This revised tip elevation will be included in the issued production pile order list.

(11) If a pile reaches driving resistances exceeding 240 blows per 12″ (300 mm) or 20 blows per 1″ (25 mm) at a tip elevation significantly above the minimum tip elevation specified, the Contractor shall immediately inform the Engineer. The Engineer will analyze the pile group and direct the Contractor to perform corrective measures as required. At this point, the Contractor shall seek other methods, as approved by the Engineer, to drive the pile to the required minimum tip elevation.

(12) If any test pile build-ups (non-driving splices) are necessary, build-ups shall be constructed in accordance with the requirements of Subsection 619.15.

(13) Cut off the test pile, if necessary, in accordance with the requirements of Subsection 619.16.

(14) After driving, prestressed concrete piles shall have their tops covered with plastic to prevent dirt and water from entering holes/sleeves provided for grouting in bar reinforcement for anchorage into the pier caps or the abutment footings. Prior to grouting in bar reinforcement, such holes/sleeves shall be blasted out with air to remove any dirt and/or water.

(b) *Driving Test Piles to Bearing Achieved by Freeze.*

(1) Steps (1) through (8) under (a) above shall be followed.

(2) After successful driving of the test pile, the Engineer will order, within two working days after completion of the initial driving, a test pile restrike to be performed in accordance with the requirements of Subsection 619.14.

(3) On jobs requiring static load testing, test pile restrikes shall be performed in accordance with the requirements of Subsection 619.14.

(4) If any test pile build-ups (non-driving splices) are necessary, build-ups shall be constructed in accordance with the requirements of Subsection 619.15.

(5) The test pile shall be cut off, if necessary, in accordance with the requirements of Subsection 619.16.

619.12 Driving Production Piles. When driving production piles, the following step-by-step procedure shall be followed:

(1) The Engineer will establish the required blow count, stroke height, and tip elevation from the test pile results.

(2) The same hammer, cushioning, and other equipment that was used to drive the test piles must be used to drive the production piles. If the Contractor elects to change hammers, the Contractor must submit necessary wave equation analysis, drive additional test piles, and/or perform dynamic pile testing, as directed by the Engineer, before driving any production piles, even if the energy ratings of the hammers are identical.

(3) The pile driving sequence shall conform to the requirements established under Subsection 619.11. If necessary, additional detail shall be provided by the Contractor so that the Engineer is fully aware and in agreement with the proposed sequence of driving.

(4) Each production pile shall be driven continuously from the time that driving is started until the required bearing capacity and/or tip elevation is reached, except as may be required for splicing the pile.

(5) No production piles shall be driven to exceed 240 blows per 12″ (300 mm) or 20 blows per 1″ (25 mm) for a minimum of 3″ (75 mm).

Piles shall be driven to such depth that they develop at least the safe bearing capacities that are specified or until they reach practical refusal. The Engineer reserves the right, however, to establish the depth to which any or all piles are to be driven, depending on the actual conditions encountered.

(6) Any pile damaged by reason of internal defects or improper driving and any pile, as indicated below, driven out of its proper location or alignment shall be removed and replaced. Any driven timber pile that shows evidence of splitting, splintering, or brooming shall be removed and replaced. Any driven shell or casing that shows bends, kinks, or other deformations which are detrimental to its use as a production pile shall be removed and replaced. As an option, a second pile may be driven adjacent to the damaged or mislocated pile if the second pile can be driven without detriment to the structure and if approved by the Engineer.

The Contractor shall check piles for heave during driving of adjacent piles or by any other cause. All piles pushed up more than ¼″ (6 mm) shall be redriven to the minimum bearing capacity and at least to their original tip elevation, or as directed by the Engineer.

The Contractor shall provide all facilities so that the required records will be kept of the pile lengths, hammer speeds, blows per foot (meter), tip elevations, and other pertinent data for all piles driven.

All piles shall be driven at locations shown on the Plans or as directed by the Engineer. Piles shall be driven within an allowed variation of 1/8″ (3 mm) per 12″ (300 mm) of pile length from the vertical or batter shown on the Plans. The maximum allowable variation at the top of the pile shall be 3″ (75 mm) in any direction from the location shown on the Plans.

No side pressure will be permitted for driving piles into the correct position.

Any material forced up between the piles during driving shall be removed to the correct elevation before any concrete is placed for the foundation.

Piles shall be driven to secure the required bearing capacity and/or tip elevation specified herein, noted on the Plans, or specified by the Engineer. After driving of each pile group, the location and alignment of the piles shall be surveyed by the Contractor.

The results of the survey shall be furnished to the Engineer. In the event that one or more of the piles are damaged by improper driving, or driven outside the allowable tolerance specified herein, the Engineer will analyze the pile group. If the analysis indicates that any pile is overstressed as a result of the damaged or out of tolerance piles, the Contractor shall remove the rejected pile or drive additional piles as directed by the Engineer. In addition, the Contractor shall modify the pile cap or abutment as required by the Engineer to accommodate the out of tolerance or added piles. All piles damaged by improper driving, or driven out of their proper location or alignment shall be rejected.

(7) Any driving splices determined necessary by the Engineer shall be made in accordance with the Plans or other details submitted by the Contractor to the Engineer for review and approval. Following the required curing time for the splice, the spliced pile shall be driven to the required bearing capacity and/or tip elevation. If it becomes necessary to splice timber piles, the method for splicing and driving shall be submitted to the Engineer for written approval.

(8) Any build-ups (non-driving splices) shall be constructed in accordance with the requirements of Subsection 619.15.

(9) If the piles are driven to a tip elevation, as shown on the Plans or directed by the Engineer, and "Bearing Achieved by Freeze" is being used to achieve the desired bearing, the Engineer may direct the Contractor to restrike selected production piles in a particular footing, bent, or structural element. If this direction is given, the production pile restrikes shall be performed in accordance with the requirements of Subsection 619.14.

(10) Cut-offs, as necessary, shall be performed in accordance with the requirements of Subsection 619.16.

(11) After driving, prestressed concrete piles shall have their tops covered with plastic to prevent dirt and water from entering holes/sleeves provided for grouting in bar reinforcement for anchorage into the pier caps or the abutment footings. Prior to grouting in bar reinforcement, such holes/sleeves shall be blasted out with air to remove any dirt and/or water.

619.13 Augering.

(a) *General.* When specifically indicated on the Plans or specifically approved by the Engineer, augering shall be used to facilitate pile driving. The Contractor shall submit its proposed equipment and augering procedures to the Engineer for approval prior to beginning pile driving operations.

When round piles are used, the auger diameter shall not be greater than 2″ (50 mm) less than the pile diameter. The auger diameters listed below shall be used for square concrete piles unless otherwise shown on the Plans:

Hole Diameter	*Pile Size*
10″ (250 mm)	12 by 12″ (300 by 300 mm)
12″ (300 mm)	14 by 14″ (350 by 350 mm)
14″ (350 mm)	18 by 18″ (450 by 450 mm)
20″ (500 mm)	24 by 24″ (600 by 600 mm)
24″ (600 mm)	30 by 30″ (750 by 750 mm)
30″ (750 mm)	36 by 36″ (900 by 900 mm)

For other pile sizes, the diameter of the augers shall be as shown on the Plans, or

approved by the Engineer. The pile holes shall be accurately augered with the hole centered over the plan location of the piling. The location and vertical alignment shall be maintained within the tolerances allowed for the piling.

For an augered hole which is required through rock material or a very dense layer that may damage the pile during driving, the augered hole diameter shall be approximately 2″ (50 mm) larger than the largest dimensions across the pile's cross-section. When required by the Plans or Project subsurface conditions, the Contractor shall maintain augered holes open both before and during pile driving operations. Bentonite slurry or an equivalent method shall be employed, if necessary, to maintain the holes in an open condition.

(b) *Augering Through Compacted Fill.*

(1) When steel H or other low displacement piles are used, piles shall be driven through the compacted fill without augering holes through the fill, except when the requirements for augering are shown on the Plans. When concrete or other high displacement piles are used, pile holes shall be augered through the fill to at least the elevation of the original ground surface.

(2) For an augered hole which is required through material that caves during driving, to the extent that the auguered hole does not serve its intended purpose, the hole shall be cased from the embankment surface to the approximate elevation of the original ground surface. After the pile is driven, annular spaces between the casing and pile shall be filled with concrete sand or other approved clean sand in a manner approved by the Engineer. Unless otherwise shown on the Plans, the casing shall be removed after the pile is driven and accepted.

Any voids between the pile and soil remaining after driving through an augered hole, cased or uncased, shall be filled with concrete sand or other approved clean sand in an approved manner. The use of spuds (a spud is a short, strong driven member that is removed to make a hole for inserting a pile) will not be permitted in lieu of augering.

619.14 Pile Restrike. After initial driving of production and/or test piles, the Engineer may order, within two working days after completion of the initial driving, a pile restrike. The restrike shall be performed within seven days of initial driving unless otherwise noted in the Contract. After the directed waiting time has elapsed, the pile restrike shall be performed as follows:

(1) Dynamic pile testing equipment shall be connected, if indicated on the Plans or directed by the Engineer, in accordance with Special Provision 621502.

(2) The pile hammer used during initial driving must be used for the Restrike.

(3) The hammer shall be warmed-up by striking another pile or pile cut-off at least 20 blows at full stoke.

(4) The elevation of the top of pile shall be established prior to performing the restrike.

(5) The hammer shall be carefully lowered and positioned on the pile. The hammer shall strike the pile 20 blows at the required stroke height.

(6) The hammer shall be removed from the pile, and the new top of pile elevation shall be established.

(7) After completion of the pile restrike, the Engineer will review the driving records and make a recommendation, within two working days, on how to proceed.

On contracts requiring dynamic pile testing, all piles to receive dynamic pile testing shall be subject to restrikes as described in Special Provision 621502.

On contracts requiring static load testing, test pile restrikes shall be performed, on each pile to be load tested, after a minimum of three but before five calendar days after completion of the pile load

test. The pile load test shall be performed in accordance with Special Provision 620525, unless directed otherwise by the Engineer.

As directed by the Engineer, up to ten production piles driven shall be subject to pile restrikes. The Engineer will specify a waiting time of five days or less to perform the pile restrikes, unless noted otherwise on the Plans.

The Engineer will attempt to schedule the pile restrikes so as to cause minimal, if any, delay to the overall pile driving operation. If the pile restrike results are satisfactory, the pile or representative group of piles shall be considered acceptable.

The pile restrikes described above shall be incidental to the price bid for the selected pile type. Under certain pile driving conditions it may become necessary to restrike various production piles and/or test piles, in addition to those described above, in order to verify the pile capacities. These additional restrikes may be a result of needing more than ten production pile restrikes or the restrike waiting time required may be greater than that specified above or in Special Provision 621502. Payment for additional pile restrikes will be as described in Special Provisions 620528 and 620529.

619.15 Pile Build-Ups. All build-ups shall be constructed as shown on the Plans or on other details submitted by the Contractor for review and approval by the Engineer.

619.16 Pile Cut Offs. Piles shall be cut to final cut-off elevation shown on the Plans or as directed by the Engineer. Cut-off sections of piles shall become the property of the Contractor at the end of the Project and shall be disposed of by the Contractor in a manner acceptable to the Engineer.

Pile shells or casings, after being driven, inspected, and approved, shall be cut off to a true plane using an acetylene or electric torch.

The tops of all timber production piles shall be sawed to a true plane at the elevation shown on the Plans, or as directed by the Engineer. Piles which support timber caps or grillage shall be sawed to conform to the plane of the bottom of the superimposed structure.

All exposed sawed surfaces of timber piles shall be thoroughly brush coated with three applications of preservative and covered with a thick layer of hot pitch or gum. Upon this shall be placed a metal covering of either a sheet of zinc or copper. Zinc sheet conforming to ASTM B 69 shall be at least 20 gage (813 µm) thick and shall be fastened with 1″ (24 mm) long galvanized large-headed nails. Copper sheet conforming to AASHTO M 138 (M 138M) shall be at least 20 gage (813 µm) thick and shall be fastened with 1″ (25 mm) copper nails. The metal covering shall measure at least 4″ (100 mm) more in each dimension than the diameter of the pile and shall be bent down over the sides of the pile, neatly trimmed, and securely nailed to the full satisfaction of the Engineer.

Test piles driven outside permanent foundation locations shall, upon satisfactory completion of test driving, be cut off at a point at least 24″ (600 mm) below finished grade or final stream bed elevation at their respective locations.

619.17 Placing Bar Reinforcement for Cast-In-Place Concrete Piles. The longitudinal bar reinforcement and circular ties shall be assembled as a complete unit. The bars and ties shall be securely fastened together at all intersections in accordance with the details shown on the Plans. The complete unit shall be accurately placed in the driven casing or shell and held rigidly in place to prevent displacement during the placing of the concrete.

The Contractor shall submit a drawing or plan, showing the proposed method of holding the bar reinforcement in position during the placing of the concrete. Approval of the method submitted will not relieve the Contractor of its responsibility for ensuring that all bar reinforcement is properly located within the body of the finished piles.

619.18 Placing Concrete for Cast-In-Place Concrete Piles. No concrete shall be placed in any pile casing or shell until all driving within a radius of 15′ (5 m) has been completed, or until all of the shells for that structure unit, such as a pier, bent, or abutment, have been driven to their final tip elevation and accepted. In the event that this limitation cannot be followed, all driving within the above limits shall be discontinued until the placed concrete has set for at least seven days.

After driving and completing the pile and other parts of the structure, the exposed part of the piling shall be cleaned of undue discoloration caused by methods of construction.

No concrete shall be deposited in a driven casing or shell until all water, dirt, and debris have been completely removed, and the Engineer has given approval.

Concrete for each shell or casing shall be placed in a continuous operation. An exception will be made if the bar reinforcement caging or dowels occupy only the upper section of the pile. In this case, no bar reinforcement shall be placed in the pile casing or shell until the concrete placed in the casing has reached the elevation of the lowest end of the bar reinforcement. The bar reinforcement shall then be rigidly set in the casing, and the placing of concrete shall be continued until the cut-off elevation has been reached. In no case shall an interruption in the sequence of placing concrete exceed 30 minutes. In the case where bar reinforcement caging or dowels occupy only the upper section of the pile, the Contractor may secure the reinforcement prior to placing any concrete if an "elephant trunk" is used to deposit concrete in the portion of the pile below the bottom elevation of the reinforcement. Concrete shall be consolidated as specified in Subsection 602.13 to a depth of at least 12″ (300 mm) below the bottom of the rebar cage.

The concrete shall be placed in such a manner as to ensure a dense, homogenous mass throughout the entire casing that is completely free from debris, oil, water, and other foreign matters to provide a permanent bond with all bar reinforcement embedded in the pile.

Piles with freshly placed concrete shall not be disturbed in any way until all concrete has set for at least 72 hours.

619.19 Method of Measurement. The installed quantity of test piles and production piles will be field measured as the total number of linear feet (linear meters) from final tip elevation to final cut-off elevation for each type of pile acceptably driven.

The quantity of build-up lengths will not be measured and paid under this Section but will be measured and paid under Section 618.

The quantity of material used for driving splices on test piles and production piles will not be measured and paid under this Section but will be measured and paid under Section 618.

The cost of constructing driving splices for Precast, Prestressed Concrete Piles will be measured on an equivalent linear foot (linear meter) basis. The cost of constructing driving splices for all other pile types will not be measured and paid.

The quantity of pile cut-offs for all pile types will not be measured for payment.

619.20 Basis of Payment. The installed quantity of timber, cast-in-place concrete, steel H, and precast, prestressed concrete test piles and production piles will be paid for at the Contract unit price per linear foot (linear meter) for each type of pile driven. Price and payment will constitute full compensation for driving and all work associated with the installation of piles, including augering and jetting, unless noted otherwise, and restriking piles and test piles per Subsection 619.14; for conducting and submitting the wave equation analysis; for driving additional test piles; for performing dynamic pile testing if the Contractor elects to change hammers; for driving additional piles adjacent to rejected piles; for revising footings or abutments due to additional piles; and for all equipment, labor, tools, and incidentals required to complete the work.

The labor required to cut-off piles will be considered incidental to the cost of "Installation of Piles". Price and payment will constitute full compensation for acceptably performing a pile cut-off to the details and elevation shown on the Plans; for the disposal of cut-off piles; and for all equipment, labor, tools, and incidentals required to complete the work.

The quantity of driving splices constructed for Precast, Prestressed Concrete Piles will be paid for on an equivalent linear foot (linear meter) basis. Price and payment will constitute full compensation for all equipment and labor required to construct a driving splice in accordance with the Plans or details submitted by the Contractor for review and approved by the Engineer. Payment will be calculated based upon a fixed price of five hundred dollars per splice. This fixed price will be converted into an equivalent length, in linear feet (linear meters), of pile for payment purposes. The equivalent length, in linear feet (linear meters), will be based on the appropriate price bid for the piles. For example, if a driving splice is required on a production pile and the unit price bid for production piles is $50 per foot, then the equivalent length in linear feet, to be added to that particular pile length for payment will be 10 ft ($500÷$50/ft=10ft) [$165 per meter, then the equivalent length, in linear meters, to be added to that particular pile length for payment will be 3 m ($500÷$165/m = 3 m)].

The cost of constructing splices for all other pile types will be considered incidental to the unit price bid for "Installation of Piles".

No payment will be made for falsework piles; for piles used in the construction of temporary wharves, platforms, and bridges, when built for the Contractor′s use; for removal and replacement of rejected piles; or for any other piles not definitely shown on the Plans or listed in the Proposal tabulations.

No payment will be made for production piles and test piles not accepted, production piles and test piles improperly driven, or production piles and test piles damaged during driving.

It is understood that driving additional test piles as required by the Engineer, due to conflicting, inconclusive, or unsatisfactory original test pile data and information, shall not serve as the basis for an increase in the original Contract unit price per linear foot (linear meter) for the type of pile, nor any other extra or increased compensation other than normal increase in payment due to the extra quantity of test piles to be paid for under this Section.

Payment for furnishing all pile materials, including preservation treatment, pile shell sections, pile material used to construct splices, material used to construct build-ups, protective coating, portland cement concrete, bar reinforcement, prestressing strands, and spiral reinforcement will be made under Section 618.

SECTION 620 – RESERVED

SECTION 621 – TIMBER SHEET PILES

621.01 Description. This work consists of the furnishing and placing of either untreated timber sheet piles or creosoted timber sheet piles.

MATERIALS.

621.02 Timber. The timber, unless otherwise noted on the Plans, or in the Special Provisions, shall consist of any species that satisfactorily withstands driving without injury. It shall be sawed with square corners and shall be free from worm holes, loose knots, wind shakes, decayed or unsound portions, or other defects which might impair its strength or tightness.

621.03 Piles. The piles shall be of the type, width, and thickness specified, prepared from sound, solid materials. They shall be drift sharpened at their lower ends so as to wedge the adjacent piles tightly together.

621.04 Preservative Treatment of Sheet Piling. Preservative treatment shall be the same as specified for piles under Section 618.

621.05 Hardware. Hardware shall conform with the requirements of Subsection 601.07.

CONSTRUCTION METHODS.

621.06 Construction Materials. Timber sheet piles may be driven or jetted into place as directed. Sheet piles shall be so driven as to form a permanent, tight structure. After piles are in final position and have attained full bearing, the tops shall be cut off to a straight line at the elevation shown on the Plans, or as required.

Sheet pile cut-offs shall become the property of the Contractor, be removed from the Project site, and be disposed of in a manner that meets with the Engineer′s approval.

Where shown on the Plans or directed, the tops of sheet pile walls shall be braced and aligned by means of timber wales. Wales shall be lapped and jointed at splices and corners and shall be solidly bolted or fastened together. The construction of wales shall conform, where applicable, with the provisions of Section 601.

621.07 Method of Measurement. The quantity of timber sheet piles will be measured as the actual number of thousands of feet board measure (cubic meters) of sheet piles, driven and accepted. No measurement will be made for material cut off.

The number of thousands of feet board measure (cubic meters) of timber wale construction will be measured in accordance with Section 601.

621.08 Basis of Payment. The quantity of timber sheet piles, including timber wales where required, will be paid for at the Contract unit price per thousand feet board measure (cubic meter).

Price and payment will constitute full compensation for furnishing, driving, and cutting off the sheet piles; for timber wale construction, including hardware, where required; and for all labor, tools, equipment, and incidentals required to complete the work.

No payment or allowance will be made for sheet pile cut-offs.

SECTION 622 – PERMANENT STEEL SHEET PILES

622.01 Description. This work consists of furnishing and placing untreated steel sheet piles.

622.02 Materials. Steel sheet piles shall be manufactured steel conforming to the requirements of AASHTO M 202/M 202M unless otherwise shown on the Plans.

All steel piles shall be straight and true at the time of driving. Pile camber and sweep shall be within the permissible mill tolerances.

622.03 Construction Methods. Construction shall not begin on the steel sheet pile bulkhead wall until all muck excavation in the immediate and adjacent area is completed and Borrow Type B is placed to

the elevations shown on the Plans.

Sheet pile units shall be placed to full penetration and shall attain firm bearing in their final position. Jetting is prohibited. Sheet piles shall be placed to form a permanent tight structure and shall be cut off at, or driven to, the elevation shown on the Plans, or as directed. All pile cut-off material shall become the Contractor's property and shall be removed from the Project site.

622.04 Method of Measurement. The quantity of steel sheet piles will be measured in the field by determining the actual number of square feet (square meters) of steel sheet piles placed and accepted, after cut-off. The cut-off portion of piles will not be measured for payment. The horizontal measurement of the completed installation shall be taken on a straight line between interlocks (the nominal or published width), not around the perimeter of the sheet pile units. The vertical measurement shall be taken from the tip elevation to the cut-off, or top elevation.

622.05 Basis of Payment. The quantity of steel sheet piles will be paid for at the Contract unit price per square foot (square meter). Price and payment will constitute full compensation for furnishing, placing, and cutting off the sheet piles; and for all labor, tools, equipment, and incidentals required to complete the work.

SECTION 623 – PRESTRESSED REINFORCED CONCRETE MEMBERS

623.01 Description. This work consists of furnishing and erecting prestressed, precast, reinforced concrete members and accessories, on substructure units.

This work also includes furnishing and installing bearing pads and materials, dowels, tie rods, nuts, plates, joints and joint materials, scuppers, and all other parts and materials required to complete the work.

MATERIALS.

623.02 Strand. Strands shall be as shown on the Plans.

623.03 Wire. Wire shall be as shown on the Plans. The Contractor may propose the use of superior materials to the Department for approval.

623.04 Bar Reinforcement. Bar reinforcement shall conform to the requirements of Section 824.

623.05 Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 812. The Contractor shall submit a mix design for the concrete to be used in prestressed members to the Department for approval. In addition, the total chloride content of the concrete mixture shall not exceed 0.06% by weight of cement. The mix design shall follow ACI design procedures and shall include the following:

Cement:	Type I, II, or III, 7 bags/yd^3 (9.2 bags/m^3)
Air Content:	5 ± 2%
Admixtures:	AASHTO M 194
Required Strength, f_{cr}:	Sufficient to ensure a minimum 28-day design strength of 5,000 psi (35 MPa) (ACI 214 evaluation)

The required test cylinder strength of the concrete at the time of transfer of the tensioning load

from strand to concrete (release of prestress) shall be not less than 4,000 psi (25 MPa).

Cylinders shall be initially cured under the same curing conditions as the members. A total of six test cylinders shall be cast for each member and tested as follows:

(a) Two cylinders (release cylinders) shall be tested to determine when transfer of the tensioning load may be permitted.

(b) Three cylinders shall be tested at 28 days.

(c) One cylinder shall be held in reserve or tested at the time of shipping, if necessary.

After the release cylinders have been tested, the remainder of the test cylinders shall be moist cured.

623.06 Bearing Materials. Elastomeric bearings shall include plain bearings, consisting of elastomer only, and laminated bearings consisting of layers of elastomer restrained at their interfaces by bonded laminates, each type being of the size indicated on the Plans.

The elastomer portion of the elastomeric compound shall be 100% virgin natural polyisoprene (natural rubber) conforming to the requirements of Table 623-A, or 100% virgin chloroprene (neoprene) conforming to the requirements of Table 623-B, as specified in the Contract. Compounds of nominal hardness between the values shown in the tables may be used and the test requirements interpolated. If test specimens are cut from the finished product, a 10% variation in "Physical Properties" will be allowed.

Laminates shall be rolled mild steel sheets conforming to AASHTO M 183/M 183M unless otherwise specified by the Engineer.

Bearings shall be manufactured according to the following requirements. Plain bearings may be molded individually, cut from previously molded strips or slabs, or extruded and cut to length. Cut edges shall be at least as smooth as specified for an ANSI 250 (6.3 μm) finish. Unless otherwise shown on the Plans, all components of a laminated bearing shall be molded together into an integral unit, and all edges of the nonelastic laminations shall be covered by a minimum of 1/8″ (3 mm) of elastomer, except at laminate restraining devices and around holes that will be entirely closed on the finished structure.

Bearing tolerances shall conform to the following requirements. Flash tolerance, finish and appearance shall meet the requirements of the latest edition of the Rubber Handbook as published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings. For both plain and laminated bearings, the permissible variation from the dimensions and configuration required by the Plans and this Section shall be as follows:

(a) Overall Vertical Dimensions:
- Average Total Thickness 1¼″ (32 mm) or less . . . . . -0, +1/8″ (-0, +3 mm)
- Average Total Thickness over 1¼″ (32 mm) . . . . . -0, +1/4″ (-0, +6 mm)

(b) Overall Horizontal Dimension:
- 36″ (900 mm) and less . . . . . -0, +¼″ (-0, +6 mm)
- over 36″ (900 mm) . . . . . -0, +½″ (-0, +13 mm)

(c) Thickness of Individual Layers of Elastomer (laminated bearing only) . . . . . ±1/8″ (±3 mm)

(d) Variation from a plane parallel to the theoretical surface (as determined by measurements at the edges of the bearings):
- Top . . . . . 1/8″ (3 mm)
- Sides . . . . . 1/4″ (6 mm)
- Individual Non-Elastic Laminates . . . . . 1/8″ (3 mm)

(e) Position of Exposed Connection Members . . . . . 1/8″ (3 mm)

(f) Edge Cover of Embedded Laminates or Connection Members . . . . . -0, +1/8″ (-0, +3 mm)
(g) Size of Holes, Slots, or Inserts . . . . . ±1/8″ (±3 mm)
(h) Position of Holes, Slots, or Inserts . . . . . ±1/8″ (±3 mm)

Whenever practical, the mechanical properties of the finished bearing shall be verified by laboratory test.

The following values shall be met under laboratory testing conditions of full size bearings:

(a) Compressive strain of any layer of an elastomeric bearing shall not exceed 7% at 800 psi (5.5 MPa) average unit pressure or at the design dead load plus live load pressure if so indicated on the Plans.

(b) The shear resistance of the bearing shall not exceed: 30 psi (205 kPa) for 50 durometer, 40 psi (275 kPa) for 60 durometer, or 50 psi (345 kPa) for 70 durometer Table 623-A compounds; and shall not exceed 50 psi (345 kPa) for 50 durometer, 75 psi (515 kPa) for 60 durometer, or 110 psi (760 kPa) for 70 durometer Table 623-B compounds at 25% strain of the total effective rubber thickness after an extended four-day ambient temperature of -20 °F (-29 °C).

Table 623-A

ASTM Standard	*Physical Properties*	*50 Durometer*	*60 Durometer*	*70 Durometer*
D 2240 D 412	Hardness Tensile Strength, minimum psi (MPa) Ultimate elongation, minimum %	50 ± 5 2500 (17) 450	60 ± 5 2500 (17) 400	70 ± 5 2500 (17) 300
	Heat Resistance			
D 573 70 hours at 158 °F (70 °C)	Change in durometer hardness, maximum points Change in tensile strength, maximum % Change in ultimate elongation, maximum %	+10 -25 -25	+10 -25 -25	+10 -25 -25
	Compression Set			
D 395 Method B	22 hours at 158 °F (70 °C), maximum %	25	25	25
	Ozone			
D 1149	25 pphm ozone in air by volume, 20% strain, 100±2 °F (38 ± 1 °C), 48 hours mounting procedure D 518, Procedure A	No Cracks	No Cracks	No Cracks
	Adhesion			
D 429 B	Bond made during vulcanization, lb/in (kN/m)	40 (7.0)	40 (7.0)	40 (7.0)
	Low Temperature Test			
D 746 Procedure B	Brittleness at -40 °F (-40 °C)	No Failure	No Failure	No Failure

Table 623-B

ASTM Standard	*Physical Properties*	*50 Durometer*	*60 Durometer*	*70 Durometer*
D 2240 D 412	Hardness Tensile Strength, minimum psi (MPa) Ultimate elongation, minimum %	50 ± 5 2500 (17) 450	60 ± 5 2500 (17) 350	70 ± 5 2500 (17) 300
	Heat Resistance			
D 573 70 hours at 212 °F (100 °C)	Change in durometer hardness, maximum points Change in tensile strength, maximum % Change in ultimate elongation, maximum %	+15 -15 -40	+15 -15 -40	+15 -15 -40
	Compression Set			
D 395 Method B	22 hours at 212 °F (100 °C), maximum %	35	35	35
	Ozone			
D 1149	100 pphm ozone in air by volume, 20% strain, 100 ± 2 °F (38 ± 1 °C), 100 hours mounting procedure D 518, Procedure A	No Cracks	No Cracks	No Cracks
	Adhesion			
D 429 B	Bond made during vulcanization, lb/in (kN/m)	40 (7.0)	40 (7.0)	40 (7.0)
	Low Temperature Test			
D 746 Procedure B	Brittleness at -40 °F (-40 °C)	No Failure	No Failure	No Failure

623.07 Non-Shrink Grout. Non-shrink grout shall be composed of one sack of cement, 105 lb (47.6 kg) of sand, and 100 lb (45.4 kg) of approved non-shrink admixture.

623.08 Structural Steel. Structural steel shall conform to the requirements of Section 605, as applicable.

623.09 Protective Coating. The Contractor shall apply an epoxy coal-tar protection coating system to the surfaces indicated on the Plans. The epoxy coal-tar application shall consist of grinding and preparing the bridge deck surfaces, applying the epoxy coal-tar resin to the prepared surfaces, and coating the epoxy with sand as described herein or as directed by the Engineer.

DESIGN AND MANUFACTURE OF PRESTRESSED MEMBERS.

623.10 Plans and Alternate Designs. The Plans show general details and information, pertaining to the prestressed, precast, concrete members, that serve as an indication of the type of construction acceptable. If the Contractor proposes an alternate design, a complete set of detailed shop drawings, with supporting design computations for the prestressed members to be furnished, shall be submitted in accordance with Subsection 105.04 for approval prior to any work.

The manufacture of prestressed members shall not proceed until the final shop drawings have been approved.

623.11 Design Criteria. The design of the prestressed, precast, reinforced concrete members shall meet the requirements of Section 6 of the AASHTO Standard Specifications for Highway Bridges.

The design load shall be HS 20-44.

For compressive strength of concrete at 28 days, f'_c shall be 5,000 psi (35 MPa) minimum.

For compressive strength of concrete at time of initial prestress, f'_c shall be 4,000 psi (25 MPa) minimum.

623.12 General Manufacturing Requirements. All plants manufacturing prestressed reinforced concrete members for work under this Contract shall be inspected and approved before manufacture of the members may be started. Only PCI certified plants, or plants which have been inspected and approved by the Department, will be permitted to manufacture prestressed primary load carrying members.

All materials, equipment, processes of manufacture, and the finished members, including handling, storage, and transportation, shall be subject to inspection and approval. Any defective construction, which may adversely affect the strength of a member or its performance in the bridge deck, shall be cause for rejection.

Permissible construction tolerances shall be in accordance with those recommended in the PCI Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products. Tolerances for reinforcing bar cover shall be from -1/4 to 1/2″ (-6 to +13 mm).

623.13 Forms. Forms and centering shall be made and maintained, during their use, true to the shapes and dimensions shown on the approved drawings.

Unless otherwise provided, only metal forms shall be used. The forms shall be well constructed, carefully aligned, substantial, firm, and securely braced and fastened together. The forms shall be sufficiently tight to prevent leakage of mortar and strong enough to withstand the action of mechanical vibrators.

Form ties shall be either the threaded type or the snap-off type. No form wires or metal pieces shall be left at the surface of the finished concrete. Corners and angles shall be mitered or rounded.

Joints between panel forms shall be made smooth and tight.

623.14 Reinforcement and Pretensioning Strands. Bar reinforcement and pretensioning strands shall be free of frost, dirt, oil, paint, mill scale, corrosion, or any foreign material that may prevent a bond between the steel and concrete. If an antibonding agent is used on the forms, every precaution shall be taken to protect the reinforcement and the pretensioning strands from being coated by the antibonding agent.

Pretensioning strands, reinforcement, and other embedded fixtures shall be accurately placed as indicated on the drawings and shall be maintained in their correct position during the manufacture of the

members.

623.15 Pretensioning. The amount of stress to be given each cable or strand shall be shown on the approved working drawings.

All cables or strands to be prestressed in a group shall be brought to a uniform initial tension prior to being given their full pretensioning. This uniform initial tension shall be approximately 500 lb (2.2 kN) per strand and shall be measured by a dynomometer or other approved means so that the initial tension can be used as a check against elongations computed and measured. After this initial tensioning, the group of strands shall be stressed until the required elongation and jacking pressure is attained. The stress induced in the cables or strands shall be measured both by jacking gages and by elongations of the cables or strands. The calculated stress based on the elongation should closely match the gage reading.

All jacks shall be equipped with accurate and calibrated gages for registering jacking pressures. Means shall be provided for measuring the elongation of the prestressing strands to at least the nearest 1/32″ (1 mm).

The Contractor shall be required to furnish the Department with satisfactory, accredited proof that all jacking equipment and gages to be used in the manufacture of the prestressed members have been calibrated by a reputable testing laboratory.

The interpretations and analysis of the elongations and jacking pressures shall consider and allow for all possible slippage or relaxation of the anchorage.

If there is a discrepancy of as much as 10% between the stresses determined by the jacking pressure and the elongation measurement, the entire operation shall be carefully checked and the source of error determined, before proceeding.

After the cables or strands are stressed in accordance with the plan requirements and this Subsection, and all other reinforcing is in place, the concrete shall be placed in the form. The temperature of the concrete shall be between 50 and 85 °F (10 and 29 °C). Cable or strand stresses shall be maintained between anchorages until the concrete has reached a minimum compressive strength of 4,000 psi (25 MPa) and the process of transferring the prestress to the member has begun.

Members shall be steam cured under a suitable enclosure to contain the live steam and minimize moisture and heat losses. The initial application of the steam shall be from four to six hours after the final placement of concrete to allow the initial set of the concrete to take place. The steam shall be at 100% relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of the steam, the ambient air temperature shall increase at a rate not to exceed 40 °F (22 °C) per hour until a maximum temperature of from 140 to 160 °F (60 to 71 °C) is reached. The maximum temperature shall be held until the concrete has reached the desired release strength. In discontinuing the steam, the ambient air temperature shall not decrease at a rate exceeding 40 °F (22 °C) per hour until a temperature has been reached that is about 20 °F (11 °C) above the temperature of the air to which the concrete will be exposed. The concrete shall not be exposed to temperatures below freezing for six days after casting. Recording charts of steam temperature shall be maintained.

The detensioning shall be done immediately following the curing period while the concrete is still warm and moist. If allowed to dry and/or cool prior to detensioning, dimensional changes take place which may cause cracking or undesirable stresses in the concrete.

In all detensioning operations, the prestressing forces must be kept nearly symmetrical about the vertical axis of the member. The detensioning must be applied in a manner that will minimize sudden or shock loading. Maximum eccentricity about the vertical axis shall be limited to one strand.

Forms, ties, inserts, holddowns, or other devices that would restrict longitudinal movement of the

members along the bed shall be removed or loosened. Alternate detensioning shall be performed in such manner and sequence that longitudinal movement is precluded.

After completing the release of the prestresses, the strands shall be cut flush with the ends of the member and painted with either an approved bitumastic compound or waterproofing compound.

623.16 Production. The manufacturing process shall provide uniform production of dense, high grade concrete for all parts of the prestressed members under all working and weather conditions. The operations of mixing, placing, finishing, and curing shall be subject to inspection and approval.

623.17 Handling, Storage, and Shipping. Prestressed members may be handled immediately after curing and detensioning of the of strands or cables. Members shall not be shipped until at least the minimum 28-day compressive strength has been attained but in no case less than three days after the placing of concrete in the forms. Members shall be handled using the pick-up points provided especially for this purpose. The members shall be maintained in a horizontal position (as when formed on the casting bed) at all times during handling, moving, storing, and shipping.

Members damaged by improper storing, handling, transporting, or erecting shall become the property of and be replaced by the Contractor.

Members will be inspected at the Project site for possible shipping damage and for verification that the member meets all dimensional requirements required by the Contract.

The Contractor shall follow the manufacturer's recommended procedures for handling and placing the precast members during the entire process of transporting, unloading, and installing the members.

623.18 Grouting Between Prestressed Members. After the deck members have been placed and fastened together with tie rods and the end anchor dowels have been placed, the longitudinal joints between adjacent members shall be filled with a non-shrink grout.

Immediately prior to filling the joints, the keyways shall be cleaned of all debris, oil, grease, and other material that may prevent effective bonding. After cleaning, the keyways shall be thoroughly soaked with water and tightly caulked with an approved material, below the bottom of the shear key to avoid grout leaks. The caulking material shall not project more than ½″ (13 mm) into the shear key area. In cold weather, the concrete against which the grout will be placed must be frost-free.

The grout shall be mixed to a consistency necessary to place the material. Traffic, or other loading, shall not be permitted on the bridge deck for at least 24 hours after the grout has been placed or, preferably, not until the end of the curing period.

The joints shall be covered with wet burlap, kept wet, and cured for three days.

623.19 Scuppers. The Contractor shall furnish and install scuppers of the material and at the locations shown on the Plans or as directed.

623.20 Method of Measurement. The quantity of prestressed, precast, reinforced concrete members, placed and accepted, will not be measured.

623.21 Basis of Payment. The quantity of prestressed reinforced concrete members placed will be paid for at the Contract lump sum price. Price and payment will constitute full compensation for furnishing and placing all materials, including the removal and replacement of all prestressed members rejected due to defective construction or improper storing, handling, or transporting; and for all equipment, tools, labor, and incidentals required to complete the work.

DIVISION 700 – MISCELLANEOUS CONSTRUCTION

PORTLAND CEMENT CONCRETE

SECTION 701 – CURB AND INTEGRAL CURB AND GUTTER

701.01 Description. This work consists of constructing curbs and integral curbs and gutters on a prepared foundation using either fixed forms or slip forms.

MATERIALS.

701.02 Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 812, Class B for either fixed-form work or slip-form work.

701.03 Preformed Expansion Joint Material. Preformed expansion joint material shall be ½″ (13 mm) nominal thickness and conform to the requirements of Subsection 808.06.

701.04 Bituminous Joint Sealant. Bituminous joint sealant shall conform to the requirements of Subsection 808.04 (c).

CONSTRUCTION METHODS.

701.05 Preparation of Foundation. The foundation shall be prepared at the required grade to accommodate the elevations, dimensions, and details shown on the Plans. Existing undisturbed soil, where used as foundation, shall be firm and unyielding. All unsuitable material shall be removed and replaced with approved material. When the foundation is to be any material other than existing undisturbed soil, the compaction and density requirements for the Section covering the material shall govern. Where rock is encountered, the grade shall be excavated to 6″ (150 mm) below the bottom of the curb and integral curb and gutter and backfilled with approved material.

701.06 Fixed Forms. Fixed forms shall be of wood or metal and shall extend the full depth of the concrete. Composite material forms may be used for radii work. Forms shall be straight, free from warp, and of sufficient strength to resist the pressure of the concrete, and shall not displace more than 3/8″ in 10′ (10 mm in 3 m) from the vertical or horizontal plane. Forms shall remain in both horizontal and vertical alignment until their removal. Forms shall be clean and coated with an approved form release agent before concrete is placed. Divider plates shall be metal.

701.07 Slip-Forming. When slip-forming is permitted, contraction joints shall be constructed at 20′ (6 m) intervals. All surfaces front, top, and back shall be tooled or sawed to a minimum depth of 1″ (25 mm) and a minimum width of 1/8″ (3 mm). Where slip-forming is used, expansion joints shall be constructed at radius points, structures, obstructions, and 200′ (60 m) intervals.

701.08 Placing Concrete. The concrete shall be placed on a moist foundation between the forms, consolidated, and worked sufficiently to bring mortar to the surface. The surface shall be struck off to the required contour and finished smooth and even with an approved float.

Limitations on placing concrete during hot or cold weather shall be as specified in Subsection 501.04.

701.09 Construction of Sections. All transverse joints shall be sealed with approved joint sealant. The sealing shall be performed immediately after the concrete has cured for 72 hours. Longitudinal joints shall be tooled adjacent to rigid pavements and structures and sealed with approved joint filler. This work shall be constructed in sections having a uniform length of approximately 10′ (3 m). Sections shall be separated by open joints at least 1/8″ (3 mm) wide by use of steel templates. Templates shall be not less than 2″ (50 mm) longer than the depth of the curb. Templates shall be secured during the placing of concrete and shall remain in place until concrete has set sufficiently. No sections shall be less than 5′ (1.5 m) in length.

701.10 Expansion Joints for Fixed Forms. Expansion joints shall be formed in curb and in integral curb and gutter at 40′ (12 m) intervals. When constructed adjacent to concrete pavement, expansion joints shall coincide with the expansion joints in the pavement.

701.11 Finishing. A wood or magnesium float shall be used to rub the surface smooth while the concrete is still green. A steel trowel finish shall next be applied, and finally a soft dampened brush shall be used longitudinally along the surface. Finishing shall be performed to a depth of 2″ (50 mm) below the proposed pavement surface elevation.

Before the concrete is given the final finish, the flow line of the gutter shall be checked and any irregularities of more than 1/8″ in 10′ (3 mm in 3 m) shall be corrected.

Irregularities in grade or alignment of the exposed surfaces shall not exceed 3/8″ in 10′ (10 mm in 3 m). Vertical alignment shall be sufficiently uniform and regular to ensure complete drainage.

701.12 Removal of Forms. Front forms may be removed as soon as concrete has hardened sufficiently. Rear and side forms shall not be removed for at least 12 hours. Surfaces exposed after 12 hours but prior to 72 hours shall be cured using materials specified in Section 812 or immediately backfilled. Minor defects shall be filled with mortar conforming to the requirements of Section 611.

701.13 Curing. Immediately, upon the completion of finishing, all exposed surfaces shall be cured for 72 hours using curing materials specified in Section 812. During the curing period, pedestrian and vehicular traffic shall not disturb newly completed curb or integral curb and gutter.

701.14 Backfilling. As soon as possible after the removal of forms or completion of the slip-form operation, the spaces adjacent to the curb and integral curb and gutter shall be backfilled to the required elevation with suitable material until firm and solid.

701.15 Method of Measurement. The quantity of portland cement concrete curb and integral curb and gutter will be measured as the number of linear feet (linear meters) along the front face of the finished curb.

701.16 Basis of Payment. The quantity of portland cement concrete curb and integral curb and gutter will be paid for at the Contract price per linear foot (linear meter). Price and payment will constitute full compensation for excavating [limited to 1′ (300 mm) in depth], furnishing, and placing all materials; for forming, placing, finishing, and curing concrete; for backfilling, compacting, and disposing of surplus materials; for sealing joints; and for all labor equipment, tools, and incidentals required to complete the work. If other than existing soil is approved for use as foundation material, it will be measured and paid for under the appropriate Section. If rock is encountered, measurement and payment for removal of the rock will be made under Section 206.

SECTIONS 702 through 704 – RESERVED

SECTION 705 – PORTLAND CEMENT CONCRETE SIDEWALK

705.01 Description. This work consists of constructing portland cement concrete sidewalk on a prepared foundation.

MATERIALS.

705.02 Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 812, Class B.

705.03 Preformed Expansion Joint Material. Expansion joint material shall conform to the requirements of Subsection 808.06.

705.04 Curing Material. Curing materials shall conform to the requirements of Subsection 812.02 (i).

CONSTRUCTION METHODS.

705.05 Preparation of Foundation. The foundation shall be formed at the required grade to accommodate the elevations, dimensions, and details shown on the Plans for the bottom of the sidewalk. Where the sidewalk foundation is to be existing undisturbed soil, the foundation shall be firm and unyielding. All soft and yielding or other unsuitable material shall be removed and replaced with approved granular material. When the sidewalk foundation is to be any material other than existing undisturbed soil, the compaction and density requirements for the Section covering that material shall govern. Where rock is encountered, the grade shall be excavated to 6″ (150 mm) below the bottom of the sidewalk, backfilled with approved granular material, and thoroughly compacted.

705.06 Forms. Forms shall be of wood or metal and shall extend the full depth of the concrete. Composite material forms may be used for radii work. Forms shall be straight, free from warp, and of sufficient strength to resist the pressure of the concrete, and shall not displace more than 3/8″ in 10′ (10 mm in 3 m) from the vertical or horizontal plane. Forms shall remain in both horizontal and vertical alignment until their removal. Forms shall be clean and coated with an approved form release agent before concrete is placed.

705.07 Placing and Finishing Concrete. The concrete shall be distributed to the required depth and for the entire width of the slab by shoveling, or an approved method which preserves the integrity of the mixture. Concrete shall be thoroughly spaded along all joints and on the inside of the forms for its entire depth. The concrete shall be leveled and immediately struck-off by means of an approved screed. The screed shall be shaped to the required crown and of sufficient strength to retain its shape under all working conditions.

While the concrete is still moist, it shall be floated with an approved float of either wood or metal to ensure that all irregularities or depressions are filled. The final finish shall be obtained by either a wood float or hair broom. Concrete shall be finished in accordance with Subsection 501.11. If concrete is permitted to be placed during cold weather, it shall be placed in accordance with Section 501.

The sidewalk shall be marked into rectangular slabs 5′ (1.5 m) long by scoring, ½″ (13 mm) minimum, with approved edging tools. The surface edges of each slab shall be rounded to a ¼″ (6 mm) radius.

705.08 Expansion Joints. Expansion joints shall extend from the surface to the foundation and must be at right angles to the sidewalk surface. A ½″ (13 mm) expansion joint, shall be placed across the walk every 20′ (6 m). This distance may be adjusted slightly to match existing joints in previously placed concrete work. Expansion material shall also be placed longitudinally along one side when sidewalk is placed between curbs, pavements, or any fixed structures. Joints shall be formed around all appurtenances, such as manholes, utility boxes, and poles that extend into and through the sidewalk.

705.09 Curing. Concrete shall be cured according to Section 501 for a period of five days. The sidewalk shall not be opened to pedestrian and vehicular traffic until the end of the curing period.

705.10 Backfill. Immediately at the end of the curing period, the sidewalk shall be backfilled with approved material.

705.11 Method of Measurement. The quantity of portland cement concrete sidewalk will be measured as the number of square feet (square meters) measured at the surface of the sidewalk, placed and accepted.

705.12 Basis of Payment. The quantity of portland cement concrete sidewalk will be paid for at the Contract unit price per square foot (square meter). Price and payment will constitute full compensation for furnishing, hauling, and placing all materials; for preparing the foundation; for shaping the shoulders; for replacing rejected sidewalk; and for all labor, equipment, tools, and incidentals required to complete the work. If other than existing soil is approved for use as foundation material, it will be measured and paid for under the appropriate Section. If rock is encountered, measurement and payment for removal of the rock will be made under Section 206.

SECTION 706 – RESERVED

DRAINAGE

SECTION 707 – CORRUGATED STEEL DOWNSPOUTS

707.01 Description. This work consists of placing corrugated steel pipe downspouts in fill slopes from portland cement concrete intake aprons and intake basins to discharge points at the top of slopes or to downspout splash aprons.

MATERIALS.

707.02 Pipe. Corrugated steel pipe shall conform to AASHTO M 36/M 36M.

707.03 Concrete. Materials and composition of the mix shall conform to the requirements of Section 812, Class B.

CONSTRUCTION METHODS.

707.04 Downspout Splash Aprons. Reinforced portland cement concrete splash aprons shall be placed at the discharge end of the corrugated steel downspouts at elevations shown on the Plans. Splash aprons shall be constructed according to the requirements of Section 602.

707.05 Intake Aprons. Portland cement concrete intake aprons shall be placed in the roadway shoulder at the locations and to the elevations shown on the Plans. The shapes and elevations shall be set and maintained with forms. The contours of the surface shall be shaped by hand methods using templates as necessary. Intake aprons shall be constructed according to the requirements of Section 602.

707.06 Intake Basins. Reinforced portland cement concrete intake basins shall be placed in the roadway shoulder at the locations and to the elevations shown on the Plans. The intake basins shall be constructed according to the requirements of Section 708.

707.07 Final Site Work and Cleanup. The discharge end of the pipe shall be completed as shown on the Plans. When all construction on the intake, downspout, and splash aprons has been completed, all excess earthwork and debris shall be removed. The areas shall conform to the typical section, and the site of each operation shall be left in a neat condition.

707.08 Method of Measurement. The quantity of corrugated steel downspout will be measured as the number of linear feet (linear meters) of downspout placed, including bends, measured along the downspout from the intake end to the discharge end of the pipe. The quantity of intake basins, intake aprons, and downspout splash aprons will be measured as the number of each constructed basin and apron placed.

707.09 Basis of Payment.

(a) *Corrugated Steel Downspouts.* The quantity of corrugated steel downspouts will be paid for at the Contract unit price per linear foot (linear meter).

(b) *Intake Aprons.* The quantity of intake aprons will be paid for at the Contract unit price for each intake apron.

(c) *Intake Basins.* The quantity of intake basins will be paid for at the Contract unit price for each intake basin.

(d) *Downspout Splash Aprons.* The quantity of downspout splash aprons will be paid for at the Contract unit price for each downspout splash apron.

Price and payment for all items in this Section will constitute full compensation for furnishing and placing all materials, including bar reinforcement, course aggregate, and grating; for excavating, backfilling, regrading shoulders and slopes, site clearing, and disposing of surplus material; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 708 – DRAINAGE INLETS AND MANHOLES

708.01 Description. This work consists of the construction of reinforced portland cement concrete drainage inlets and manholes.

MATERIALS.

708.02 Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 812, Class B.

708.03 Mortar. Mortar shall conform to the requirements of Section 611.

708.04 Bar Reinforcement. Bar reinforcement shall conform to the requirements of Section 824.

708.05 Castings. Castings for frames and covers shall conform to AASHTO M 105, Class 30. Castings shall be boldly filleted at angles, and the arises shall be sharp and exact. Castings shall be true to pattern in form and dimension and free from pouring faults, sponginess, cracks, blowholes, and other defects that impair the strength and value for the service intended.

708.06 Gratings. Gratings shall be fabricated as shown on the Plans and the Standard Construction Details from cast iron conforming to the requirements of ASTM A 48, Class 30.

708.07 Steps. Drainage inlet steps shall be of the type constructed of molded plastic with a reinforcing bar core, conforming to the requirements of AASHTO M 31/M 31M, and ASTM A 478, and D 4101.

CONSTRUCTION METHODS.

708.08 Excavation. Excavation shall be made to the required depth. The foundation upon which the concrete floor of the drainage inlet is to be placed shall be compacted to a firm, even surface.

708.09 Reinforced Concrete Construction. Reinforced concrete drainage inlets and manholes shall be constructed according to the requirements of Section 602.

708.10 Precast Drainage Inlets and Manholes. Precast drainage inlets and manholes shall be constructed as shown on the Standard Construction Details.

The annular space of joints between precast sections shall be filled with a joint sealant meeting the requirements of AASHTO M 198.

708.11 Frames of Castings. Frames of castings shall be set in full mortar beds.

708.12 Steps. All drainage inlets and manholes which are 4′ (1.2 m) or more in depth, measured from the top of grate or cover to the invert of the lowest pipe, shall have steps installed on the back wall or as specified on the Plans. The steps shall be embedded a minimum of 3″ (75 mm) in the wall, protrude out 6″ (150 mm) from the wall, start within 24″ (600 mm) of the top of grate/lid, end no more than 12″ (300 mm) above the lowest invert (except where a pipe is in the backwall), and be spaced vertically at 12″ (300 mm) intervals.

708.13 Inlet and Outlet Pipes. Inlet and outlet pipes shall be the same size and type as the connecting pipes shown on the Plans and shall extend through the walls and be flush with the inside of the wall.

If an end of reinforced concrete pipe is cut off, the end shall be cut clean and smoothly finished with mortar so that no bar reinforcement remains exposed. Any space between the pipe and the walls of the

precast drainage inlet shall be filled with non-shrink grout conforming to the requirements of ASTM C 1107. The greatest dimension of the opening in the drainage inlet for the pipe shall be no greater than the outside pipe diameter plus 4″ (100 mm).

708.14 Backfill. The area around drainage inlets and manholes shall be backfilled with Borrow Type C material to the required elevation. Backfill placement shall be in 6″ (150 mm), loose-thickness lifts. Each lift shall be placed and compacted to 95% or more of the maximum density. No backfill shall be placed prior to approval.

708.15 Method of Measurement. The quantity of drainage inlets and manholes will be measured as the actual number of each, installed and accepted. Inlet and outlet pipe will not be measured under this Section, but will be measured with the adjoining pipe under the appropriate Section for the size and type of pipe installed.

708.16 Basis of Payment. The quantity of drainage inlets and manholes will be paid for at the Contract unit price for each drainage inlet or manhole. Price and payment will constitute full compensation for furnishing and placing all materials, including any necessary fittings, metal frames, gratings, covers, top units, and hoods; for excavating, backfill, backfilling, compacting, and disposing of surplus materials; and for all labor, equipment, tools, and incidentals required to complete the work. If rock is encountered, rock excavation will be paid under Section 206.

Inlet and outlet pipe will be paid for under the appropriate Section for the size and type of pipe installed.

SECTION 709 – RESERVED

SECTION 710 – ADJUSTING AND REPAIRING DRAINAGE INLETS AND MANHOLES

710.01 Description. This work consists of adjusting and repairing existing drainage inlets and manholes.

MATERIALS.

710.02 Portland Cement Concrete. Portland cement concrete shall conform to the requirements of Section 812, Class B.

710.03 Mortar. Mortar shall conform to the requirements of Section 611.

710.04 Brick. Brick shall conform to the requirements of Section 611 or shall be concrete brick conforming to the requirements of ASTM C 139, except absorption shall not exceed of 15 lb/ft³ (240 kg/m^3).

710.05 Select Borrow. Select borrow, used as backfill, shall conform to the requirements of Subsection 209.04, Borrow Type C.

710.06 Concrete Block. Concrete block shall conform to the requirements of Section 819.

CONSTRUCTION METHODS.

710.07 Drainage Inlets and Manholes. Drainage inlets and manholes, including the concrete curb portion of the drainage inlet, shall be adjusted to vertical grade. Drainage inlets and manholes shall be repaired as required, prior to the paving operations. The concrete curb portion of the drainage inlet shall be removed and replaced. Covers of drainage inlets and manholes shall be removed so that the Engineer can inspect the manhole or drainage inlet. Existing castings shall be removed and replaced on a full mortar bed, as required. At the direction of the Engineer, all reinforced concrete or masonry found to be in poor condition shall be rebuilt using materials conforming to the original structure's dimensions and construction type.

710.08 Excavation and Backfill. The materials necessary to be excavated to perform the work under this Section shall be removed from the site. All such excavations shall be backfilled with select borrow by methods conforming to the requirements of Section 708.

710.09 Method of Measurement. The quantity of drainage inlets and manholes adjusted or repaired will be measured as the actual number of each, adjusted or repaired.

710.10 Basis of Payment. The quantity of drainage inlets and manholes adjusted or repaired will be paid for at the Contract unit price for drainage inlets and manholes repaired from the top of grate (or cover) to a depth of 3′ (900 mm) below. Drainage inlets and manholes repaired below a depth of 3′ (900 mm), but not more than 4½′ (1.4 m), will be paid for at one and one-half times the unit price. Drainage inlets and manholes repaired below a depth of 4½′ (1.4 m) will be paid for at two times the unit price. Price and payment will constitute full compensation for excavating, backfilling, compacting, and disposing of materials; for removing and resetting covers and portions of structures; for furnishing and placing all materials, including the replacement of the concrete curb portion of drainage inlets and all mortar repair; and for all labor, equipment, tools and incidentals required to complete the work.

SECTION 711 – RESERVED

SECTION 712 – RIPRAP

712.01 Description. This work consists of furnishing and placing dry, pre-mixed, bagged riprap and stone riprap. This work also consists of preparing the bedding areas for the placement of riprap.

MATERIALS.

712.02 Portland Cement Concrete. The portland cement, water for curing, and fine aggregate shall conform to the requirements of Section 812. The composition of the mix shall be a fine aggregate to cement ratio of 4:1 by weight. As an alternate, a dry mix of Class B concrete may be submitted.

The fine aggregate to cement, or fine aggregate to cement to coarse aggregate, shall be mixed dry throughout, in the proportions specified. The mixed material shall be accurately measured into each bag, with care being taken to place the same amount of material in each bag. Immediately after filling,

the bags shall be sealed ready for delivery to the Project site.

712.03 Bags. The bags shall be either multi-wall paper, perforated throughout on approximate 1″ (25 mm) center, or a woven polyester or polypropylene mesh bag. The bags shall hold the mix without leakage when handled and shall permit the passage of water when wetted. The bags shall be of adequate seal, thickness, and strength to maintain the integrity of the riprap until the concrete mix has set. The dry bagged riprap shall be of uniform size, rectangular in shape, and approximately 4 or 6″ (100 or 150 mm) thick, in order to provide a uniform appearance in the completed work. The bags shall be consistent in color and blend with the surrounding area. The bag composition shall be such that the bags will disintegrate without presenting environmental problems. Filled bags shall be free from tears and strong enough to handle without ripping or splitting. Only one type and size bag shall be used at any one structure. The filled bags shall weigh approximately 60 to 90 lb (27 to 41 kg) per bag with the following approximate size and capacity limits:

US CUSTOMARY

Bag Type	Nominal Filled Bag Size	Capacity	Bags/yd³ (Dry)
60 lb paper	4 by 12 by 18″	0.50 ft³	54
80 lb paper	4 by 14 by 21″	0.67 ft³	40
90 lb polypropylene	6 by 12 by 18″	0.75 ft³	36

METRIC

Bag Type	*Nominal Filled Bag Size*	*Capacity*	*Bags/m³ (Dry)*
27 kg paper	100 by 300 by 450 mm	0.014 m³	71
36 kg paper	100 by 350 by 525 mm	0.019 m³	52
41 kg polypropylene	150 by 300 by 450 mm	0.021 m³	47

The Contractor shall furnish to the Department, a Certificate of Compliance stating that both bag and blended material meet the above requirements. Prior to approval to proceed, the supplier's plant may be inspected by the Department. The Contractor shall also furnish sample bags of the type proposed for use in the work and shall not proceed with the work until the bags proposed for use have been approved. At least two weeks prior to delivery, samples of approximately 5 lb (2.3 kg) each of the fine aggregate and cement to be used in the dry mix shall be submitted to the Department.

712.04 Stone. Stone for riprap shall be hard, durable stone free from structural defects and foreign substances such as soil, shale, and organic materials. The stone shall be hard angular rock with neither width nor thickness less than one-third its length; the minimum specific gravity shall be 2.5, bulk-saturated, surface-dry basis; and each load shall be well-graded, from the smallest to the largest size. Stone shall be obtained from an approved source and samples submitted to the Department for petrographic examination for durability prior to use.

The gradation of the stone shall be controlled by visual inspection. Two sample stockpiles of stone, at least 5 tons (metric tons) each or one-half the Project quantity, whichever is smaller, shall be used as a reference for judging the size and gradation of the stone supplied and placed. One sample shall be supplied at the construction site and one at the quarry. The construction site sample may be incorporated into the work. The stone riprap identified on the Plans shall conform to the following

requirements:

Percent Passing (Square Openings) by Weight

NCSA Rock Size*	*R-7*	*R-6*	*R-5*	*R-4*
30″ (762 mm)	100**	---	---	---
24″ (610 mm)	---	100**	---	---
18″ (457 mm)	15 - 50	---	100**	---
12″ (305 mm)	---	15 - 50	---	100**
9″ (229 mm)	0 - 15	---	15 - 50	---
6″ (152 mm)	---	0 - 15	---	15 - 50
4″ (102 mm)	---	---	0 - 15	---
3″ (76 mm)	---	---	---	0 - 15

* National Crushed Stone Association
** Maximum allowable rock size

712.05 Geotextile. Geotextile for riprap shall conform to the requirements of Subsection 827.06.

CONSTRUCTION METHODS.

712.06 Pre-Sacked Concrete Riprap. If not installed the same day of delivery, the pre-sacked concrete riprap shall be protected from moisture by a waterproof covering such as polyethylene. Prior to installation, bags containing material which has begun to hydrate due to prolonged storage, inadequate protection, or other causes will be rejected by the Department and shall be replaced by the Contractor.

Pre-sacked riprap shall be placed on slopes for protection. The bagged riprap shall be laid with staggered joints, in a regular pattern, and tamped into place to cause them to conform to the prepared slope and to adjacent bags in place. Bags ripped or torn in placing shall be removed and replaced with sound, unbroken bags. The bagged riprap shall then be thoroughly wetted by hosing, sprinklers, or other approved methods capable of providing sufficient water to saturate the entire installation and initiate the cement hydration process. Where more than one course of bagged riprap is specified, each new course shall be thoroughly wetted as described above, before the next course is placed. In multi-level construction, all joints shall be clean, and intimate bag to bag contact will be required to ensure good bonding.

Every effort shall be made to avoid disturbing the placed bags until the concrete has sufficiently set. During hot and dry weather, additional water curing may be required to sustain the hydration process.

712.07 Stone Riprap. Riprap shall be placed in accordance with this Section, to the dimensions and at the locations shown on the Plans or as established by the Engineer.

The area for placement of the stone riprap shall be excavated to the required placement depth. The area shall be in a relatively smooth condition, free from large stone, vegetation, debris, and areas of soft material. Preparation of the area may include, but is not limited to, excavating, removing unsuitable material, backfilling, placing embankment, and clearing and grubbing.

The geotextile shall be placed on the prepared area in a loose and unstretched condition to minimize tearing and shifting. The adjacent edges of the fabric shall be joined with a lock-type or chain-type stitch folded seam or overlapped a minimum of 12″ (305 mm), if permitted. The overlap direction shall be upstream over downstream and upslope over downslope. The fabric shall be anchored in place

by securing pins or other acceptable methods. The fabric shall be covered as soon as possible so that it is not exposed for more than two weeks.

The riprap shall be carefully placed on the geotextile to produce an even distribution of pieces, with a minimum of voids and without tearing the geotextile. The riprap shall be placed to the full-course thickness in a manner which prevents segregation of stone sizes and which prevents displacement of underlying material. If necessary, individual stones shall be rearranged to ensure a uniform distribution.

712.08 Method of Measurement. The quantity of pre-sacked concrete riprap will be measured as the actual number of cubic yards (cubic meters) of riprap incorporated into the finished construction and accepted.

The quantity of stone riprap will be measured as either the actual number of square yards (square meters) or the actual number of tons (metric tons) of riprap for each class placed and accepted. If stone riprap is measured by the square yard (square meter), the quantity will be determined by computations based on field measurements taken on and along the completed finished surfaces (no horizontal projection) and the specified placement thickness for the class. If stone riprap is measured by the ton (metric ton), the weight will be determined as specified in Subsection 109.01.

712.09 Basis of Payment. The quantity of pre-sacked concrete riprap will be paid for at the Contract unit price per cubic yard (cubic meter). The quantity of stone riprap will be paid for at the Contract unit price per square yard (square meter) or ton (metric ton). Price and payment will constitute full compensation for excavating and preparing the bedding areas if applicable; for furnishing, preparing, and placing all materials, except for geotextile; for replacing rejected bags; and for all labor, equipment, tools, and incidentals required to complete the work.

Payment for geotextile will be made under the appropriate Section.

SECTION 713 – GEOTEXTILES

713.01 Description. This work consists of furnishing and placing geotextiles.

Materials.

713.02 Stabilization. Geotextile for stabilization shall conform to the requirements of AASHTO M 288, Class 1.

713.03 Separation. Geotextile for separation shall conform to the requirements of AASHTO M 288, Class 2.

713.04 Riprap. Geotextile for placement under riprap shall conform to the requirements of Subsection 827.06.

713.05 Construction Method. Geotextile shall be placed in conformance with Subsection 712.07 unless specified otherwise on the Plans.

713.06 Method of Measurement. The quantity of geotextile will be measured as the actual number of square yards (square meters) for each type of geotextile placed and accepted. The quantity will be determined by computations based on field measurements taken on and along the geotextile covered

surface.

713.07 Basis of Payment. The quantity of geotextile will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for furnishing and placing all materials including anchoring devices, and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 714 – DITCHING

714.01 Description. This work consists of excavating lateral and longitudinal ditches. This work also includes clearing alongside the ditches, as necessary.

714.02 Construction Methods. Ditches shall be excavated as shown on the Plans. All material excavated from the ditches shall be spread on top of the land on each side of the ditch, graded to conform to the surface contours, and blended into the surrounding ground. Where necessary, the land shall be prepared and conditioned in all sections along both sides of the ditch to the width necessary to receive the material. As necessary, the Contractor shall clear the brush alongside the ditches. Brush shall be disposed as specified in Subsection 106.09.

714.03 Method of Measurement. The quantity of ditching will be measured in linear feet (linear meters) along the centerline of the ditch, constructed and accepted.

714.04 Basis of Payment. The quantity of ditching will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for clearing, disposing of debris, excavating, and grading and for all labor, materials, equipment, tools, and incidentals required to complete the work.

SECTION 715 – PERFORATED PIPE UNDERDRAINS

715.01 Description. This work consists of constructing and performing a video inspection of underdrains from perforated, corrugated metal pipe or perforated, corrugated polyethylene tubing.

MATERIALS.

715.02 Perforated, Corrugated Metal Pipe. Perforated, corrugated metal pipe shall conform to the requirements of AASHTO M 36/M 36M, Class 1.

715.03 Perforated, Corrugated Polyethylene Tubing (CPT). Perforated CPT shall conform to the requirements of AASHTO M 252, and shall be supplied in individual lengths no shorter than 10′ (3 m). Coil pipe will only be permitted in 4″ (102 mm) diameter, when it is to be machine installed.

715.04 Stone. Stone for backfill shall conform to the requirements of Section 813, Delaware No. 8.

715.05 Filter Fabric. Filter fabric shall conform to the requirements of AASHTO M 288.

CONSTRUCTION METHODS.

715.06 General. The underdrain shall be constructed in accordance with the details shown on the Plans or the Standard Construction Details and at the locations shown on the Plans. The pipe shall be placed as directed by the Engineer. Lateral connections to the pipe shall be made with connectors recommended by the manufacturer. Stone backfill shall be placed in 6″ (150 mm) lifts and compacted with a vibratory plate to the satisfaction of the Engineer.

715.07 Video Inspection. After completion of the roadway base and prior to the Project′s final inspection, the entire underdrain system shall be videoed. The entire underdrain system involved shall be numbered and then inspected by means of a closed-circuit television. The inspection will be done one section at a time in the presence of the Department′s inspector.

The television camera used for the inspection shall be specifically designed and constructed for such inspection, capable of producing color video. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing quality to the satisfaction of the Department. If unsatisfactory, the equipment shall be removed and replaced.

The camera shall be moved through the pipe run in either direction at a speed of 2 to 3″/s (0.05 to 0.08 m/s) but in no case greater than 6″/s (0.15 m/s). Manual winches, power winches, television cable and power rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the pipe condition shall be used to move the camera through the pipe.

When manually operated winches are used to pull the television camera through the pipe run, telephones or other means of communication shall be used to ensure good communications between members of the crew pulling the camera.

The technician operating the camera shall be experienced and qualified in conducting video pipe inspections. The technician shall have the capability of controlling the movement of the television camera, adjusting the brightness of the built-in lighting system, and focusing the television camera by remote control. The importance of accurate distance measurements is emphasized. A distance meter and location indicator shall appear on the monitor and video tape indicating the exact location of the camera in the pipe between two structures.

The view scanned by the television camera shall be transmitted to a color monitor of not less than 12″ (300 mm), measured diagonally across the screen. The monitor shall be located such that the Department′s inspector has full visual access.

The technician shall stop and document on a separate written report and on audio any unusual conditions including but not limited to crushed pipe, open joints, obstructions, debris, roots, sharp bends, sags, and water pockets. A copy of this written report shall be supplied to the Department along with the visual and audio record on a good quality VHS videotape in a hard plastic case which will become the property of the Department.

The videotape will be evaluated by the Engineer for the purpose of acceptance of the underdrain system. Any defects noted shall be repaired by the Contractor.

715.08 Method of Measurement. The quantity of perforated pipe underdrains will be measured from end-to-end in linear feet (linear meters) of pipe completed and accepted.

715.09 Basis of Payment. The quantity of perforated pipe underdrains will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for

furnishing and placing all materials, including perforated pipe, connectors, stone for backfill, and filter fabric; for constructing perforated pipe drains; for excavating, backfilling, compacting, and video inspection; and for all labor, tools, equipment, and incidentals required to complete the work. If rock is encountered during excavation for perforated pipe underdrain, payment for rock removal will be made under Section 206.

SECTION 716 – CONVERTING DRAINAGE INLETS TO JUNCTION BOXES

716.01 Description. This work consists of placing a reinforced concrete cover on an existing drainage inlet and salvaging and stockpiling gratings.

716.02 Materials. Portland cement concrete shall conform to the requirements of Section 812, Class B. Bar reinforcement shall conform to the requirements of Section 824.

716.03 Construction Methods. The existing drainage inlet frame and grate shall be removed. A reinforced concrete cover shall be constructed and placed directly bearing on the drainage inlet walls.

716.04 Method of Measurement. The quantity of drainage inlets converted to junction boxes will be measured as the actual number of drainage inlets converted to junction boxes, placed and accepted.

716.05 Basis of Payment. The quantity of drainage inlets converted to junction boxes will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for constructing and placing the concrete cover; for furnishing and placing all materials, including bar reinforcement; for salvaging and stockpiling gratings; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 717 – PERMANENT ROADWAY DRAINS

717.01 Description. This work consists of constructing permanent roadway drains.

717.02 Materials. The material used for backfilling the permanent roadway drains shall conform to the requirements of Section 813, Delaware No. 8.

CONSTRUCTION METHODS.

717.03 Preparation. Before excavation for the permanent roadway drains begins, the foundation of the roadway and the shoulder shall be properly shaped, uniformly and thoroughly compacted, and maintained as established in Section 202.

The side ditches shall be acceptable to the Engineer prior to beginning the excavation for the permanent roadway drains.

717.04 Construction of Drains. All materials removed in the work of constructing permanent roadway drains shall be used in the formation of embankments, shoulders, and slopes unless the Engineer classifies the excavated material as unsuitable for re-use, whereupon the material shall become the property of the Contractor and be disposed of as specified in Subsection 106.09.

The permanent roadway drains shall be constructed through the shoulder toward the side ditches as extensions of the graded aggregate base course. The ditches shall be constructed at intervals not to exceed 300′ (90 m), unless otherwise designated on the Plans, and at all low points in the grade and at other points as established by the Engineer.

The permanent roadway drains shall be at least 12″ (300 mm) in width and have a constant slope from the base course to the side ditch.

The Contractor shall conduct its operations in such a manner that the Engineer can take the necessary measurements before any backfill is placed. The excavated ditches shall be backfilled with approved material for a minimum thickness equal to that of the graded aggregate base course.

717.05 Performance Requirements. The permanent roadway drains shall be constructed to ensure adequate drainage of water from the graded aggregate base course to the side ditches.

717.06 Method of Measurement. The quantity of permanent roadway drains will be measured as the number of linear feet (linear meters) of permanent roadway drains accepted by the Engineer, measured along the centerline length of the bottom of the ditch from the nearest edge of the graded aggregate base course to the nearest edge of the side ditch.

Work and materials required for Subsection 717.03 will not be measured.

717.07 Basis of Payment. The quantity of permanent roadway drains will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for preparing, excavating, and disposing or re-using of the excavated material; for furnishing and placing the backfill material; and for all equipment, tools, labor, and incidentals required to complete the work.

SECTION 718 – ROOF DRAINS

718.01 Description. This work consists of furnishing pipe for outlets and roof drains and furnishing and constructing connections to pipes, drainage inlets, and endwalls.

MATERIALS.

718.02 Polyvinyl Chloride Pipe (PVC). PVC pipe shall meet the requirements of ASTM D 3034, Type PSM. The acceptable standard thermoplastic pipe dimension ratios (SDR) are SDR-35 and SDR-41. The pipe and fittings shall be made of PVC plastic. The two joining systems are:

(a) Solvent cement joints.

(b) Elastomeric gasket joints: Assembly shall be in accordance with the pipe manufacturer′s recommendations.

718.03 Steel. Steel pipe shall conform to the requirements of ASTM A 53 and shall be galvanized in accordance with AASHTO M 111/M 111M.

718.04 Construction Methods. The portion of roof drain under the sidewalk or connecting to the curb and gutter shall be 3″ (80 mm) diameter steel pipe and shall be connected to the curb as shown on the Standard Construction Details. All remaining roof drains shall be PVC pipe.

The Contractor may use PVC pipe for the entire length including under sidewalk or curb if the connecting curb or gutter are portland cement concrete curb Type 1 or Type 2; or integral portland

cement concrete curb and gutter Type 1 or Type 3.

All pipe shall be laid in accordance with Subsection 612.08. Joints shall be finished in accordance with the pipe manufacturer's recommendations.

Backfilling of pipe trenches shall be as specified under Section 208.

When an existing sidewalk must be replaced over a roof drain, an expansion joint shall be constructed over the centerline of the pipe.

718.05 Method of Measurement. The quantity of roof drains will be measured as the actual number of linear feet (linear meters) of pipe, including 3″ (80 mm) steel pipe and specially manufactured connections, measured from end to end of pipe, excluding structures, installed and accepted.

718.06 Basis of Payment. The quantity of roof drains will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for furnishing and installing all pipe; for excavation, backfilling, and compaction of trenches; and for all materials, tools, and incidentals required to complete the work.

SECTION 719 – RESERVED

GUARDRAIL AND FENCING

SECTION 720 – GALVANIZED STEEL BEAM GUARDRAIL

720.01 Description. This work consists of furnishing and erecting galvanized steel beam guardrail.

720.02 Materials. All materials for galvanized steel beam guardrail shall conform to the requirements of the following Section and Subsection:

Portland Cement Concrete, Class B 812
Steel Posts, Steel Offset Blocks, and Steel Shapes 828.02
Beams, Type II 828.02
Hardware 828.02
Rods and Turnbuckles 828.02
Reflectorized Washers 828.02
Timber Posts and Timber Offset Blocks 828.02

720.03 Construction Methods. Posts shall be set plumb, true to the line and grade shown on the Plans, or as directed.

Guardrail shall be erected to form a smooth, continuous rail conforming to the required line and grade.

All bolts, except through expansion joints, shall be drawn tight. Bolts through expansion joints shall be drawn up as tight as possible without preventing the beams from sliding past one another longitudinally. Bolts shall extend at least ¼″ (6 mm) beyond the nuts. Bolts which are necessary for adjustment shall not extend more than ½″ (13 mm) beyond the nuts. The Contractor shall be required to burr the last thread of post railing bolts to prevent removal of such bolts.

All hot-mix bituminous pavement that cracks or breaks as a result of installing guardrail posts shall be repaired in accordance with the requirements in Section 406.

Reflectorized washers shall be installed in accordance with the Standard Construction Details. Reflectorized washer colors shall be as follows:

(a) On any divided highway or one way ramp, the surface facing traffic shall be white or silver on the right side and yellow on the left side. The back surface of all of the washers shall be red.

(b) On any undivided highway, all reflectorized washer surfaces shall be white or silver on the front and back.

720.04 Method of Measurement. The quantity of galvanized steel beam guardrail will be measured as the number of linear feet (linear meters) of guardrail installed and accepted. Guardrail will be measured from the center of end post to the center of end post, excluding barrier connections and end treatments. The quantity of guardrail components furnished and installed will be measured as the number of each component. The quantity of guardrail over culverts will be measured as the number of each installed and accepted.

720.05 Basis of Payment. The quantity of galvanized steel beam guardrail will be paid for at the Contract unit price per linear foot (linear meter) of guardrail. The quantity of guardrail components will be paid for at the Contract unit price per each component. The quantity of guardrail over culverts will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing and placing all materials, including reflectorized washers; for burring of bolts; for excavating, backfilling, compacting, and disposing of surplus materials; for patching hot-mix around posts; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTIONS 721 through 724 – RESERVED

SECTION 725 – GUARDRAIL-TO-BARRIER CONNECTION(APPROACH AND EXIT TYPES)

725.01 Description. This work consists of furnishing and erecting approach and exit type guardrail-to-barrier connections.

725.02 Materials. The materials for guardrail-to-barrier connections shall conform to the requirements of the following Subsection:

Beams, Type I 828.02
Hardware 828.02
Reflectorized Washers 828.02
Timber Blocks and Timber Offset Blocks 828.02

725.03 Construction Methods. Construction methods shall conform, as applicable, to the requirements of Section 720. In addition, the Contractor shall exercise great care so as not to chip, crack, or otherwise damage the concrete barrier while drilling holes in the barrier and attaching the guardrail.

725.04 Method of Measurement. The quantity of guardrail-to-barrier connections will be measured as the number of each guardrail-to-barrier connection.

725.05 Basis of Payment. The quantity of guardrail-to-barrier connections will be paid for at the Contract unit price for each guardrail-to-barrier connection. Price and payment will constitute full compensation for furnishing and placing all materials, including reflectorized washers; for burring of bolts; for excavating, backfilling, compacting, and disposing of surplus materials; for patching hot-mix around posts; for repairing any damage to the concrete barrier that resulted from the process of attaching the guardrail to the barrier; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 726 – GUARDRAIL END TREATMENT

726.01 Description. This work consists of furnishing and erecting guardrail end treatments.

726.02 Materials. All materials for guardrail end treatment shall conform to the requirements of the following Section and Subsection:

Portland Cement Concrete, Class B 812
Steel Posts, Steel Offset Blocks, and Steel Shapes 828.02
Beams, Type II 828.02
Hardware 828.02
Swaged Cable Assemblage 828.02
Reflectorized Washers 828.02
Timber Posts and Timber Offset Blocks 828.02

726.03 Construction Methods. Construction methods shall conform, as applicable, to the requirements of Section 720.

726.04 Method of Measurement. The quantity of guardrail end treatment will be measured as the number of each guardrail end treatment.

726.05 Basis of Payment. The quantity of guardrail end treatments will be paid for at the Contract unit price per each end treatment. Price and payment will constitute full compensation for furnishing and installing all materials, including reflectorized washers; for burring of bolts; for excavating, backfilling, compacting, and disposing of surplus materials; and for all labor, tools, equipment, and incidentals required to complete the work.

SECTION 727 – FENCES AND GATES

727.01 Description. This work consists of furnishing and erecting chain-link and right-of-way fence and gates, and resetting and repairing chain-link fence.

727.02 Materials. All materials for fences and gates shall conform to the requirements of the following Section and Subsections:

Portland Cement Concrete, Class B 812
Right-Of-Way Fence:
  Metal Posts 825.02
  Barbed Wire 825.02

727.03 Fabrication. Fabrication of materials furnished under this Section shall conform to the sizes, shapes, dimensions, and other factors shown on the Plans and shall show careful, finished workmanship in all respects.

727.04 Markings. Each roll of fence fabric shall carry a tag showing the type of base metal (steel or aluminum alloy number), type of coating, class of coating, the diameter of the wire, the length of fencing in the roll, and the name or mark of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, type of base metal (steel or aluminum alloy number), class or coating, and other pertinent data sufficient for proper identification and verification of conformance to the requirements of Section 825.

727.05 Inspection. Each product or item furnished shall be subject to inspection at the factory and the fabricating plant, in laboratories of the Department's choosing, and at all other points of delivery.

CONSTRUCTION METHODS.

727.06 Removal of Obstructions. Before starting fence construction, all trees, brush, old fences, and other obstacles that interfere with the proper construction of the fence shall be removed in accordance with Section 201.

727.07 Concrete Footings. Concrete footings shall be constructed in accordance with the dimensions shown on the Standard Construction Details. All posts, except line posts for right-of-way fence, shall be set in concrete. Posts shall be centered in the footing. The concrete shall be thoroughly compacted around the posts by tamping or vibrating, and shall be slightly higher than the ground line. The top surface of the footings shall be smooth and sloped to drain moisture away from the posts. No attachments shall be placed on the posts, and no posts shall be disturbed in any manner, within 72 hours after the concrete footing is completed. Hand mixed concrete shall not be used, unless approved.

727.08 Rock Excavation. When rock is encountered at a depth less than the planned concrete footing depth, a hole 2″ (50 mm) in diameter larger than the greatest dimension of the post cross-section shall be drilled to a depth of 12″ (300 mm), into the rock. After the post is set, the remainder of the drilled hole shall be filled with grout, composed of one part portland cement and two parts mortar sand. Any remaining space above the rock shall be filled with concrete in the manner described in Subsection 727.07 for post footings. All excess excavation from footings shall be disposed of in a manner satisfactory to the Engineer.

727.09 Posts, Rails, and Braces.

(a) *Chain-Link Fence.* Posts for chain-link fence shall be plumb and spaced at 10′ (3 m) centers maximum, with a tolerance of -2′ (-0.6 m). Spacing of posts shall be as uniform as practicable under local conditions. Terminal posts shall be installed at all abrupt changes in grade, at changes in line direction over 15 degrees, and at all ends. In no case shall the distance between terminal posts exceed 500′ (150 m).

Top rail shall pass through intermediate post tops and form a continuous brace from end to end of each stretch of fence. Top rail is to be fastened to terminal posts with heavy pressed steel connectors.

Couplings used to join the top rail segments shall allow for expansion. Expansion devices shall be approved by the Engineer. Couplings are to be placed approximately every 20′ (6 m).

Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts. Sufficient braces shall be applied to allow complete bracing from each terminal post to adjacent line posts. Roll formed rail and brace shall be installed 2′ (600 mm) apart and the tubular rail and brace shall be installed 2′ - 6″ (750 mm) apart. Rail and brace shall extend from the terminal post to the first adjacent line post. Braces shall be fastened to the posts by heavy pressed steel connections, then trussed from the line posts back to the terminal post with round rods as shown on the Standard Construction Details.

When barbed wire is required, posts shall be equipped with extension arms. The arms shall extend at a 45 degree angle. Lock-wires, securely fastening the barbed wire, shall be equally spaced along the extension arm. The top strand shall be located 12″ (300 mm) above the fabric and 12″ (300 mm) out from the fence line. Extension arms shall be capable of supporting a dead load of 200 lb (90 kg) at the top strand attachment point, without permanently deforming.

(b) *Right-Of-Way Fence.* Metal posts for right-of-way fence shall be plumb and spaced 12′ (3.5 m) apart, unless otherwise shown on the Plans. Posts shall be firmly embedded in the ground to a depth of at least 2′ - 6″ (750 mm).

Metal post braces shall be firmly attached to metal end posts, intermediate end posts, corner posts, and gate posts. Metal posts and braces shall be set in concrete footings, as indicated on the Standard Construction Details. Corner posts and intermediate end posts shall be provided with two braces, one each way from the post in the main line of the fence. End posts and gate posts shall be provided with one brace in the line of the fence. Line posts shall be braced in both directions as described above at intervals of not more than 500′ (150 m).

727.10 Gates.

(a) *Chain Link Fence.*

(1) *Vehicular Gates.* Gate frames shall be made of steel pipe according to the requirements of ASTM A 53, with an outside diameter of 1.90″ (48.3 mm) and a nominal weight of 2.72 lb/ft (4.05 kg/m). Corners shall be heavy malleable iron or pressed steel fittings, securely riveted or welded. Welds shall be painted with aluminum base or zinc base paint.

Fabric to match the fence shall be installed in the frame by means of tension bars and hook bolts. Each frame shall be equipped with 3/8″ (10 mm) diameter adjustable truss rods. Bottom hinges shall be ball and socket type, designed to carry the weight of the gate on the post footing. The upper hinge shall be a wrap-around adjustable type. All gates shall be equipped with a positive type latching device, with a provision for padlocking. All drive gates are to be provided with a center plunger rod, and catch and

semi-automatic outer catches to secure the gate in the opened position. Vehicular gates shall be capable of being operated by one person and shall be able to swing open 180 degrees.

The bottom of vehicular gates shall be 3 to 5″ (75 to 125 mm) above the ground when closed and shall be at least 3″ (75 mm) above ground at all points of swing. The Contractor shall modify the existing grade within the area of the swing, if necessary, to meet this requirement, when directed.

(2) *Walk Gates.* Walk gates shall be 4′ (1.2 m) in width. The walk gate height shall be as shown on the Standard Construction Details or as indicated in the Special Provisions.

Walk gates shall be equipped with approved latches, stops, locking devices, and approved devices to allow for padlocking.

The bottom of walk gates shall be 3 to 5″ (75 to 125 mm) above the ground when closed and shall be at least 3″ (75 mm) above ground at all points of swing. The Contractor shall modify the existing grade within the area of the swing, if necessary, to meet this requirement, when directed.

(b) *Right-Of-Way Fence.*

(1) *Vehicular Gates.* Vehicular gates shall be equipped with approved latches, stops, locking devices, and approved devices to allow for padlocking and for securing and supporting the free end of vehicular gates in the open position to prevent damage to the gates or fence by over-swing. All gate stops shall be of the type shown on the Plans or an alternative as approved by the Engineer and shall be set in concrete as shown on the Standard Construction Details. Hinges shall be of the pivot type, heavy duty, with large bearing surfaces. Hinges shall clamp onto posts and shall not twist or turn under the action of gates. Hinges shall be configured such that closed gates cannot be lifted off their hinges. Vehicular gates shall be capable of being operated easily by one person and shall be able to swing open 180 degrees.

The bottom of vehicular gates shall be 3 to 5″ (75 to 125 mm) above the ground when closed and shall be at least 3″ (75 mm) above ground at all points of swing. The Contractor shall modify the existing grade within the area of the swing, if necessary, to meet this requirement, when directed.

(2) *Walk Gates.* Walk gates shall be 4′ (1.2 m) in width. The walk gate height shall be as shown on the Standard Construction Details or as specified in the Special Provisions.

Walk gates shall be equipped with approved latches, stops, locking devices, and approved devices to allow for padlocking.

The bottom of walk gates shall be 3 to 5″ (75 to 125 mm) above the ground when closed and shall be at least 3″ (75 mm) above ground at all points of swing. The Contractor shall modify the existing grade within the area of the swing, if necessary, to meet this requirement, when directed.

727.11 Fence Construction.

(a) *General.* Fence shall be erected at the locations indicated on the Plans. The fence shall be true to line, taut, and shall comply with the best practice for fence construction. Fence fabric shall be installed on the roadway side of posts. The bottom of the fabric shall be placed a nominal distance of 3″ (75 mm) above the ground line; however, over irregular ground a minimum clearance of 1″ (25 mm) and a maximum clearance of 6″ (150 mm) will be permitted for a horizontal distance not to exceed 8′ (2.4 m). Any excavation and backfilling required to comply with these provisions shall be made.

Tension wire shall be secured to fence posts using chain-link bands. The wire shall be attached to the fence using hog rings spaced at approximately 24″ (600 mm) on center as shown on the Standard Construction Details.

At locations of small natural swales or drainage ditches, and where it is not practical to have the fence conform to the general contour of the ground surface, such that the distance between the bottom of the fence and the ground surface exceeds 6″ (150 mm), the opening below the fence shall be spanned with barbed wire as shown on the Standard Construction Details.

Existing fences shall be permanently fastened to terminal posts of the new fence, at the location indicated on the Plans.

(b) *Chain-Link Fence.* Fabric shall be attached to the line posts with 6 gage (5 mm) wire clips spaced approximately 14″ (350 mm) apart, and attached to the top rail and brace rail with 9 gage (3 mm) tie wires on approximately 24″ (600 mm) centers. End connectors shall be as close to the ends of the fabric as possible. The chain-link fabric shall be securely fastened to all terminal posts with 3/16 by 3/4″ (5 by 19 mm) tension bars and 11 gage (3 mm) pressed bands spaced approximately 14″ (350 mm) apart, or the fabric shall be woven integrally into lock loops on roll form sections.

(c) *Right-Of-Way Fence.* Fabric shall be installed according to the Standard Construction Details.

727.12 Chain-Link Fence Resetting. Chain-link fence resetting shall conform as close as practical to the requirements of this Section. Fences shall be reset true to the line and grade shown on the Plans, or as determined by the Engineer. The elevation of the top of the fences shall be uniform. Chain-link fence material shall be new and conform to the requirements of Subsection 727.02, unless older types are necessary to maintain good appearances. Lost or damaged materials shall be replaced. Necessary grading to accomplish these requirements shall be performed by the Contractor.

727.13 Electrical Grounds. Electrical grounds shall be installed at intervals of no more than 2000′ (600 m) in all lines of fence and directly below all locations where a power line passes over the fence. Grounding shall be accomplished with a copper clad rod 8′ (2.4 m) long and a minimum of 5/8″ (16 mm) in diameter. The rod shall be driven vertically until the top is approximately 6″ (150 mm) below the top of the soil surface. A No. 6 solid copper conductor shall be clamped to the rod and to the fence, in such a manner that each element of the fence is grounded.

727.14 Method of Measurement.

(a) *Fence.* The quantity of fence will be measured by the linear foot (linear meter) along the actual fence, excluding gates, constructed and accepted.

(b) *Reset Fence.* The quantity of chain-link fence reset and repaired will be measured as the actual number of linear feet (linear meters) of fence repaired and reset by the Contractor, measured along the fence.

(c) *Gates.* The quantity of gates will be measured as the number of each type fabricated, installed, and accepted.

727.15 Basis of Payment.

(a) *Fence.* The quantity of fence will be paid for at the Contract unit price per linear foot (linear meter) for each type of fence.

(b) *Resetting Fence.* The quantity of chain-link fence reset and repaired, including all posts and gates, will be paid for at the Contract unit price per linear foot (linear meter) for fence reset. Portions of fence which are entirely new will be paid for at the Contract unit price for new fence.

(c) *Gates.* The quantity of gates will be paid for at the Contract unit price for each type of gate.

Price and payment for work in Subsection 727.15 (a), (b), and (c) will constitute full compensation for clearing and grading the line of fence; for furnishing and erecting new fences, gates, and all posts; for excavating and backfilling for footings; for furnishing and placing concrete for footings; for furnishing and installing all materials, including fittings, hardware, and grounds; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTIONS 728 through 731 – RESERVED

LANDSCAPING AND EROSION CONTROL

SECTION 732 – TOPSOIL

732.01 Description. This work consists of furnishing and placing topsoil for planting.

732.02 Materials. Topsoil shall be original surface friable loam topsoil of uniform quality and free from heavy clay, frozen clods, lumps, plants, roots, sticks, and foreign materials harmful to plant growth, such as fragments of hot-mix, concrete pavement, and surface treatment.

Topsoil shall be reasonably free of noxious perennial weeds or wood vegetation and completely void of Johnsongrass (Sorghum halapense) as determined through prior inspection by an authorized representative of the Department.

Topsoil shall have an acidity range of pH 6.0 to pH 7.5, and, if necessary, lime shall be applied, as directed by the Engineer, and incorporated with the furnished topsoil.

Topsoil shall contain not less than 2% nor more than 30% organic matter as determined in accordance with AASHTO T 194.

The method of testing topsoil shall be in accordance with the requirements of AASHTO T 88, Modified; AASHTO T 89, Method B; and AASHTO T 90; and shall meet the following gradation requirements:

Gradation Requirements

Sieve Size	*Minimum Percent Passing by Weight*
2″ (50 mm)	100
No. 4 (4.75 mm)	90
No. 10 (2.00 mm)	80

	Minimum Percent	*Maximum Percent*
Passing No. 10 (2.00 mm) and retained on No. 200 (75 µm) sieve		
Sand	15	65
Passing No. 200 (75 µm) sieve		
Silt	10	60
Clay	5	40

Topsoil shall not be delivered until samples have been approved by the Engineer.

732.03 Areas From Which Obtained. Topsoil shall be secured from areas from which topsoil has not been previously removed either by erosion or mechanical methods, and it shall not be removed to a depth in excess of the depth approved.

The area or areas from which topsoil is secured shall possess such uniformity of material depth, color, texture, drainage, and other characteristics as to offer assurance that when removed in commercial quantities, the product is homogeneous in nature and conforms to the requirements of this Section.

CONSTRUCTION METHODS.

732.04 Clearing the Area. All areas from which topsoil is to be secured shall be cleaned of all brush, sticks, weeds, stones, bricks, ashes, and other refuse which may hinder or prevent growth.

732.05 Approval of Materials. In securing topsoil from an approved source, should strata or seams of materials be encountered which do not qualify as topsoil, such materials shall be removed from the topsoil or, if required, the source shall be abandoned.

732.06 Placing. Before placing or depositing topsoil upon any section as shown on the Plans, the foundation upon which the topsoil is to be placed shall be approved.

Topsoil shall be spread on these areas to a depth sufficiently greater than that specified on the Plans, so that after natural settlement has taken place the work shall conform to the elevations on the Plans.

732.07 Maintaining the Topsoil. The Contractor shall maintain the topsoil until final completion and acceptance of the Contract. Maintenance shall consist of preserving, protecting, replacing, and such other work as may be necessary to keep the topsoil in a satisfactory condition.

732.08 Final Cleaning. Upon the completion of this work, final cleaning shall be done within the limits of the Project and shall consist of completely cleaning the Project of excess material, sweeping pavements and structures of dirt and rubbish, and removing of any unused material which may mar the appearance of the Project.

732.09 Method of Measurement. The quantity of topsoil will be measured as the number of square yards (square meters) of topsoil furnished, placed, and accepted only in the areas shown on the Plans or where directed. Measurements will be made along the surfaces of the completed topsoiled areas.

732.10 Basis of Payment. The quantity of topsoil will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for preparing the grade; for furnishing, hauling, and placing all materials, including necessary quantities of lime; for maintaining topsoil; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 733 – TOPSOILING

733.01 Description. This work consists of refertilizing and placing the topsoil which has been salvaged and stockpiled under Section 202.

733.02 Materials. Topsoil shall be stockpiled and salvaged under Section 202.

733.03 Construction Methods. The placement of topsoil shall conform to the requirements of Section 732. After placement, the Contractor shall refertilize the topsoil in accordance with Subsection 734.03 (a) and (b)(1). Refertilization shall occur a minimum of six months after the initial seeding.

733.04 Method of Measurement. The quantity of topsoiling will be measured as the number of square yards (square meters) of topsoil placed and accepted only in the areas shown on the Plans or where directed. Measurements will be made along the surfaces of the completed topsoiling areas.

733.05 Basis of Payment. The quantity of topsoiling will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for preparing the grade; for hauling and placing all topsoil salvaged under Section 202; for maintaining topsoil; and for all labor, equipment, tools, and incidentals required to complete the work.

Refertilization will be incidental to the work in this Section.

SECTION 734 – SEEDING

734.01 Description. This work consists of furnishing and placing seed and soil supplements.

MATERIALS.

734.02 Water. Water shall conform to the requirements of Section 803.

734.03 Soil Supplements.

(a) Limestone shall be ground agricultural limestone and shall contain not less than 85% calcium and magnesium carbonates. Dolomitic lime or magnesium lime shall contain at least 10% magnesium oxide. The limestone shall be ground to meet the following gradation:

Sieve Size	*Percent Passing*
No. 10 (2.00 mm)	100
No. 20 (850 µm)	90
No. 100 (150 µm)	50

(b) Fertilizer shall conform to the following mix requirements:

(1) *Permanent Grass Seeding - Dry Ground, Wet Ground, and Subdivisions; and Temporary Grass Seeding - Dry Ground.*

a. 70 lb/ac (78 kg/ha) nitrogen (N); 50% by weight of the nitrogen content shall be available from ureaformaldehyde.

b. 42 lb/ac (47 kg/ha) available phosphate; phosphorous pentoxide (P_2O_5**)** shall be the sum of the water soluble and the citrato-soluble phosphate.

c. 28 lb/ac (31 kg/ha) water soluble potash; potassium oxide (K_2O)

(2) *Permanent Crown Vetch Seeding.*

a. 152 lb/ac (170 kg/ha) nitrogen (N), 100% by weight of the nitrogen content shall be available from ureaformaldehyde.

b. 100 lb/ac (112 kg/ha) available phosphate; phosphorous pentoxide (P_2O_5) shall be the sum of the water soluble and the citrato-soluble phosphate.

c. 100 lb/ac (112 kg/ha) water soluble potash; potassium oxide (K_2O)

(c) Commercial fertilizer shall be furnished in containers plainly marked with the chemical analysis of the product or, if provided in bulk, a certificate guaranteeing the fertilizer analysis must

accompany each delivery to the Project. No fertilizer shall be used which has not been marketed in accordance with the State and Federal laws.

(d) The ureaformaldehyde specified above shall meet the following requirements:

(1) The water insoluble nitrogen shall be at least 60% of the total nitrogen.

(2) The activity index of the water insoluble nitrogen shall be either:

a. not less than 40% by the Association of Official Analytical Chemists International (AOAC International) method for ureaformaldehyde products, or

b. not less than 50% by the AOAC International alkaline permanganate method, or

c. 80% by the AOAC International neutral permanganate method.

(e) Wood cellulose fiber shall be a processed wood product having uniform fiber characteristics which remains in uniform suspension in water under agitation and blends with seed, fertilizer, and other additives to form a homogeneous slurry.

The fiber shall perform satisfactorily in hydraulic seeding equipment without clogging or damaging the system. The slurry shall contain a green dye that provides easy visual inspection for uniformity of application.

734.04 Grass and Agricultural Seeds.

(a) *Seeds.* All seed shall be fresh, clean, from new crop seed, and delivered to the site in original unopened packages in accordance with the Delaware Code and respective State laws.

(b) *Seed Inspection.*

(1) Blended seed lots shall be mixed in the presence of an authorized representative of the Department. All such blended seed shall also display an official Department's inspection tag which has been sewn into or otherwise attached to the bag.

No seed shall be used after the expiration date placed on the official Department's inspection tag by an authorized representative of the Department.

(2) With all single seed lots, the Contractor shall furnish to the Project inspector two copies of the certified mill analysis for the seed to be used. The Project inspector will compare the mill analysis with the mill tags sewn into the bags of seed for lot number, guaranteed analysis, and certification date.

If the mill tags and mill analysis data are identical and meet the Project requirements, single seed lots can be used on the basis of verification by the Project inspector.

If the entire bag of a single seed lot is not used, the weight of the seed used from the bag shall be so noted on the mill tag which shall be left intact on the bag. In addition, the Project inspector will also include the Contract number of the Project and the date on which the seed was used, and so verify the above with its signature on the mill tag. Partial bags which have the above information noted on the mill tag will be accepted for use on Department projects.

No seed shall be used which has a dated mill analysis or mill tag older than nine months.

(c) *Permanent and Temporary Seeding.* The Seeding Chart on the following pages shall be used for the following specified seeding:

Permanent Grass Seeding - Dry Ground,
Permanent Crown Vetch Seeding,
Permanent Grass Seeding - Wet Ground,
Permanent Grass Seeding - Subdivisions,
Temporary Grass Seeding - Dry Ground, and

Temporary Grass Seeding - Wet Ground.

Seeding Chart					***Modification Factors for Seeding Rate pounds per acre (kilograms per hectare)***			***Modification Factors for Seeding Periods***	
Species	*Max. % Weed Seeds* [7]	*Min. % Purity*	*Min. % Germination*	*Seeding Rate lb/ac (kg/ha)*	*Seeding Period A (2/16 to 4/15)*	*Seeding Period B (4/16 to 8/15)*	*Seeding Period C (8/16 to 2/15)*	*North District*	*Central and South Districts*
Permanent Grass Seeding - Dry Ground									
Hard Fescue blend [2] (Festuca trachyphylla) Perennial Ryegrass (Lolium perenne)	0.15 0.15	98 98	85 90	100 (113.0) 10 (12.0)	Add 5 lb/ac (6.0 kg/ha) Redtop (Agrostis alba) + 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 2/16 to 3/1	Add 4 lb/ac (5.0 kg/ha) Korean or Kobe Lespedeza (Lespedeza stipulacea)	Add 5 lb/ac (6.0 kg/ha) Redtop (Agrostis alba) + 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 10/15 to 2/15		Add 3 lb/ac (4.0 kg/ha) Weeping Lovegrass (Eragrostis curvula) during Seeding Period B [8]
Total Seed Quantity lb/ac (kg/ha)				**110 (125.0)**	**180 (204.0)**	**114 (130.0)**	**180 (204.0)**		**117 (134.0)**
Permanent Crown Vetch Seeding									
Crown Vetch (Coronilla varia) variety: Penngift Annual Ryegrass (Lolium multiflorum)	0.35 0.15	99 95	70 [3] 90	30 (34.0) 22 (25.0)	Add 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 2/16 to 3/1	Add 4 lb/ac (5.0 kg/ha) Korean or Kobe Lespedeza (Lespedeza stipulacea)	Add 5 lb/ac (6.0 kg/ha) Redtop (Agrostis alba) + 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 10/15 to 2/15		
Total Seed Quantity lb/ac (kg/ha)				**52 (59.0)**	**117 (132.0)**	**56 (64.0)**	**122 (138.0)**		
Permanent Grass Seeding - Wet Ground [4]									
Redtop (Agrostis alba) Creeping Bentgrass (Agrostis palustris) Sheep Fescue [5] (Festuca ovina) Rough Stalked Bluegrass (Poa trivialis)	0.75 0.75 0.50 0.50	95 98 98 98	90 90 85 80	40 (45.0) 25 (28.0) 35 (40.0) 25 (28.0)	Add 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 2/16 to 3/1		Add 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 10/15 to 2/15		
Total Seed Quantity lb/ac (kg/ha)				**125 (141.0)**	**190 (214.0)**		**190 (214.0)**		
Permanent Grass Seeding - Subdivisions									
Hard Fescue blend [2] (Festuca trachyphylla) Perennial Ryegrass (Lolium perenne)	0.15 0.15	98 98	85 90	100 (113.0) 10 (12.0)				Add 50 lb/ac (56.0 kg/ha) Kentucky Bluegrass (Poa pratensis) during Seeding Periods A [1], B [1], and C [1]	
Total Seed Quantity lb/ac (kg/ha)				**110 (125.0)**				**160 (181.0)**	

Seeding Chart					Modification Factors for Seeding Rate pounds per acre (kilograms per hectare)			Modification Factors for Seeding Periods	
Species	*Max. % Weed Seeds* [7]	*Min. % Purity*	*Min. % Germination*	*Seeding Rate lb/ac (kg/ha)*	*Seeding Period A (2/16 to 4/15)*	*Seeding Period B (4/16 to 8/15)*	*Seeding Period C (8/16 to 2/15)*	*North District*	*Central and South Districts*
Temporary Grass Seeding - Dry Ground									
Annual Ryegrass (Lolium multiflorum)	0.15	95	90	40 (45.0)	Add 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 2/16 to 3/1		Add 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 10/15 to 2/15		
Total Seed Quantity lb/ac (kg/ha)				**40 (45.0)**	**105 (118.0)**		**105 (118.0)**		
Temporary Grass Seeding - Wet Ground [6]									
Annual Barnyard grass/ Duck Millet (Echinocloa spp.)	1.00	90	90	40 (45.0)	Add 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 2/16 to 3/1		Add 65 lb/ac (73.0 kg/ha) Winter Rye (Secale cereale) from 10/15 to 2/15		
Total Seed Quantity lb/ac (kg/ha)				**40 (45.0)**	**105 (118.0)**		**105 (118.0)**		

Seeding Chart Notes

1 The seed shall be a blend of certified Bluegrass varieties with no one variety representing more than 25% by weight of the total, at least one variety must be a Mid-Atlantic ecotype.

2 Combination of improved certified varieties with SR-3000 representing a minimum of 50% by weight of the total.

3 Germination shall include a total of 60% minimum quick germination or normal sprouts plus a minimum of 20% hard seed.

4 *Permanent Seeding - Wet Ground* should be used on saturated or seasonally flooded areas as dictated by defined wetland limits on the Plans.

5 Festuca ovina shall be an improved variety of Sheep Fescue as approved by the Department. Selection should be based on performance within the Mid-Atlantic region as determined by the most current National Turfgrass Evaluation Program Progress Report.

6 Wet, bare ground, leaf litter covered or partially vegetated retention ponds, traps, or basins, or all intermittently flooded sites in general may be seeded with *Temporary Seeding - Wet Ground*. No wood fiber mulch shall be added to the hydroseeder. In addition, no mulching item should be included with this seeding. Unless indicated on the Plans, Echinocloa spp. is equivalent to E. muricata, E. crusgalli, or E. walteri. No fertilizer or limestone shall be applied with this seeding.

7 No Johnsongrass seed (Sorghum halapense) or Canada Thistle (Cirsium arvense) shall be allowed under the maximum allowable percentage of weed seeds and in accordance with Section 1, Chapter 24, Title 3 of the Delaware Code.

8 Add 3 lb/ac (4.0 kg/ha) Weeping Lovegrass on all slopes 1:3 (vertical to horizontal) or steeper and greater than 10″ (250 mm) vertically in height throughout the Central and South Districts during all seeding periods to *Permanent Grass Seeding - Dry Ground*, *Permanent Crown Vetch Seeding*, and *Permanent Grass Seeding - Wet Ground*.

734.05 Seed Inoculant. The inoculant for *Permanent Crown Vetch Seeding* shall be a pure culture of nitrogen fixing bacteria selected for maximum vitality and for the ability to transform nitrogen from the air into soluble nitrates and deposit them in the soil. Inoculant shall consist of purely bred cultures and shall not be used later than the date indicted on the container. Four times the normal amount of

inoculant as indicated on the packaging shall be used for wet application. The inoculant shall be kept as cool as possible until used. Since temperatures above 75 to 80 °F (24 to 27 °C) weaken the bacteria, the Contractor shall take every precaution possible while handling the inoculant.

CONSTRUCTION METHODS.

734.06 General. This work shall consist of preparing the ground and furnishing and placing all lime, fertilizer, and seed on the areas indicated on the Plans and as specified by the Engineer. This work shall include, in addition to the lime, fertilizer, and seed, the specified quantity of inoculant and mulch required in the seeding slurry when placing crown vetch. The Engineer reserves the right to stop seeding operations whenever conditions are determined to be unfavorable. All materials used on this Contract shall be obtained by the Contractor from a dealer or manufacturer whose product is shown by analysis to fulfill the guarantee claimed by the producers.

Permanent Seeding - Wet Ground and *Temporary Grass Seeding - Wet Ground*, where specified for dry application by the kilogram, shall be seeded through a hand spinner type spreader. Areas specified for this method of application shall be remote sites not otherwise accessible with wet application equipment.

734.07 Seeding Slopes Flatter than 1:3 (vertical to horizontal).

(a) *General.* All topsoil placement and grading where specified shall be completed before seeding. This shall apply to the following specified seeding:

Permanent Grass Seeding - Dry Ground,
Permanent Grass Seeding - Wet Ground,
*Permanent Grass Seeding - Subdivision*s,
Temporary Grass Seeding - Dry Ground, and
Temporary Grass Seeding - Wet Ground.

(b) *Seedbed Preparation for Dry Ground Areas with Topsoil.* The area to be seeded shall be thoroughly loosened to a depth of not less than 6″ (150 mm). The topsoil shall be original surface friable loam topsoil conforming to Section 732. The topsoil shall be of uniform quality, free from gravel and stones retained on a 2″ (50 mm) sieve, heavy clay, frozen clods, lumps, roots, sticks, and foreign materials harmful to plant growth, such as 2″ (50 mm) or larger fragments of hot-mix, concrete, and surface treatment. If shaped to the prescribed grade, the seedbed shall be considered satisfactory and shall require no further work.

However, when the area to be seeded is partially sodded, barren, weedy, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily removed, and the soil shall then be scarified or otherwise loosened to a depth of not less than 6″ (150 mm). Clods and lumps shall be broken. Rubbish, rocks, fragments 2″ (50 mm) or larger of hot-mix, concrete, surface treatment, and other extraneous matter shall be removed clear of the seeding site.

No seedbed preparation will be required for *Permanent Grass Seeding - Wet Ground*, *Temporary Grass Seeding - Wet Ground*, or *Temporary Grass Seeding - Dry Ground*.

(c) *Quantities of Material.* The quantity of limestone as specified according to Subsection 734.03 (a) shall be applied at the rate of 3000 lb/ac (3400 kg/ha). Fertilizer, wood cellulose fiber, and other required seeding agents shall be applied in accordance with Subsection 734.03.

The quantity of seed applied shall be in accordance with the Seeding Chart under Subsection 734.04.

(d) *Application Equipment.* All wet application equipment shall have a tank equipped with an agitation system capable of keeping all of the solids in a state of complete suspension at all times

during the seeding operation. All dry application equipment to include drop or hopper type spinner spreaders and drills shall require that all seed be blended by the seed supplier and so certified prior to dumping or loading to reduce seed segregation.

(e) *Wet Application of Lime, Fertilizer, Wood Cellulose Fiber, Seed, Inoculant, and Any Coloring or Binding Agents.* The Contractor shall apply all ingredients specified for the seeding operations described in Subsection 734.07 (a) according to both manufacturer's equipment and material specifications and as set forth according to individual seeding requirements as specified under Subsection 734.03.

Permanent Grass Seeding - Dry Ground shall be used in accordance with this Section on all areas not delineated or defined as wetlands that are flatter than 1:3 (vertical to horizontal) in grade and on areas behind guardrail to the top or breakpoint of slope. The only exception shall apply to slopes 1:3 (vertical to horizontal) or steeper in urban areas as described under Subsection 734.08. In these areas, topsoil shall be required at a depth of 6″ (150 mm) in accordance with Sections 732 and 733 respectively.

Permanent Grass Seeding - Wet Ground shall be used in accordance with this Section on all areas delineated or defined as wetland on the Plans with the exception of dry fill such as stormwater pond embankments and dikes or regraded areas comprised of fill above the original wetland profile. Areas stripped under Section 202 and specified for *Permanent Grass Seeding - Wet Ground* shall be covered with 6″ (150 mm) of topsoil in accordance with Section 733. Permanent dry fill areas above the original wetland profile, as described above, shall be seeded under *Permanent Grass Seeding - Dry Ground*.

In stormwater management ponds with permanent pools *Permanent Grass Seeding - Wet Ground* shall be used on the slope between the permanent pool water level and the contour line 2′ (0.6 m) above the water level. In ponds without permanent pools, this seeding mix shall be applied from the pond bottom to the elevation reached during flood routing 1″ (25 mm) of runoff (water quality extended detention).

Permanent Grass Seeding - Subdivisions shall be used in accordance with this Section on all areas defined as legal subdivisions or residential communities where maintenance is provided by the Department from curb to curb only or is limited to the raveled way and shoulders. Areas specified for *Permanent Grass Seeding - Subdivisions* shall be topsoiled with 6″ (150 mm) of approved topsoil in accordance with Section 732.

Temporary Grass Seeding - Dry Ground shall be used in accordance with Subsection 734.03 on all areas that represent dry ground areas disturbed during actual construction and/or prior to the establishment of permanent grades as determined by the Engineer in the field.

Temporary Grass Seeding - Wet Ground shall be used on wet, bare ground, leaf litter covered or partially vegetated retention ponds, traps, basins, and all intermittently flooded areas during construction.

(f) *Dry Application of Lime, Fertilizer, and Seed.* Only the ingredients described shall be applied by dry application. All lime, fertilizer, and seed shall be applied each as a separate operation when using dry methods of application. Dry application of lime, fertilizer, and seed shall apply to all forms of seeding described under Subsection 734.07 (e).

(g) *Responsibility for Seeded Areas.* The Contractor shall perform all seeding and mulching in accordance with this Section in the presence of the Engineer. If all work as noted is performed in complete accordance with this Section to the satisfaction of the Engineer, all seeding and mulching so approved shall be accepted.

The Department retains the right to request that the Contractor reseed any and all areas where a satisfactory stand of grass or crown vetch or both as determined by the Engineer does not exist at the time of the final inspection.

If the Engineer determines that reseeding is necessary, the Contractor shall begin reseeding within five working days of an oral or written request from the Engineer.

734.08 Seeding Slopes 1:3 (vertical to horizontal) or Steeper.

(a) *General.* For slopes 1:3 (vertical to horizontal) or steeper, the following specified seeding shall be used:

Permanent Crown Vetch Seeding,
Permanent Grass Seeding - Dry Ground, and
Temporary Grass Seeding - Dry Ground

(b) *Seedbed Preparation.* All slopes shall be tilled and scarified across the slope, or tracked to prevent gully and sheet erosion to the satisfaction of the Engineer.

(c) *Quantities of Material.* The quantity of limestone as specified according to Subsection 734.03 (a) shall be applied at the rate of 3000 lb/ac (3400 kg/ha) for all seeding except *Permanent Crown Vetch Seeding* which shall be applied at a rate of 55 lb/ac (60 kg/ha). Fertilizer, wood cellulose fiber, and other required seeding agents shall be applied in accordance with Subsection 734.03. Refertilization and liming when specified for use shall be applied in accordance with Subsection 734.03 (a) and (b)(1).

The quantity of seed applied shall be in accordance with the Seeding Chart under Subsection 734.04.

(d) *Application Equipment.* All wet application equipment shall have a tank equipped with an agitation system capable of keeping all of the solids in a state of complete suspension at all times during the seeding operation. All dry application equipment to include drop or hopper type spinner spreaders and drills shall require that all seed be blended by the seed supplier and so certified prior to dumping or loading to reduce seed segregation.

(e) *Wet Application of Lime, Fertilizer, Wood Cellulose Fiber, Seed, Inoculant, and Any Coloring or Bindings Agents.* The Contractor shall apply all ingredients specified for the seeding operations described in Subsection 734.08 (a) according to both manufacturer's equipment and materials specifications and as set forth according to individual seeding requirements as specified under Subsection 734.03.

Permanent Crown Vetch Seeding shall be used in accordance with this Section on all slopes 1:3 (vertical to horizontal) or steeper such as fill embankments or berms that are not mowable. Areas specified for crown vetch shall not be topsoiled. Landlocked or isolated small areas such as guardrail end terminal slopes shall be seeded with crown vetch rather than other normally specified seeding to facilitate maintenance.

The only exception shall apply to slopes 1:3 (vertical to horizontal) or steeper in urban areas, where at the designer's discretion, *Permanent Grass Seeding - Dry Ground* may be selected in lieu of *Permanent Crown Vetch Seeding*. In these areas, topsoil shall be placed at a depth of 6″ (150 mm) in accordance with Section 732 or 733 respectively.

(f) *Dry Application of Lime, Fertilizer, and Seed.* Only the ingredients described shall be applied by dry application. All lime, fertilizer, and grass seed shall be applied each as a separate operation when using dry methods of application. Dry application of lime, fertilizer, and grass seed shall apply to all forms of seeding described under Subsection 734.07 (e).

All lime, fertilizer and crown vetch seed shall be applied each as a separate operation when using dry methods of application. Inoculant shall be pre-mixed with the crown vetch seed

at triple the normal rate of inoculant in the presence of the Project inspector. The inoculant and crown vetch seed must be mixed with an approved wetting or bonding agent.

(g) *Responsibility for Seeded Areas.* The responsibilities for seeded areas shall conform to the requirements of Subsection 734.07 (g).

734.09 Method of Measurement. The quantity of refertilization and the type of seeding will be measured in square yards (square meters) of surface area.

Exceptions to this are *Permanent Grass Seeding - Wet Ground* and *Temporary Grass Seeding - Wet Ground* when specified for dry application. For these exceptions, the quantity will be measured in total number of pounds (kilograms) of grass seed.

Where units are expressed in total square yards (square meters), the quantity will be measured along the ground surface of seeded areas.

734.10 Basis of Payment. The quantity of refertilization and the type of seeding will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for preparing the ground; for furnishing and placing all materials; and for all labor, equipment, tools, and incidentals required to complete the work.

Exceptions to this are *Permanent Grass Seeding - Wet Ground* and *Temporary Grass Seeding - Wet Ground* when bid by the pound (kilogram). For these exceptions, price and payment will constitute full compensation for furnishing and placing all materials and for all labor, equipment, tools, and incidentals required to complete the work.

Payment for any and all reseeding of areas, where a satisfactory stand of grass or crown vetch, or both, as determined by the Engineer does not exist at the time of final inspection, will be made at the Contract unit price for seeding and mulching. If the Contractor fails to respond within five working days of the Engineer′s oral or written request, no payment for such reseeding will be made.

SECTION 735 – MULCHING

735.01 Description. This work consists of furnishing, placing, and anchoring mulch over seeded areas.

735.02 Materials.

Small Grain Straw. Straw for mulching shall be from oats, wheat, rye, or other approved grain crops that are free from noxious weeds, mold, or other objectionable material. Straw mulch shall be in an air-dry condition and shall be suitable for placing with an approved mechanical blower.

735.03 Construction Methods.

Small Grain Straw. Straw mulching shall be used on all slopes flatter than 1:3 (vertical to horizontal) with the exception of slopes or sites not accessible to tracking or crimping tools and equipment. In these situations, straw-coconut fiber blankets or bonded fiber matrix shall be used.

Small grain straw shall be uniformly and evenly applied immediately after seeding has been completed.

An approved mechanical blower shall be used to apply the straw. Straw mulch applied by blowers shall provide a loose depth of not less than 1/2 nor more than 2″ (13 nor more than 50 mm). Ninety-five percent of the blown and shredded straw mulch shall be 6″ (150 mm) or more in length when in place.

Straw mulch shall be applied at the rate of 4000 lb/ac (4500 kg/ha) and secured by one of the following methods:

(1) *Crimping Method.* This method of incorporating the straw into the ground shall be accomplished with the use of crimping device that produces horizontally oriented indentation. Straw mulch shall be incorporated into the soil to a minimum depth of 2″ (50 mm). The crimping device shall be approved by the Engineer.

(2) *Tracking Method.* This method may be used on all sites mulched with straw and shall involve the use of steel-cleat track-type equipment driving up and down the slopes producing horizontally oriented indentations with the cleats. Cleats shall be capable of incorporating the straw mulch into the soil to a minimum depth of 1½″ (40 mm). The equipment used and the method of tracking shall be approved by the Engineer.

735.04 Method of Measurement. The quantity of mulching will be measured in square yards (square meters) of actual surface mulched along the surface of the treated area.

735.05 Basis of Payment. The quantity of mulching will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for furnishing and placing all materials; for all methods of securement; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 736 – SODDING

736.01 Description. This work consists of preparing the ground area, and furnishing and placing approved sod.

MATERIALS.

736.02 Sod. Sod shall be well rooted from high quality seed of known origin and native to the locality of the work. The Department reserves the right to visit the proposed sod source prior to the granting of a source approval. Sod shall be stripped, delivered, and laid within a period of 36 hours. Sod stripped and delivered but not laid within this period shall be reinspected and approved by the Engineer prior to use.

If Fine Fescue-Bluegrass sod is used, it shall contain the following percentages by weight in the blend:

Creeping Red Fescue (Festuca rubra L. subsp. Rubra)	10%
Chewing Fescue (Festuca rubra L. subsp. commutata Gavd.)	20%
Hard Fescue (Festuca longifolia Thuill.)	55%
Kentucky Bluegrass (Poa pratensis L.)	15%

The varietal makeup of the Fine Fescue-Bluegrass sod must be submitted to the Engineer for approval prior to the actual cutting and lifting of the sod.

Sod shall be free of objectionable grassy and broadleaf weeds. Sod shall be considered free of such weeds if less than five such plants are found per 100 ft² (10 m^2) of area. Sod shall not be acceptable of it contains any of the following weeds: common bermudagrass (wiregrass), quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canadian thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, or bromegrass.

Sod shall be reasonably free of thatch, diseases, nematodes, and soil-borne insects. All sod must display the official State Certification tags of the state from which the sod originated. The same shall apply to all sod shipped intra-state with prior inspection and tagging through the Delaware State Department of Agriculture.

736.03 Water. Water shall conform to the requirements of Section 803.

CONSTRUCTION METHODS.

736.04 Cutting Sod. Before stripping, sod shall be mowed uniformly at a height of 1 to 2½″ (25 to 65 mm). Sod shall be machine cut at a uniform soil thickness of 5/8 ± ¼″ (16 ± 6 mm), at the time of cutting. Measurement for thickness shall exclude top growth and thatch. The sod pad size shall be cut to a minimum uniform width of 12″ (300 mm) and a minimum length of 12″ (300 mm).

736.05 Placing. Sod shall be placed only when the soil is moist and favorable to growth. Sod shall not be placed between November 1 and April 1, unless weather and soil conditions are considered favorable and permission is granted.

736.06 Preparation of Grade. The area to be sodded shall be shaped and finished to the lines and grades indicated on the Plans, and the surface loosened prior to placing the sod. The Contractor shall water the slope before the sod is placed.

736.07 Laying the Sod. The sod shall be placed on the prepared surface with the edges in close contact. Each strip or section of sod shall be fitted and tamped into place with hand tampers of not less than 100 in² (64 000 mm²) in area.

After slopes of either cuts or fills have been shaped to conform to the finished grade and cross-section shown on the Plans, the shoulders and toes of the slope shall be rounded off to a 5′ (1.5 m) radius, or as otherwise indicated in the Plans.

On all slopes, sod shall be laid with the long edges parallel to the contour starting at the bottom of the slope. Successive strips shall be neatly matched, and all joints staggered or broken. When placing sod in drainage ditches, the length of the strip shall be laid parallel to the direction of the flow of the water. Where the sod may be displaced during sodding operations, the workers, when replacing it, shall work from ladders or treated planks to prevent further displacement.

Each strip or section of sod placed on slopes 1:2 (vertical to horizontal) and steeper, and surface drainage V-shaped or flat bottom ditches or gutters, shall be staked securely with at least two stakes or pins spaced not more than 24″ (600 mm) apart with the flat side against the slope. Stakes shall either be wood wedges or T-shaped wire pins. Wood wedges shall be ½ by 1 by 6″ (13 by 25 by 150 mm) to ½ by 1 by 12″ (13 by 25 by 300 mm), as required by soil conditions, and driven so that the last 1″ (25 mm) remains above the top of the sod. T-shaped wire pins shall be machine bent from 15″ (380 mm) pieces of 8 gage (4.1 mm) low carbon bright steel with a 8″ (200 mm) leg, a 4″ (100 mm) head, and a 1″ (25 mm) secondary drive and driven flush with the top of the sod.

When sodding adjacent to a sidewalk, curb, pavement, or retaining walls, sufficient allowance shall be made in grading for the thickness of the sod, so that when placed, the sod shall be flush with the tops of such structures. The sod shall be tamped to ensure tight joints and a smooth level surface. As the top of the slope is reached, the sod shall be trimmed to a line placed at a fixed distance from the break of the bank and along the entire length of the cut or fill. The top of the bank shall have been

previously graded, so that the sod, when applied, comes flush with the average level of the top of the bank. All surfaces shall be uniform in appearance and reasonably true to line and grade.

The Contractor shall water the sod immediately after placement to a depth sufficient so that the underside of the new sod pads and soil immediately below the sod are thoroughly wet. The sod shall be kept moist until growth is established. All sod in which shrinking, burning, or turning brown occurs shall be rejected, removed, and replaced.

A satisfactory stand of grass from sod, as determined by the Engineer, shall be required. To be acceptable, a stand of grass from sod must display an even flush of growth and show evidence of soil surface contact, minimal undermining, and minimal erosion.

736.08 Method of Measurement. The quantity of sodding will be measured in square yards (square meters) along the surface of the area of sod placed and accepted.

736.09 Basis of Payment. The quantity of sodding will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for furnishing all materials, including sod; for grading, rounding the shoulders and toes of slopes, hauling, laying, and tamping; for all watering until final acceptance; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 737 – PLANTING

737.01 Description. This work consists of furnishing and planting specified plants, shrubs, and trees and the replacement and cultural care of the material.

MATERIALS.

737.02 Plant Material.

(a) *Quality.* All plants shall be true to type and nomenclature and typical of their species or variety. They shall have a normal habit of growth with well-developed branch systems and vigorous root systems. They shall be sound, healthy, and vigorous plants, free from defects, disfiguration, injury, disease of any kind, insect eggs, borers, and any infestation. All plants shall be nursery grown. They shall have been growing under similar climatic conditions to those of the locality of the Project for at least two years prior to planting. All plant material shall have been grown in a soil that is similar to this area and shall not have been grown in a muck type soil or other foreign type. It shall be the responsibility of the Contractor to inspect the plants before removal from the nursery where they have been grown to make sure that the plants meet these requirements. All plants shall be freshly dug, and no heeled-in or cold storage plants will be accepted, with the exception of plant material delivered prior to planting as outlined in Subsection 737.14.

(b) *Measurements.* All plants shall conform to all sizes and measurements specified in the Plant List. Plants that conform to the requirements specified in the Plant List but do not have a normal balance between height and spread will not be accepted. Where any requirement or exact measurement is omitted, the plants furnished shall be normal for the species and variety as listed in AAN′s "USA Standards for Nursery Stock". Plants for use where symmetry is required shall be matched as close as possible. All plants shall be measured for height and spread with the branches in their normal position. The diameter of all trees shall be taken 6″ (150 mm) above

the ground level for up to and including 4″ (100 mm) diameter sizes, and 12″ (300 mm) above the ground level for larger sizes. The height of the branches on the tree trunks need not be as specified if the required height can be obtained by pruning the lower branches without leaving unsightly scars and damaging the trunk. No pruning of branches for this effect shall be done before delivery to the site unless approved.

Plants larger in size than specified may be used. Larger plants, when selected for use over that which is specified, shall be dug with an earth ball or root spread proportionate to the increased size.

With plants smaller than specified, credit shall be offered to the Department for approval. The basis of a credit shall be the average wholesale value based on the difference between the specified size and the next smaller size. The average wholesale value shall be substantiated with written submissions in accordance with Subsection 737.02 (e).

(c) *Inspection.* The Contractor shall be responsible for all certificates of inspection of plant materials that may be required by Federal, State, or other authorities to accompany shipment of plants.

The Contractor shall furnish complete information as to the location of all plants which it intends to supply and use. The right is reserved to inspect, tag, and approve all plants at the source of supply. This inspection and tagging shall not in any way eliminate the right of rejection at the site. All plants must be inspected and approved before they are planted. Any plants placed without prior inspection at the site will be rejected at the discretion of the Engineer.

The Contractor shall furnish a complete listing of the locations and the quantities of each species at each location for all plant species it intends to use on the Project. Plant materials shall be protected according to best horticultural practice while in transit in such a way as to prevent the drying or possible desiccation of plant tissue. All plant material arriving at the site with broken or loose balls, or dry or insufficiently developed roots, and plants which are weak or thin, damaged or defective, or which do not comply with the specifications, will not be accepted. The Engineer reserves the right to reject all stock that is found to be unsatisfactory. All plant material determined as unsatisfactory by the Engineer shall not be planted under any circumstances and shall be removed from the Project site by the close of the working day. Failure on the part of the Contractor to comply with any of the above procedures will require an immediate suspension of all work.

(d) *Nomenclature.* Plants shall conform to the nomenclature of "Standard Plant Names" as accepted by the American Joint Commission of Horticulture Nomenclature, 1942 Edition. Names of varieties not included shall conform to names accepted in nursery trade. Size and grading shall conform to those listed in AAN's "USA Standards for Nursery Stock". No substitution will be permitted except by written permission of the Engineer.

(e) *Availability.* The Engineer, after receiving written request from the Contractor for substitution, will verify and establish the non-availability of the specified plant and size to this satisfaction. Upon determining that a substitution is justified, the Contractor will be directed to provide certification in the form of five letters from five independent growers who list the specified plant form in their most current catalog, stating that the item in question is not available as specified.

(f) *Experience.* Under Special Condition No. 22 of the U.S. Army Corps of Engineers 404 Permit, it is stipulated that:

> *The mitigation and post-planting monitoring plans shall be developed and implemented by a firm with demonstrated expertise in wetland creation activities.*

Therefore, the firm that does the actual planting and seeding of the mitigation site shall possess a record of successful wetland woody and wetland herbaceous and seeding programs that

have received final approval by the U.S. Army Corps of Engineers, or have on-site staff personnel who have managed successful wetland woody and herbaceous planting and seeding programs that have received final approval by the U.S. Army Corps of Engineers. At the request of the Department, information indicating compliance with this "Special Condition" shall be forwarded within 14 days.

737.03 Trees. Trees shall have straight trunks according to their habit of growth and shall be well branched and rooted. Shade trees of standard variety shall have a single leader and shall be branched at 6 to 8′ (1.8 to 2.4 m) height unless otherwise directed.

737.04 Shrubs. Shrubs shall be well branched, with full and compact growth and have ample well branched root systems capable of sustaining vigorous plant growth.

There are two categorizes of wetland shrubs:

(a) *Wetland Grown Containerized Shrubs.* All shrubs shall be wet grown plants. These plants shall been grown in permanently saturated soils for a minimum of one full growing season prior to the planting of the material. The stock shall not be grown in soilless mixes. The nursery providing these materials shall certify in writing that these plants have been grown in permanently saturated soils for a minimum of one full growing season.

All container shrubs shall be healthy, vigorous, well rooted, and established in the container in which they are grown. They shall have tops of good quality and in a healthy growing condition. There shall be a minimum of two healthy vigorous canes per shrub. The container grown stock shall have been grown in the container long enough to allow for new fibrous roots to have developed so that the root mass retains its shape and holds together when removed from the container.

(b) *Wetland Shrub Cuttings.* Cuttings shall be fresh 24″ (600 mm) long stems of woody plants. Each cutting shall have a living terminal bud (end bud). Prior to installation, the cutting shall be kept cool and moist to prevent desiccation of the material. Degraded, rotting, or dried out material will not be accepted.

737.05 Ground Cover, Herbaceous Perennial, and Wildflowers. Ground cover shall be one year old, container grown plants, unless otherwise approved or specified in the Contract documents and shall have been growing for at least six months in the size specified as verified by the Department′s inspection representative.

Herbaceous perennial shall be six months old, container grown plants and shall have been growing for at least three months in the size specified as verified by the Department′s inspection representative.

Wildflowers shall be native annual, biennial, or perennial forms at least three months old, container grown plants and shall have been growing for at least one and a half months in the size specified as verified by the Department′s inspection representative.

737.06 Topsoil. Planting topsoil shall consist of natural surface soil from well drained areas from which no topsoil has previously been stripped. The topsoil shall be free of subsoil, heavy clay, hard clods, weeds, roots, sticks, toxic substances, or any other extraneous material. The topsoil shall have a pH range of from 5.5 to 6.8 and contain not less than 2% nor more than 10% organic matter. The topsoil shall exhibit the following grading analysis:

Sieve Size	*Minimum Percent Passing*
2″ (50 mm)	100
No. 4 (4.75 mm)	90
No. 10 (2.00 mm)	80

The Contractor shall take the necessary action to ensure that the topsoil meets the sieve analysis, acidity, and organic matter requirements. A certificate of analysis of soil samples shall be provided to the Engineer and approved prior to delivery of topsoil to the Project site.

737.07 Peat Moss and Peat Humus.

(a) *Peat Moss.* Peat moss shall be from sphagnum peat bogs. All peat moss shall be shredded, not dusty, and free of twigs, stones, hard lumps, roots, or any other undesirable materials. All peat moss must be moistened before using, but not watered to a saturated or puddled, unworkable condition. Peat moss shall show an acid reaction of 3.5 to 5.5 pH. The Contractor shall provide written certification from the manufacturer that the peat moss was obtained from sphagnum peat bogs.

(b) *Peat Humus.* Peat humus shall be a natural peat or peat humus from fresh water saturated areas, consisting of sedge, sphagnum, or reed peat and be of such physical condition that it passes through a ½″ (12.5 mm) sieve. The humus shall be free from sticks, stones, roots, and other objectionable materials. Samples taken at the source of supply shall have the following analysis:

Acidity Range . . . . . 4.0 to 7.5 pH
Minimum Water Absorbing Ability . . . . . 200% by weight on oven-dry basis
Minimum Organic Content . . . . . 60% when dried at 221 °F (105 °C)

737.08 Fertilizer. Fertilizer shall be a 20-10-5 analysis or approved equal in accordance with the following minimum guaranteed analysis:

Total Nitrogen (N) 20.00%
Derived from urea-formaldehyde
7.0% water soluble nitrogen
13.0% water insoluble nitrogen
Available Phosphoric Acid (P_2O_5) 10.00%
Derived from calcium phosphate
Soluble Potash (K_2O) 5.00%
Derived from potassium sulfate
Combined Calcium (Ca) 2.60%
Derived from calcium phosphate
Combined Sulfur (S) 1.60%
Derived from ferrous and potassium sulfates
Iron (expressed as elemental Fe) 0.35%
Derived from ferrous sulfate

The fertilizer shall be formulated in tablet form weighing a minimum of 20 g per tablet.

The fertilizer shall conform to all State and Federal regulations. The Engineer will require the Contractor to furnish an affidavit from the vendor or a testing laboratory as to the available nutrients contained therein.

Fertilizer shall be furnished in new, clean, sealed, and properly labeled packages or containers. Fertilizer failing to meet the specified analysis may be used as determined by the Engineer, providing sufficient materials are applied to comply with the specified nutrients per unit of measure.

737.09 Mulch. Mulch shall be either chopped pine bark, licorice root, shredded hardwood bark, wood chips, tan bark, or an approved equal as accepted by the Engineer. All mulching materials will be visually inspected by the Engineer prior to delivery at the planting site and shall conform to the following requirements:

(a) Chopped pine bark shall be freshly prepared so as not to be decomposed or in any condition that may shorten its lifetime as an effective mulch. It shall be free of stones, sticks, weed seeds, pieces of wood, or bark that measure 4″ (100 mm) in their longest dimension and shall not contain any toxic or foreign materials. The mulch shall contain no more than 50% of material passing through a 3/4″ (19.0 mm) sieve.

(b) Licorice root shall be the by-product of the licorice extraction process. It shall be fibrous material free from all foreign and toxic substances.

(c) Tan bark shall be a by-product of the tanning process. It shall be fibrous and free of foreign and toxic substances.

(d) Shredded hardwood bark shall be from a deciduous hardwood source and be mechanically ground to a maximum size of 6″ (150 mm). In addition, the bark shall be relatively free of bark fines dust and shall exclude all foreign and toxic substances.

(e) Wood chips must be stockpiled for at least one year prior to placement as verified by the Department's inspection representative and shall not contain leaves, twigs, wood shavings and sawdust, or any foreign or toxic substances. In addition, fertilizer in accordance with Subsection 737.08 shall be applied at the rate of 0.5 lb/yd² (0.25 kg/m^2) prior to wood chip placement.

Only one of the above mulches will be selected and approved for use throughout the entire Project, and written certification for the above listed requirements of the mulch shall be submitted by the Contractor.

737.10 Stakes, Guys, and Related Materials.

(a) *Guy Wire or Cable.* Guy wire shall be annealed galvanized wire, free of bends or kinks, with a diameter of 14 or 12 gage (2.0 or 2.7 mm). Guy cable shall be ¼″ (6 mm) seven-strand wire rope.

(b) *Turnbuckles.* Turnbuckles shall be galvanized with 4½″ (108 mm) openings and 5/16″ (8 mm) threaded ends with screw eyes. Zinc coating when tested shall conform to the requirements of AASHTO M 232/M 232M specifications for galvanization.

(c) *Tree Stakes.* Tree stakes shall be hardwood stakes at least 2 by 2″ (50 by 50 mm) rough sawed to the length required. The lower half of each stake shall be given a flow coat of 5% pentachlorophenol solution or otherwise treated with an approved material and method. The Contractor shall submit the manufacturer's written certification for any stake treatment and accomplish such work in the presence of the Engineer.

(d) *Rubber Hose.* Rubber hoses shall be new, two-ply rubber (reinforced) hose with an outside diameter of at least 5/8″ (16 mm).

(e) *Wrapping Materials.* Wrapping material shall be clean, new burlap, 7 to 8 oz/yd² (240 to 270 g/m^2), in strips 4 to 6″ (100 to 150 mm) wide, or horticultural approved waterproof wrapping paper 30-30-30 ratings in 4″ (100 mm) strips. The Contractor shall provide in writing the manufacturer's certification for the above-mentioned wrapping material requirements.

(f) *Twine.* The tying material used to secure the tree wrap shall be at least two-ply jute twine.

(g) *Anchors.* Anchors for guy wire shall be malleable iron or aluminum alloy with 3000 lb (13 kN) holding capacity designed to be inserted with a driving rod to a depth specified by the manufacturer. The anchor assembly shall be designed to turn, once located at the proper depth,

at a right angle to the line of force applied. All manufacturer's recommendations shall be followed for installing ground anchors.

(h) *Tree Wound Dressing.* Dressing for treating tree wounds or cuts shall be either:

(1) an approved black paint asphaltum base antiseptic paint;

(2) an approved black paint consisting of Bordeaux Mixture, raw linseed oil, and lamp black; or

(3) an approved black paint consisting of zinc oxide, raw linseed oil, and lamp black.

737.11 Water. All water for watering plants shall conform to the requirements of Section 803.

CONSTRUCTION METHODS.

737.12 Planting Periods. All plant material shall be planted during the following planting period with the exceptions as noted:

Balled or Burlapped and Potted or Container Grown Plant Material:

March 1 to December 1:

(1) All planting of broadleaf evergreens during the fall season shall be completed by November 1.

(2) All bare root material shall be planted between October 15 and May 15.

(3) All material planted from May 30 to August 30 must be treated with an approved antitranspirant in a manner recommended by the manufacturer, and written approval for moving plants within this period must first be obtained from the Engineer.

(4) Wetland shrubs and cuttings shall be installed as dormant materials between October 30 and December 1 or between March 1 and May 1.

The above mentioned period may be extended or reduced according to weather and soil conditions at the time and at the discretion of the Engineer. The Engineer reserves the right to stop planting operations at any time.

The Contractor shall not plant when weather conditions are unfavorable for proper work or when the soil is in a frozen condition.

737.13 Soil Mixture. Soil mixtures for the various plantings shall consist of the following:

(a) *All Plants Except Epricaceous Material.* For each cubic yard (cubic meter) of baled peat moss, or approved equal, add from 43 to 54 yd^3 (43 to 54 m^3) of planting topsoil.

(b) *Epricaceous Plants.* For each cubic yard (cubic meter) of baled peat moss, or approved equal, add from 36 to 45 yd^3 (36 to 45 m^3) of planting topsoil.

If peat humus is furnished in lieu of peat moss in the above mix, the mixture shall be based in the proportion of 1.8 yd^3 (1.8 m^3) of peat humus for each cubic yard (cubic meter) bale of peat moss specified for the above soil mix. Other approved equal materials shall be mixed according to manufacturer's printed recommendations which shall be submitted to the Engineer for written approval.

The above soil mixtures shall be mixed as specified in an area approved by the Engineer. No mix shall be prepared prior to notification of the Engineer at least 48 hours in advance of the mixing operation. Where ground covers or herbaceous perennials are specified, the soil mix may be mixed in place providing the existing topsoil conforms to the requirements of Section 732.

The fertilizer as specified in accordance with Subsection 737.08 shall be placed according to the following requirements:

(a) *Bare Root, Balled or Burlapped, or Container Stock.* Position the plant in the hole, and backfill no higher than halfway up the root ball. Place the recommended number of tablets evenly around the perimeter of and immediately adjacent to the root ball. Complete the backfilling, tamping, and watering.

(b) *Small Ground Cover Plants and Herbaceous Perennials.* Position the plant in the hole, and backfill no higher than halfway up the root ball. Place the recommended number of tablets evenly around the perimeter of and immediately adjacent to the root ball. Complete the backfilling, tamping, and watering.

(c) *Trees.* Use one 20 g tablet for each ½″ (13 mm) of tree trunk diameter based on size specified for planting.

(d) *Shrubs.* Use one 20 g tablet for each 12″ (300 mm) of height or spread based on size specified for planting.

(e) *Ground Cover and Herbaceous Perennials.* Use one 20 g tablet for each plant.

No backfill shall be placed in any pit until the excavation has been inspected. Excess excavated material shall be removed from the Project site. The single exception to the above guidelines relates to wetland shrubs. In the wetland shrub areas, topsoil or muck shall be placed prior to the planting. At the discretion of the Engineer, this topsoil or muck shall serve as the soil mixture for the wetland shrubs.

737.14 Digging and Handling. All precautions customary in good trade practice shall be taken in preparing plants for transplanting. Plants transplanted with workmanship that fails to meet the highest standards will be rejected. All plants shall have firm, natural balls of earth of ample proportions and diameter not less than as specified in AAN′s "USA Standards for Nursery Stock". Plants with cracked, broken, or crushed balls, which occur either before or during planting operations, will be rejected and shall be removed from the site immediately. Bare root plants shall be dug with sufficient spread and depth of roots as to ensure full and prompt recovery and development of the plants. Bruises and injury to roots shall be avoided. All plants shall be handled so that roots are adequately protected and moist at all times. Material that cannot be planted immediately after delivery shall be adequately protected by covering with canvas, wet straw, burlap, moss, or other suitable material and kept covered until ready to be planted. Trees should not be planted with frozen earth balls.

737.15 Location of Plants. Plants shall be located as indicated on the Plans, but may be shifted to avoid utilities subject to the approval of the Engineer. In all mass planting areas, the plants shall be evenly spaced to give uniform cover in the planting bed area. No excavation shall commence until locations are approved.

737.16 Planting. All trees and shrubs shall be planted in pits as detailed on the Standard Construction Details. Pits shall be excavated with vertical sides. Pits shall be of such a depth that, when planted and settled, the crown of the plant shall bear the same relation to finished grade as it did to soil surface in its place of growth. With the approval of the Engineer, the Contractor may elect to plant wetland grown containerized shrubs on small mounds raised no more than 2″ (50 mm) above the final grading elevation shown on the Plans.

Open plant pits shall not be allowed overnight in residential areas or in any location where it is determined by the Engineer to pose a potential hazard to pedestrians or traffic.

All backfill topsoil shall be covered with a waterproof material after mixing. Pits shall be backfilled with specified soil mix and compacted firmly, especially under ball of roots to establish a firm

foundation. Plants shall be set in the center of pits in a vertical position so that the crown of the plant is level with the finished grade after allowing for watering and settling of soil. The "Soil Mixture" shall be carefully and firmly worked and tamped under and around the base of the ball to fill all voids. When partially backfilled and compacted, the burlap shall be removed from the sides and tops of the balls and cut away to prevent air pockets, but no burlap shall be pulled from under the balls. A ring of earth shall be formed around the plant to produce a dish for watering. All plants shall be thoroughly watered immediately after planting as directed by the Engineer. This shall mean complete saturation of all backfill in the pits and beds during the same day of planting. Care shall be taken during all planting operations to ensure that no excavated material is dumped on any grassed area unless a suitable type of matting or protective underlay is used. The Contractor shall be responsible for all damage to any grassed, planted, or other landscaped area caused by its operations and shall repair any damage so caused in a manner satisfactory to the Engineer.

For wetland shrub cuttings, immediately prior to installation, the basal 12″ (300 mm) segment of the 24″ (600 mm) long wood cutting shall be moistened and treated with a standard horticulture rooting compound for woody stock. The cutting shall then be inserted into the ground to a depth of 12″ (300 mm), terminal bud end up. To ensure good cutting/soil contact and to eliminate air pockets, firm foot pressure shall be applied immediately adjacent to the cutting. This material shall be mulched in accordance with (c) below with a mulching radius of 12″ (300 mm).

Ground cover and herbaceous perennial areas shall be prepared by rototilling to a minimum depth of 10″ (250 mm). The mixing of peat moss, peat humus, or approved equal may be performed separately in order to obtain the proportion of ground cover or herbaceous perennial soil mixture as specified.

Beyond the minimum excavation as stated above for soil mixing, the root system of the plant shall determine the actual depth for individual plant excavation. Plants shall be backfilled with the soil mixture and compact firmly around roots. All areas shall have a smooth and uniform grade and a minimum of 2″ (50 mm) of approved mulch.

(a) *Pruning.* All plants shall be pruned immediately after planting or transplanting to remove all injured or dead wood. All trees inspected and tagged at the nursery shall conform to AAN Standards, and any subsequent pruning by the Contractor shall in no way alter the natural habit or shape of the plant. All pruning shall be done with sharp tools by workers skilled in this operation. All cuts shall be made flush, leaving no stubs. On all cuts over 3/4″ (19 mm) in diameter and bruises or scars on the bark, the injured cambium shall be traced back to living tissue and removed; wounds shall be smoothed and shaped so as to preserve the branch bark ridge.

(b) *Watering.* Plants shall be watered as required to maintain them in a live and healthy condition.

(c) *Mulching.* Trees and shrubs shall be mulched with at least a 4″ (100 mm) cover of mulch. Mulch shall be placed the same day of planting, unless otherwise approved by the Engineer.

(d) *Wrapping.* All trees shall be wrapped with the wrapping material overlapping 1½″ (38 mm), wound from the lowest main branches to the base of the tree as illustrated on the Plans. The wrapping shall be tied at the top and bottom and at 12″ (300 mm) intervals along the trunk with twine.

(e) *Staking and Guying.* Unless approved by the Engineer, all staking and guying specified shall be completed the same day as planting and mulching.

(f) *Cleaning Up.* Throughout the course of planting, excess and waste materials shall be immediately removed from the site, seeded areas kept clean, and all precautions taken to

avoid damage to existing structures, trees, shrubs, plants, and grass. When planting in an area that has been otherwise completed, the area shall, upon completion of the planting, be immediately and thoroughly cleared of all debris, rubbish, subsoil, and all waste materials removed from the site. All ground surfaces shall be raked smooth. All sodded areas disturbed as a result of construction shall be repaired by the Contractor.

737.17 Plant Establishment. The plant establishment period for all planting shall begin immediately after all planting and replacements, as specified under Subsection 737.16, are complete and acceptable to the Engineer. The plant establishment period consists of one full growing season during which time the Contractor shall be responsible for all work necessary to keep the plants in a live and healthy condition. If the Contractor completes all planting or transplanting, as specified under Subsection 737.16, by May 1, the semi-final inspection will be held on or about October 1 of that year. In the event the Contractor does not complete all planting and transplanting by May 1, the semi-final inspection will be held on or about October 1 of the following year. All replacement plant material determined to be necessary at the semi-final inspection must then be approved at the replacement plant source by October 15. At this time, the Engineer will direct the Contractor to replace those plants determined to be dead or unhealthy by December 1. The Contractor shall notify the Engineer in writing that all replacement planting has been accomplished. The Engineer will conduct a final inspection within 15 days after such notification to determine the acceptability of the replacements. If all replacements are at this time determined satisfactory by the Engineer, the Contractor will be relieved of all further responsibility for care and replacement.

The plant establishment and acceptance requirements for wetland grown containerized shrubs and wetland shrub cuttings are as follows:

(a) *Wetland Grown Containerized Shrubs.* Acceptance of this stock shall be in full compliance with Subsection 737.04, except for those portions that deal with weed and grass invasion and damage that results from fire, theft, vehicular damage, or acts of vandalism. For a three-year period following the initial planting, the Engineer may request new plantings, and the Contractor shall furnish such plantings at the original bid price plus inflation. The inflation factor will be determined by the Department.

(b) *Wetland Shrub Cuttings.* The installation of cuttings is an experimental procedure requested by the interagency task force that designed the mitigation. There shall be no guarantees or plant establishment periods associated with this installation.

All planting areas shall be kept free of weeds and grass during the life of the Contract. The Contractor may use a pre- or post-emergent herbicide to control such grass and weeds and shall be totally responsible for the proper use and placement of any such herbicide. As requested in writing by the Engineer, the Contractor shall be responsible to weed within all plant beds and within the saucer limits of individual plants, beginning ten calendar days after the date of notification. The Contractor shall prune and apply insecticides or fungicides as required, repair or replace stakes and guy wires, tighten guy cable or wire, and repair plant saucer washouts when and as specified by the Engineer.

Any plants that settle below or rise above the desired finished grades shall be reset at the proper grades. All replacements shall be plants of the same kind, size, and quality as originally specified in the Contract, and they shall be furnished, planted, mulched, guyed, and watered as specified herein for new plant material.

If dead or unhealthy plants are discovered, they shall be removed and replaced within ten calendar days after the date of written notification.

If, upon written request, the Contractor fails to proceed within seven calendar days with the above requirements, the Engineer may arrange for and proceed with adequate labor, equipment, and material to perform the work requested.

The Contractor shall be responsible for all damage incurred to plant material, tree protection, wire, or staking as a result of fire, theft, vehicular damage, or acts of vandalism.

The Contractor shall water all plants as required to sustain them in a healthy condition.

737.18 Method of Measurement. The quantity of planting will be measured as the total number of the various species of new plants of each designated height, spread, and diameter, planted as specified in the Contract.

737.19 Basis of Payment. The quantity of planting will be paid for at the Contract unit price for each of the various items of planting scheduled in the Contract. Price and payment will constitute full compensation for furnishing and placing all materials, including plants, soil mixes, and mulch; for protecting plants after digging and prior to planting; for staking, excavating plant pits, pruning, wrapping, and guying; for all watering until final acceptance, for the cultural care of the plants until the completion and acceptance of all landscape work; for disposing of excess and waste materials; for replacement planting; for cleanup; for repairs to plant material, tree protection, wire, or staking due to fire, theft, vehicular damage, or acts of vandalism; for repairs to damaged grassed, planted, or other landscaped area due to the Contractor's operations; for ensuring that topsoil meets the sieve analysis, acidity, and organic matter requirements; for applying sufficient materials to fertilizer that originally failed to meet the specified analysis; for using pre- or post-emergent herbicide to control grass and weeds; for the work outlined under Subsection 737.17; and for all labor, equipment, tools, and incidentals required to complete the work.

Payment for the various items of planting as described above may be processed if, in the opinion of the Engineer all work required, except that specified under Subsection 737.17 is satisfactorily completed. No partial payment will be made for any living plants or associated planting material. No additional payment will be made for using plants larger than specified.

On contracts where assessment of time is in working days, the Contractor will be charged working days while engaged in actual planting and directly related work such as plant pit excavation, staking, wrapping, and mulching. The Contractor will not be charged time for indirectly related work such as watering, weed control, pruning, and other responsibilities as described under Subsection 737.17.

The cost to remove and replace plants that settle below or rise above the desired finished grades, or that die or are unhealthy as described in Subsection 737.17 shall be the responsibility of the Contractor.

SECTION 738 – TRANSPLANTING

738.01 Description. This work consists of transplanting trees and shrubs from one site to another within the limits of the right-of-way.

738.02 Materials. Existing plants shall be transplanted with appropriate ball diameters as specified on the Plans.

738.03 Construction Methods. Vermeer Models TS-84 through TS-20 hydraulic spades, or an approved equal, shall be used for all transplanting work.

The root structure of each plant shall be transplanted as a conically shaped earthen core cut by the hydraulically-operated cutter blades. The spade shall be located so the hydraulically-operated cutter blades are positioned equidistantly from the trunk(s) or stem(s) of the plant being transplanted. The core excavated at the new planting site shall be 2 to 4″ (50 to 100 mm) larger than the minimum ball diameter specified so that the plant, when placed, will be slightly below finished grade. All excavated plant pits shall be loosened with a digging iron, mattock, or similar device, to eliminate the hard compacted surface created in digging with a hydraulic spade. All trees or shrubs transplanted shall be tamped lightly around the edge of the ball and approved topsoil added where required by the Engineer to fill any small cracks or voids formed during the transplanting operation. Guying, staking, mulching, and wrapping will be required on all trees and shrubs transplanted as described under Subsection 737.16.

738.04 Method of Measurement. The quantity of transplanting will be measured as the total number of the various species of trees and shrubs of each designated height, spread, and diameter actually transplanted as specified in the Contract.

738.05 Basis of Payment. The quantity of transplanting will be paid for at the Contract unit price for each height-spread-diameter category of trees and shrubs transplanted. Price and payment will constitute full compensation for furnishing all materials, including soil mixes and mulch; for transplanting all plant materials; for plant establishment according to Subsection 737.17, excluding replacement; for all watering until final acceptance, pruning, and guying; for the cultural care of the plants until the completion and acceptance of all landscape work; for disposing of excess and waste materials; and for all labor, equipment, tools, and incidentals required to complete the work. There will be partial payments for completed work exclusive of plant establishment requirements as determined by the Engineer in accordance with Section 737.

SECTIONS 739 and 740 – RESERVED

SECTION 741 – TREE REMOVAL

741.01 Description. This work consists of removing and disposing of trees with a diameter over 6″ (150 mm).

741.02 Construction Methods. The appropriate construction methods of Section 201 shall apply to this work. Removal of additional trees is predicated on damage to the root system.

Final determination and need for removal of additional trees not noted in the Plans will be made by the Engineer during the construction operation when the damage to the root system is determined. It is the intent of this Section to save as many of those additional trees as possible.

For trees which do not fall within proposed pavement, shoulder, or crossover limits, tree removal shall consist of cutting, bucking, and topping trees, the removal of stumps to a depth of not less than 10″ (250 mm) below the surrounding ground line, and the removal of all portions or remnants of the tree and stump from highway right-of-way and abutting properties. Trees, which do fall within the proposed pavement, shoulder, or crossover limits shall be completely removed, including stumps and all roots.

All portions or remnants of the tree shall become the property of the Contractor and shall be removed from the right-of-way and abutting properties at the close of each working day. All stumps, which cannot be removed the same day as cutting, shall be cut flush with the ground prior to the end

of work that day. All right-of-way removal sites shall be restored to preconstruction condition, satisfactory to the Engineer, if ground disturbance, such as ruts or sod damage, occurs during removal in areas not to be disturbed by grading operations.

741.03 Method of Measurement. The quantity of trees for removal will be measured as the actual number of trees acceptably removed.

The trunk diameter of the tree will be measured at a point 4′- 6″ (1.4 m) above the ground, and, in the case of multi-trunk trees, the diameter will be measured at the point immediately below the branching split or juncture regardless of the branching height above the ground. The diameter of the tree will be determined from the circumference of the tree as measured above.

741.04 Basis of Payment. The quantity of trees designated for tree removal will be paid for at the Contract unit price per each tree by category, as follows:

6″ (151 mm)	to	10.9″ (279 mm)
11″ (280 mm)	to	14.9″ (379 mm)
15″ (380 mm)	to	18.9″ (479 mm)
19″ (480 mm)	to	24.9″ (639 mm)
25″ (640 mm)	to	30.9″ (789 mm)
31″ (790 mm)	to	36.9″ (939 mm)
37″ (940 mm)	to	42.9″ (1099 mm)
43″ (1100 mm)	to	48.9″ (1249 mm)
49″ (1250 mm)	and larger	

Trees with a diameter of 6″ (150 mm) and under will be removed under Section 201.

Price and payment will constitute full compensation for removal of designated trees; for restoration of ground disturbance in right-of-way removal sites; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 742 – RESERVED

TRAFFIC

SECTION 743 – ARROW BOARDS

743.01 Description. This work consists of furnishing and maintaining arrow boards.

MATERIALS.

743.02 Arrow Boards. Arrow boards shall be trailer mounted, vehicular mounted, or mounted on any suitable support and shall comply with the requirements of this Section and the Traffic Control Manual, as revised. Arrow boards shall have a nominal size of 48 x 96″ (1.2 by 2.4 m) and be equipped with not less than 15 amber lensed, 8800 lumina (minimum), hooded, sealed beam lamps. Lamps shall be arranged to form a double arrow nominally 15″ (380 mm) on center horizontally and 10″ (250 mm) on center vertically. The rate of flash shall be 30 flashes per minute. Unit controls shall include an

intensity adjustment for day/night operation. The back panel of arrow boards shall be equipped with three indicator lamps, visible to the work area, which indicate proper functioning of the board.

743.03 Trailer. The trailer for trailer mounted arrow boards shall be designed for support of the sign panel and the power supply unit. The height of the bottom of the sign panel from the roadway shall be 7′ (2.1 m) minimum.

743.04 Controller. The controller shall provide the following messages:

Right Arrow
Left Arrow
Double Arrow
Warning Light Bar

Provisions for dimming at night shall be required.

743.05 Construction Methods. The arrow boards shall be furnished by the Contractor and shall remain the property of the Contractor. Time and location for use of arrow boards shall be as directed by the Engineer.

The arrow message may be transmitted to the motorists by means of simultaneous flashing of the light panel board of sequentially presenting the message.

Throughout the life of the Contract, the Contractor shall maintain the arrow boards and trailers in a good operational condition, including, but not limited to, changing burned out sealed beam units and repairing or replacing any defective parts.

743.06 Method of Measurement. The quantity of arrow boards will be measured as the number of each used per day.

743.07 Basis of Payment. Arrow boards will be paid for at the Contract unit price for each per day that they are used on the Project, as directed by the Engineer. Price and payment will constitute full compensation for furnishing fuel; for maintaining arrow boards; and for all labor, materials, equipment, and tools required to complete the work.

For payment purposes, any part of a day will constitute a full day.

SECTION 744 – CONDUIT JUNCTION WELLS

744.01 Description. This work consists of constructing conduit junction wells.

744.02 Materials. Materials shall conform to the requirements of the following Section and Subsections:

Brick Masonry 611.06
Castings 708.05
Concrete, Class B 812

744.03 Construction Methods. The conduit junction wells shall conform to the dimensions shown on the Standard Construction Details as modified on the Plans, and shall be built high enough to ensure that the castings are properly level with the surrounding surface. Several conduits may extend into the wells.

At the discretion of the Engineer, sod that must be removed for the placement of conduit junction wells shall either be removed by the use of an approved sod cutter and then replaced or 4″ (100 mm) of topsoil shall be placed and the surface seeded in accordance with Section 734. In areas where new pavement is to be placed or in areas where total reconstruction is taking place, sodding or seeding may not be required by the Engineer.

744.04 Method of Measurement. The quantity of conduit junction wells will be measured as the number of each per type, which are constructed and accepted.

744.05 Basis of Payment. The quantity of conduit junction wells will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing all materials including cast iron lid, frame, topsoil, and grass seed, and for all labor, tools, formwork, equipment, and incidentals required to complete the work.

All conduit extending into the junction well will be paid for under Section 745.

SECTION 745 – CONDUITS (NON-METALLIC OR GALVANIZED)

745.01 Description. This work consists of installing conduits (non-metallic or galvanized) with all necessary fittings.

745.02 Materials. All rigid steel conduits and fittings to be furnished and installed shall be hot-dipped galvanized and conform to the requirements of ANSI C80.1, UL-6, and UL-514. Intermediate metallic conduit shall not be used. Non-metallic 3 and 4″ (75 and 100 mm) conduit shall be PVC Schedule 40 pipe meeting specification C5-272-05(PVC).

745.03 Construction Methods.

(a) *Under Existing Pavement, Galvanized Conduit.* Conduit shall be installed by jacking, boring, or other approved method, under the existing pavement. It shall be installed with a minimum cover of 24″ (600 mm) and a maximum cover of 36″ (900 mm). If a 10′ (3 m) length of conduit has to be cut, it shall be cut with a pipe cutter, reamed with a pipe reamer, and threaded with a pipe threader. The thread length shall be as necessary to ensure that the sections of conduits, when screwed into a coupling, tighten and butt together when tightened with the appropriate wrenches. If approved by the Engineer, a threadless coupling shall be used to join two lengths of conduits. The threadless coupling shall not be used on a piece of conduit that is to be driven. All cut conduits shall be reamed before a threadless coupling is installed. Conduit shall be terminated 24″ (600 mm) beyond the edge of the pavement unless otherwise directed by the Engineer. The standard sheets show typical methods of termination. Ends of all conduit shall be protected with threaded bushings with knockouts. When the jacking or boring is completed, the forward end of the conduit shall be uncovered and compressed air used to clear all foreign matter before inspection. The Contractor shall be responsible for correcting any existing conduit which is disturbed during construction. Each conduit shall have a 10 gage (3.4 mm) galvanized fish wire left in for future use. In instances where the Contractor installs the cable, the fish wire may be eliminated.

The size of a bore made under the pavement shall not exceed the outside diameter of the pipe by more than 1″ (25 mm). If it does, cement grout shall be pumped into the void around the outside of the pipe.

At the discretion of the Engineer, sod that must be removed for the placement of conduits shall either be removed by the use of an approved sod cutter and then replaced or 4″ (100 mm) of topsoil shall be placed and the surface seeded in accordance with Section 734. In areas where new pavement is to be placed or in areas where total reconstruction is taking place, sodding or seeding may not be required by the Engineer.

Elbows of rigid steel conduit manufactured by the Contractor with a hydraulic bender will be acceptable provided that a smooth radius of the proper dimension is achieved and the galvanizing is not damaged.

(b) *Under Existing Pavement, PVC Conduit.* Conduit shall be placed by jacking, boring, or other approved method, under the existing pavement. It shall be installed with a minimum cover of 18″ (450 mm) and a maximum cover of 25″ (640 mm) as measured from the top of the finished pavement. It shall be extended from the specified location under the roadway to a conduit junction well as specified. The pipe shall slope slightly toward the junction well. Joints shall be squared, reamed, and shall be fully set and cemented, with the upper end covered with a manufactured cap or plug and the lower end open. Conduit shall be flush with the inside wall of the junction well.

The size of the bore made under the pavement shall not exceed the outside diameter of the pipe by more than 1″ (25 mm). If it does, cement grout shall be pumped into the void around the outside of the pipe.

At the discretion of the Engineer, sod, that must be removed for the placement of conduits, shall either be removed by the use of an approved sod cutter and then replaced or 4″ (100 mm) of topsoil shall be placed and the surface seeded in accordance with Section 734. In areas where new pavement is to be placed or in areas where total reconstruction is taking place, sodding or seeding may not be required by the Engineer.

(c) *Under New Pavement, Galvanized and PVC Conduit.* Conduit shall be installed directly in the earth with a minimum cover of 24″ (600 mm) and maximum cover of 36″ (900 mm). If a 10′ (3 m) length of conduit has to be cut, it shall be cut with pipe cutter, reamed with a pipe reamer, and threaded with a pipe threader. The thread length shall be as necessary to ensure that the section of conduits, when screwed into a coupling, tighten and butt together when tightened with the appropriate wrenches. If approved by the Engineer, a threadless coupling shall be used to join two lengths of conduit. All cut conduits shall be reamed before a threadless couplings is installed. Conduit shall be terminated 24″ (600 mm) beyond the edge of the pavement unless otherwise directed by the Engineer. The standard sheets show typical methods of termination. Ends of all conduits shall be protected with threaded pipe bushings with knockouts after compressed air has been used to clear all foreign matter. Backfill in conduit trenches shall be compacted thoroughly as it is being placed. Each empty conduit shall have a 10 gage (3.4 mm) galvanized fish wire left in for future use. In instances where the Contractor installs the cable, the fish wire may be eliminated.

At the discretion of the Engineer, sod, that must be removed for the placement of conduit, shall either be removed by the use of an approved sod cutter and then replaced or 4″ (100 mm) of topsoil shall be placed and the surface seeded in accordance with Section 734. In areas where new pavement is to be placed or in areas where total reconstruction is taking place, sodding or seeding may not be required by the Engineer.

Elbows of rigid steel conduit manufactured by the Contractor with a hydraulic bender will be acceptable provided that a smooth radius of the proper dimension is achieved and that the galvanizing is not damaged.

745.04 Method of Measurement. The quantity of non-metallic or galvanized conduit will be measured in linear feet (linear meters) of conduit, in place and accepted.

745.05 Basis of Payment. The quantity of non-metallic or galvanized conduit will be paid for at the Contract unit price per linear foot (linear meter), for the size used. Price and payment will constitute full compensation for furnishing and installing all materials, and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 746 – POLE BASES

746.01 Description. This work consists of furnishing pole bases Types 1, 2, 2A, 2B, 3, 3A, 3B, 4, 5, and 6 for poles at locations as directed by the Engineer.

746.02 Materials. The concrete for pole bases shall conform to Section 812, Class B. Bar reinforcement shall meet the requirements of Section 603 Grade 60 (Grade 420). Ground rods shall be copper covered, approved by the Underwriters' Laboratory and be supplied with approved clamps for connecting the grounding conductor to the rod. Conduit for sweeps shall meet the requirements for galvanized rigid steel conduit in Section 745. Anchor bolts will be supplied by the Department for Types 1, 2, 2A, 2B, 3A and 3B bases and will be supplied by the District Engineer in charge of the project. For Types 4, 5, and 6, the Contractor shall supply the anchor system as indicated on the Standard Construction Details and as directed by the Engineer. The anchor bolts and nuts for Types 5 and 6 shall be hot-dipped galvanized and meet the requirements of AASHTO M 314. Anchor bolts shall have a minimum yield strength of 55,000 psi (379 MPa).

746.03 Construction Methods. The bases shall conform to the dimensions as indicated on the Standard Construction Details. A ground rod shall be installed as shown. A minimum of 6′ (1.8 m) of the ground rod must be driven into undisturbed soil.

If a utility or a right-of-way conflict is found when a Type 2 or Type 3 base is specified in the Plans, an alternate base of equivalent strength may be used as directed by the Engineer. A Type 2 base has two equivalents, namely Types 2A and 2B. A Type 3 base has two equivalents, namely Types 3A and 3B.

Though the Contract calls for the use of a round pole base, the Contractor may use a square base at its discretion.

Excavation for the pole bases may not exceed the dimension of the foundation by more than 12″ (300 mm) in any one direction. If a form is used in the excavation more than 18″ (450 mm) below the ground surface, it is necessary that the area between the form and the excavation be filled and tamped on all sides in layers not to exceed 6″ (150 mm).

Where a pole base is to be placed in existing concrete pavement such as a sidewalk, the concrete shall be saw cut in a square pattern or removed to the nearest joint. In other pavement material, a round hole may be cut using an appropriate tool. Any damage to existing pavement shall be repaired. The repair will be approved by the Engineer.

The bases shall be edged and have a broom finish.

746.04 Method of Measurement. The quantity of pole bases will be measured as the actual number of bases constructed.

746.05 Basis of Payment. The quantity of pole bases will be paid for at the Contract unit price for each pole base type. If an alternate base type is selected by the Engineer, payment will be the Contract unit price for the alternate selected. Price and payment will constitute full compensation for furnishing and placing all materials; for a minimum of two conduit sweeps extending into the base; for excavating, backfilling, and compacting around the base; for repairs to damaged existing pavement; for removal or replacement of pavement; and for all labor, equipment, tools, and incidentals required to complete the work.

Payment for any additional sweeps will be paid for under Section 745.

The Contractor's use of square base rather than a specified round base shall not result in any additional cost to the Department.

SECTION 747 – CABINET BASES

747.01 Description. This work consists of installing cabinet bases.

747.02 Materials. The concrete for cabinet bases shall conform to Section 812, Class B. The ground rod shall be at minimum a 3/4″ (19 mm) diameter by 10′ (3 m) copper covered ground rod approved by the Underwriters' Laboratories and include an approved clamp for connecting the grounding conductor to the rod. The Contractor shall supply the anchoring system for the cabinet bases. The anchoring system shall consist of four 5/8″ (M16) inserts and four galvanized 5/8″ (M16) hex bolts, 1½″ (38 mm) long.

747.03 Construction Methods. The bases shall conform to the dimensions as shown on the Standard Construction Details. A minimum of 6′ (1.8 m) of the ground rod must be driven into undisturbed soil. Conduits entering the base must enter only in the designated area. A minimum distance of 1″ (25 mm) shall be maintained between conduits and a minimum distance of 2″ (50 mm) between conduits and the ground rod.

The bases shall be formed to the full depth or as directed by the Engineer. Where conduit had previously been installed, connection to the conduit in the base shall be made before placing concrete. Conduit sweeps shall be placed in the base as indicated on the Plans and the Standard Construction Details. All bases shall be constructed with one capped spare conduit sweep in addition to all conduit sweeps shown on the Plans. An arrow shall be placed on the surface of the outer edges of the base indicating where each conduit leaves the base. Conduit sweeps shall be 90 degree elbows with smooth 24″ (600 mm) radii and undamaged galvanizing.

747.04 Method of Measurement. The quantity of cabinet bases will be measured as the actual number of cabinet bases constructed.

747.05 Basis of Payment. The quantity of cabinet bases will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing and placing all materials; for excavating and backfilling around the bases; and for all labor, equipment, tools, and incidentals required to complete the work.

All conduit sweeps in the base will bepaid for under Section 745.

SECTION 748 – PAVEMENT MARKINGS

748.01 Description. This work consists of supplying and installing pavement markings on the individual lifts of pavement material and the final surface of the roadway.

748.02 Definitions. There shall be two types of pavement markings as described below:

(1) *Temporary Markings.* Temporary markings, which replace those removed by milling or planing of pavement, are placed on individual sublifts of paving materials or on final travel surfaces, and which are kept in service for less than four weeks. Temporary markings shall be applied as specified in the Traffic Control Manual.

(2) *Permanent Markings.* Permanent markings are usually placed on the final travel surface. Permanent markings shall always be applied in accordance with the MUTCD.

Any of the two types of markings may be used in the following applications except as limited by the MUTCD.

(1) *Lane Line.* Lines of marking material placed between lanes of traffic.

(2) *Edge Line.* Lines of marking material placed on the right hand side of a travel lane with two way traffic or both sides of a traveled way having one way traffic.

(3) *Center Line.* Lines of marking material placed between lanes of traffic traveling in opposite directions.

(4) *Detour Markings.* Markings which are placed to cause or require traffic to move from the normal or previous travel path. All detour markings shall be installed using standard marking patterns as specified in the MUTCD.

(5) *No Passing Zones.* Any centerlines between opposing directions as on a multilane highway shall be applied in accordance with the MUTCD, or as directed by the Engineer, for all temporary or permanent markings.

MATERIALS.

748.03 Approved Materials. The Department periodically conducts tests of various pavement marking materials to determine which materials are suitable for use on Delaware roads. A list of approved materials is available from the Engineer. There is no approved list of materials for temporary paint. The paint used for temporary marking need only be paint intended for use on roadway materials and retain sufficient amounts of beads to remain reflective.

748.04 Alkyd Type Thermoplastic Material. The thermoplastic material that is available in white and highway yellow shall be homogeneously composed of pigment, filter, resins, and glass reflectorizing spheres. It shall melt uniformly with no evidence of skins or unmelted particles. It shall not deteriorate on contact with sodium chloride, calcium chloride, or other de-icing chemicals or because of oil content of paving materials or oil drippings. It shall be tested in accordance with AASHTO T 250 and M 249 or with the appropriate method in FED-STD-141C or ASTM designation.

The thermoplastic material shall be suitable for application immediately after compaction of the final lift of asphaltic concrete. The thermoplastic shall be neither permanently discolored nor softened by contact with hot-mix bituminous concrete.

The white thermoplastic material shall not exceed a yellowness index of 0.15.

The yellow color shall reasonably match color chip No. 13538 of FED-STD-595B. The test shall be performed at 77 °F (25 °C).

(1) *Alkyd Binder.* The binder shall consist of mixture of synthetic resins, at least one of which is solid at room temperature, and high boiling point plasticizer. At least one-third of the binder composition shall be solid maleic-modified glycerol ester resin and shall be no less that 18% by weight of the entire material formulation. The binder shall not contain petroleum based hydrocarbon resins.

(2) *Composition.* The pigment, glass beads, and filler shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt, and foreign materials or objects and shall comply with the following requirements.

Composition (percent by weight)

Component	*White*	*Yellow*	*Black*
Alkyd Binder	18.0 minimum	18.0 minimum	18.0 minimum
Glass Beads	30 - 40	3 0 -40	0.0 maximum
Titanium Dioxide	10.0 minimum	---	0.0 maximum
Calcium Carbonate and Inert Fillers	42.0 maximum	50.0 maximum	52.0 maximum
Yellow Pigment	52.0 maximum	50.0 maximum See Note (a)	---

Note (a): Amount of yellow pigment, calcium carbonate, and inert filers shall be at the option of the manufacturer, providing all other requirements of this specification are met.

(3) *Physical Characteristics.*

(a) *Specific Gravity.* The specific gravity of the thermoplastic traffic line material shall not exceed 2.15.

(b) *Storage Life.* Any unused material which does not conform to the requirements of the specification for a period of one year shall be replaced by the manufacturer at no cost to the Department.

(c) *Set Time.* When applied at a temperature range of 412 ± 12 °F (211 ± 7 °C) and at a thickness of 0.0625 to 0.125″ (1.5 to 3.0 mm), the material shall set to bear traffic in not more than two minutes when the air temperature at 50 ± 4 °F (10 ± 2 °C), and not more than ten minutes when the air temperature is 90 ± 4 °F (32 ± 2 °C).

(d) *Color.** Daylight reflectance at 45 degrees - 0 Degrees:

White: 75%
Yellow: 45%

(e) *Bond Strength.** The bond strength to the pavement shall exceed 1,800 psi (1.24 MPa).

(f) *Resistance to Cracking at Low Temperature.** Applied to concrete blocks, and cooled to 201 ± 4 °F (94 ± 2 °C), the material shall show no cracks.

(g) *Impact Resistance.** The impact resistance shall be a minimum of 10 in·lb (1.13 N·m) upon test specimens.

(h) *Softening Point.** Tested in accordance with ASTM D 36, the materials shall have a softening point of 216 ± 14 °F (102 ± 8 °C).

(i) *Flowability.** Tested for flowability, the white thermoplastic shall have a maximum residue of 18% and the yellow thermoplastic shall have a maximum residue of 21%.

(j) *Flowability Extended Heating.** After extending the heat period by four hours and 30 minutes, when tested for flowability, the thermoplastic shall have a maximum residue of 28%.

* For the tests (d) through (j), the thermoplastic material shall be heated under agitation for four hours plus or minus five minutes at 424 ± 4 °F (218 ± 2 °C) prior to the start of the test.

748.05 Glass Spheres.

(a) *Pre-Mixed in the Material.* The glass spheres shall be uncoated and shall conform to the requirements of AASHTO M 247, Type 1.

(b) *Surface Applied.* The glass spheres shall conform to the requirements of AASHTO M 247, Type 1, except that the beads must be moisture resistant coated to conform to the requirements of procedure 4.4.2 (AASHTO M 247) and a maximum of 5% shall pass the No. 80 sieve (180 µm) screen. Glass spheres shall have a minimum of 70% true spheres on each sieve and 80% true spheres overall.

748.06 Packaging and Marking. The thermoplastic material shall be packaged in suitable containers to which it will not adhere during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb (23 kg). Each container shall designate the color, binder (alkyd), spray or extrude, user information, manufacturer's name and address, batch number, and date of manufacture. Each batch manufactured shall have its own separate number. The label shall warn the user that the material must be heated in the range of 400 to 440 °F (204 to 227 °C).

748.07 Vendor Qualification. In order to be eligible to supply the required pavement marking materials, evidence of three years successful services for alkyd-based materials in transverse and/or symbol applications shall be provided in writing. Successful service shall be evidenced by color stability, retention of retroreflective properties, crack resistance, and lack of softening or permanent discoloration due to exposure to oil and grease drippings for the required three year period. The documentation must be from three projects in areas with similar climactic conditions within the United States.

748.08 Equipment. The equipment used to apply pavement markings shall conform to the following requirements:

(1) *Paint Equipment.*
- (a) Shall be able to apply double centerlines simultaneously (except temporary markings may be applied separately).
- (b) Shall be capable of applying paint and glass beads to pavement at same time, leaving no more than 2″ (50 mm) of painted line without glass beads at the beginning or end of a line.
- (c) Shall be capable of hand gun operation for applying special markings. (This may be a separate piece of equipment.)

(2) *Truck Mounted Paint Equipment.*
- (a) Shall have steerable gun carriages.
- (b) Must be able to apply double centerlines simultaneously.
- (c) Shall be capable of pneumatically applying glass beads 1″ (25 mm) behind the spray pattern of the paint gun.

(d) Shall have an automatic, electrically controlled skipline mechanism capable of retracing the existing 10′ (3 m) stripe and 30′ (9 m) skip or applying a new 10′ (3 m) stripe and 30′ (9 m) skip.

(3) *Thermoplastic Equipment.*

(a) Shall provide for constant mixing and agitation of the material.

(b) Shall apply the material to the road surface in a molten state at the temperature specified in Subsection 748.08 (c)(1) by screed extrusion means.

(c) Shall apply glass beads instantaneously upon the installed line to ensure adhesion.

748.09 Application.

(a) *General.* The Contractor shall protect all pavement markings until track free. In the event any vehicle should cross wet pavement markings, the damaged markings shall be removed by sand blasting, heat, or other methods acceptable to the Department and replaced.

All necessary markings shall be installed before the end of the workday. Whenever work is interrupted by weather, the markings shall be installed as soon as possible. Due to safety requirements, this Section shall overrule Subsection 101.39 which prevents work on holidays.

The Contractor shall furnish to the Department the applicable warranty for the material to be installed to ensure proper performance.

Thermoplastic pavement markings shall not be applied on portland cement concrete and other concrete surfaces.

(b) *Paint.*

(1) This specification is to cover the application of pigmented binder (white and yellow) and optical glass spheres system to the highway surface with specialized equipment.

(2) The reflective surface shall be obtained by applying optical glass spheres at the rate of 5 lb/gal (0.6 kg/L) of paint onto and into the pigmented binder in one operation as specified under this Subsection. The number of gallons (liters) of paint used and the number of pounds (kilograms) of beads used shall be determined. Rate application will be calculated by dividing the gallons (liters) of paint used for the day into the number of pounds (kilograms) of beads used for the day, and the result should be 5 lb/gal (0.60 kg/L) within ±2%. If the result does not meet this limit, the days work shall be redone.

(3) Pigmented binder (paint), white or yellow, shall be applied by the Contractor according to the paint manufacturer′s recommendations. The paint shall only be applied when ambient air temperature is 40 °F (4 °C) or higher. The wet film thickness shall be 0.015 ± 0.001″ (0.38 ± 0.03 mm).

(c) *Thermoplastic Alkyd Type Material.*

(1) *Application.* For optimum adhesion, the thermoplastic material shall be installed in a molten state at a temperature between 400 to 425 °F (204 to 218 °C) on a clean, dry, and solvent free surface. The Contractor shall clean off pavement surface dirt and grease where necessary by approved removal methods. Thermoplastic pavement marking materials shall not be applied when pavement temperatures are below 50 °F (10 °C) or when the surface of the pavement shows evident moisture.

A primer sealer if recommended by the manufacturer of the thermoplastic material shall be applied prior to the installation of thermoplastic material on the pavement if required by the Department. The primer shall be void of solvent and water prior to the installation of thermoplastic material.

The material shall readily apply to the pavement from either manual or self propelled application equipment by the screed/extrusion method wherein one side of the

shaping die is the pavement and the other three sides are contained by a part of suitable equipment for heating and controlling the flow of material.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly upon any type of old thermoplastic line, provided that the initial material was properly bonded, or on worn paint line showing considerable pavement exposure. Such new material shall bond itself to the old line in such a manner that no splitting or separation takes place.

The application equipment shall conform to the requirements of this Subsection and be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be accomplished in a true arc. The heating kettle and application equipment shall conform to the requirements of the National Fire Underwriters of the National Fire Protection Association and of the State.

The equipment used to install hot applied thermoplastic material by contract under this Section shall be constructed to provide continuous uniform heating to temperatures exceeding 400 °F (204 °C), mixing, and agitation of the material. The conveying parts of the equipment between the main material reservoir and the line dispensing device shall prevent accumulation and clogging. All parts of the equipment which come in contact with the material shall be constructed for easy accessibility for cleaning and maintenance. The equipment shall operate so that all mixing and conveying parts, including the line dispensing aprons or similar appliances which the dispenser overruns, will not be permitted. The equipment shall provide for traffic marking application of varying widths in even multiples of 4 or 6″ (100 or 150 mm).

Glass spheres shall be applied to the surface of the completed stripe by drop-on or pressure spray methods at an approximate uniform rate of 0.100 lb of glass spheres every square foot (0.49 kg of glass spheres every square meter) [0.033 lb/ft of 4″ (50 g/m of 100 mm)] from automatic dispenser attached to the striping machine so that the glass spheres are dispensed closely behind the installed line. The glass sphere dispenser shall be equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.

(2) *Patterns*. The thickness measurement prior to application of drop-on glass beads shall be 0.125″ (3.18 mm) for crosswalks and stop bars and 0.090″ (2.28 mm) for lanelines, centerlines, and edgelines.

Calibration shall be done by placing black tapes, film, or metal plates of known and uniform thickness in the area to be striped. Once the striper has passed over, the sample is removed by making sharp cuts with a knife and measurement of the stripe plus base are made with a micrometer or vernier calipers with a proper correction for the base.

For longitudinal lines, these thickness checks shall be made every 1,600′ (500 m) or more frequently at the judgment of the Engineer. For symbols and intersection markings, the frequency of checking shall be at the option of the Engineer. These thicknesses shall be considered as the average of two or more measurements made in a 3′ (1 m) distance.

Longitudinal lines shall be offset at least 2″ (50 mm) from construction joints and 2″ (50 mm) to the inside of shoulder breaks of pavement. Openings 6″ (150 mm) in length shall be provided at 20′ (6 m) intervals in edgelines placed on the inside of super elevated curves to prevent ponding of water on the pavement surface.

The finished lines shall have well defined edges.

The typical skip pattern shall be based on a 40′ (12 m) cycle made up of a 10′ (3 m) painted surface and a 30′ (9 m) space.

(d) *Reflectivity for Paint and Alkyd Type Thermoplastic Material.*

After satisfactory completion of all striping work and written notification from the Contractor, the Department will test the striping to ensure it has the minimum reflectivity. The testing will be completed within 30 calendar days from notification. The Contractor shall accept lower average readings derived from late testing due to the Contractor's failure to notify the Engineer. The Contractor may request that tests be conducted on completed phases or portions of the work. Approval of such a request will be at the discretion of the Engineer. Testing will be done using a Delta LTL 2000 Retrometer (30 meter geometry). Five readings will be taken per line per 1 mile (1.6 kilometer). Projects less than 1 mile (1.6 kilometer) in length will have a minimum of five readings per line.

The required minimum initial reflectivity reading in millicandellas for alkyd thermoplastic markings shall be:

White 300
Yellow 200

For alkyd thermoplastic markings below these minimums and above 125 millicandellas, payment will be reduced as described under Basis of Payment.

All markings (paint and alkyd thermoplastic) with an average reflectivity below 125 millicandellas shall be removed and replaced at the sole expense of the Contractor.

(e) *Guarantee for Alkyd Type Thermoplastic Material.*

Acceptance of this project will be contingent upon successful completion of a 180 day observation period under traffic beginning upon the satisfactory completion of all striping work required by the Contract.

During the 180 day observation period the thermoplastic Pavement Marking Material furnished and installed under this Contract shall be warranted against failure due to blistering, excessive cracking, bleeding, staining, discoloration, oil content of the pavement materials, smearing and spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, or gasoline drippings, chipping, spalling, poor adjesion to the pavement materials, vehicular damage, and wear. Any markings that have not performed satisfactorily during the 180 day observation shall be replaced by the Contractor at no expense to the Department.

Marking replacement shall be performed in accordance with the requirements specified herein for the initial application, including but not limited to possible surface cleaning, pavement marking removal, seasonal and weather limitations, etc.

The Contractor shall replace or renew, entirely at his/her expense, the amount of pavement markings deemed by the Engineer to have failed to perform useful service during the period noted above. The replacement material installed under this guarantee shall be the same as the original material.

748.10 Method of Measurement. The different types of pavement markings will be measured as follows:

(1) *Temporary Markings.* The quantity of temporary pavement markings will be measured by the linear foot (linear meter) of 4 or 6″ (100 or 150 mm) line and by the square foot (square meter) for symbols, installed and accepted.

(2) *Permanent Markings.* The quantity of permanent pavement markings will be measured by the linear foot (linear meter) of 4 or 6″ (100 or 150 mm) line and by the square foot (square meter) for symbols, installed and accepted.

The linear foot (linear meter) of 4 or 6″ (100 or 150 mm) line refers to all 4 or 6″ (100 or 150 mm) lines parallel to the centerline. The square foot (square meter) of symbols refers to all STOP bars, transverse lines, arrows, and words. All symbols will be measured according to the following square foot (square meter) values.

Straight Arrow	12.5 ft² (1.2 m^2)
Left and Right Arrow Symbol	15.5 ft² (1.4 m^2)
Combination Arrow	20 ft² (1.9 m^2)
"Only" Legend	23 ft² (2.1 m^2)
"School" Legend	35 ft² (3.3 m^2)
"Stop" Legend	23.5 ft² (2.2 m^2)
8″ (200 mm) Transverse Line	0.66 ft² per linear foot (0.20 m², per linear meter)
12″ (300 mm) Transverse Line	1.00 ft² per linear foot (0.30 m², per linear meter)
16″ (400 mm) Transverse Line	1.33 ft² per linear foot (0.41 m^2, per linear meter)
24″ (600 mm) Transverse Line	2.00 ft² per linear foot (0.61 m^2, per linear meter)
"R X R" Railroad Crossing Symbol	69 ft² (6.4 m^2)

748.11 Basis of Payment. The quantity of temporary and permanent paint pavement marking will be paid for at the Contract unit price per linear foot (linear meter) for 4 or 6″ (100 or 150 mm) line and the Contract unit price per square foot (square meter) of symbol. The quantity of permanent alkyd thermoplastic pavement marking will be paid for at the Contract unit price per linear foot (linear meter) of line and the Contract unit price per square foot (square meter) of symbol unless payment is reduced due to below minimum reflectivity as described below:

For alkyd thermoplastic pavement markings with reflectivity readings of 125 millicandellas or above but below 300 millicandellas for white or 200 millicandellas for yellow payment will be pro-rated based on the following formula:

$$\frac{A \times B}{C}$$

A = Average measured reflectivity readings*
B = Contract bid price for striping **
C = Required minimum initial reading
* = Must be greater than or equal to 125 millicandellas
** = Item bid price; not material cost

Price and payment will constitute full compensation for furnishing and installing all materials; for preparation of the pavement; for replacement of reflective surface that does not conform to the application rate specified in Subsection 748.08 for removal and repair of markings damaged by vehicles crossing wet markings; and for all labor, tools, equipment, and incidentals required to complete the work.

SECTION 749 – REINFORCED CONCRETE SIGN FOUNDATIONS

749.01 Description. This work consists of constructing reinforced portland cement concrete foundations for sign structures.

749.02 Materials. Materials for reinforced concrete sign foundations shall conform to the following Sections:

Backfill Material, Borrow Type G 209
Portland Cement Concrete, Class A 812
Bar Reinforcement 824

749.03 Construction Methods. Construction of reinforced concrete sign foundations shall conform to Section 602, except as permitted herein. The exact field location of reinforced concrete sign foundations will be designated by the Engineer prior to beginning work.

Excavation shall be made to the required dimensions by a method acceptable to the Engineer. Excavated areas not occupied by portland cement concrete shall be of sufficient width, if not otherwise specified, to permit the placement and compaction of backfill material. All backfill material shall be placed and compacted to 95% or more in accordance with Section 202.

749.04 Method of Measurement. The number of reinforced concrete sign foundations will be measured as the actual number of reinforced concrete sign foundations and accepted.

749.05 Basis of Payment. The quantity of reinforced concrete sign foundations will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing all materials, including fittings and backfill material; for forming, sheeting, and shoring; for excavating, backfilling, compacting, and disposing of surplus materials; and for all labor, equipment, tools, and incidentals required to complete the work. Rock excavation will be paid for under Section 206.

SECTION 750 – ADJUSTING WATER VALVE BOXES

750.01 Description. This work consists of adjusting water valve boxes.

750.02 Materials. Materials for adjusting water valve boxes shall conform to the following Sections:

Backfill Material, Borrow Type C 209
Portland Cement Concrete, Class B 812
Stone, Delaware No. 8 813

All pipe, fittings, and hardware shall conform to the requirements shown on the Plans and to the standards and specifications of the utility owner.

750.03 Construction Methods. All metal boxes shall be adjusted to grade with repairs performed as required and as directed by the Engineer. Water valve boxes shall be adjusted in accordance with the details shown on the Plans and the standards and specifications of the utility owner, and as directed by the Engineer. The Contractor shall acquaint itself with these standards and specifications prior to the submission of a proposal for the construction of the work included in the Contract documents. The location of the water valve boxes shall be as shown on the Plans.

The materials necessary to be excavated under these items shall be removed from the site. All such excavations shall be backfilled with approved materials.

750.04 Method of Measurement. The quantity of water valve boxes adjusted will be measured as the actual number of water valve boxes adjusted and accepted.

750.05 Basis of Payment. The quantity of adjusted water valve boxes will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing and placing all materials; for removing any covers or portions of structures; for excavating, backfilling, compacting, and disposing of surplus material; for resetting the valve boxes to proper grades; and for all labor, equipment, tools, and incidentals required to complete the work.

Any damage to the water valves or boxes caused by the Contractor shall be repaired at the Contractor's expense.

SECTION 751 – ADJUSTING FIRE HYDRANTS

751.01 Description. This work consists of adjusting fire hydrants.

751.02 Materials. Materials for adjusting fire hydrants shall conform to the following Sections:

Backfill Material, Borrow Type C 209
Portland Cement Concrete, Class B 812
Stone, Delaware No. 8 813

All pipe, fittings, and hardware shall conform to the requirements shown on the Plans and to the standards and specifications of the utility owner.

751.03 Construction Methods. Fire hydrants shall be adjusted in accordance with the details shown on the Plans and the standards and specifications of the utility owner, and as directed by the Engineer. The Contractor shall acquaint itself with these standards and specifications prior to the submission of a proposal for the construction of the work included in the Contract documents. The location of the fire hydrants shall be as shown on the Plans, but the exact position of the adjusted hydrants shall be determined in the field.

751.04 Method of Measurement. The quantity of fire hydrants adjusted will be measured as the actual number of fire hydrants adjusted and accepted.

751.05 Basis of Payment. The quantity of fire hydrants adjusted will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for all materials, including concrete, stone, and any contingent materials relative and necessary to the work; for all excavating, backfilling, testing, compacting, and disposing of excess material; and for all labor, equipment, tools, and incidentals required to complete the work.

Any valves, fittings, connections, or joints determined by the Engineer to be unsuitable for reuse shall be replaced at the Contractor's expense.

SECTION 752 – RELOCATING FIRE HYDRANTS

752.01 Description. This work consists of relocating fire hydrants.

752.02 Materials. Materials for relocating fire hydrants shall conform to the following Sections:

Backfill Material, Borrow, Type C 209
Portland Cement Concrete, Class B 812
Stone, Delaware No. 8 813

Valve boxes, tie rods, pipe, bends, miscellaneous fittings, and hardware required to relocate the fire hydrants shall conform to the requirements shown on the Plans and to the standards and specifications of the utility owner.

752.03 Construction Methods. Fire hydrants shall be relocated in accordance with the details shown on the Plans and the standards and specifications of the utility owner, and as directed by the Engineer. The Contractor shall acquaint itself with these standards and specifications prior to the submission of a proposal for the construction of the work included in the Contract documents. The location of the existing hydrants and the approximate position of the relocated hydrants shall be as shown on the Plans. The work shall be performed under the supervision and with the approval of the owner of the utility.

752.04 Method of Measurement. The quantity of fire hydrants relocated will be measured as the actual number of fire hydrants relocated and accepted.

752.05 Basis of Payment. The quantity of fire hydrants relocated will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for all materials, including concrete, stone, valve boxes, tie rods, pipe, bends, and any contingent materials relative and necessary to the work; for all excavating, backfilling, compacting, and disposing of excess material; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 753 – ADJUSTING SANITARY SEWER LATERALS

753.01 Description. This work consists of adjusting sewer connections that interfere with the proposed construction or which are damaged by unavoidable construction operations.

753.02 Materials. Materials for adjusting sanitary sewer laterals shall conform to the following Sections:

Backfill Material, Borrow Type C 209
Portland Cement Concrete, Class B 812
Stone, Delaware No. 8 813

All pipe, fittings, and hardware shall conform to the requirements shown on the Plans and to the standards and specifications of the utility owner.

753.03 Construction Methods. All sewer connections shall be adjusted in accordance with the details shown on the Plans and the standards and specifications of the utility owner, and as directed by the Engineer. The Contractor shall acquaint itself with these standards and specifications prior to the submission of a proposal for the construction of the work included in the Contract documents. The location of the sewer connections shall be as shown on the Plans.

No lateral changes shall be made without the approval of the Engineer or the Engineer′s authorized representative.

All existing sanitary or combined sewers must be retained in service during construction and until acceptance of portions of new replacement facilities. Temporary piping, if necessary, shall be utilized to maintain service during construction. All construction shall be coordinated with and written approval obtained from the utility owner prior to the interruption for temporary connections or new facilities of existing sanitary or combined sewers.

753.04 Method of Measurement. The quantity of sanitary sewer laterals adjusted will be measured as the actual number of laterals adjusted and accepted.

753.05 Basis of Payment. The quantity of sanitary sewer laterals adjusted will be paid for at the unit price per each. Price and payment will constitute full compensation for all necessary excavating, backfilling, compacting, and disposing of excess material; for all cribbing, shoring, and sheeting; for furnishing and installing pipe and fittings regardless of size; for concrete encasement of fittings, regardless of size; for concrete encasement of fittings and joints, if required; and for all material, labor, equipment, tools, and incidentals required to complete the work.

SECTION 754 – ADJUSTING WATER SERVICES

754.01 Description. This work consists of adjusting the water line services to private properties.

754.02 Materials. Materials for adjusting water services shall conform to the following Sections:

Backfill Material, Borrow Type C 209
Portland Cement Concrete, Class B 812
Stone, Delaware No. 8 813

All pipe, fittings, and hardware shall conform to the requirements shown on the Plans and to the standards and specifications of the utility owner, or as directed by the Engineer.

754.03 Construction Methods. The plumbing work required under this Section must be performed in accordance with applicable codes and industry standards.

Water services shall be adjusted in accordance with the details shown on the Plans and the standards and specifications of the utility owner, and as directed by the Engineer. The Contractor shall acquaint itself with these standards and specifications prior to the submission of a proposal for the construction of the work included in the Contract documents.

The Contractor shall install water services and appurtenances of the sizes and to the lines required, and as designated by the Engineer.

Proper and suitable tools and appliances for the safe and convenient handling and laying of pipe and fittings shall be used. Pipe, fittings, and other appurtenances shall be carefully handled and lowered into the trench. The ends of the pipe shall abut against each other in such a manner that there shall be no unevenness on the inside of the pipe.

Special care shall be taken to ensure that the pipes are well bedded on a solid foundation. Any defects due to settlement shall be repaired by the Contractor. A special precaution shall be exercised to prevent any pipe from resting on rock.

The pipes and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed work. At the close of work each day, the end of the pipe lines shall be tightly closed with a suitable stopper so that no dirt or foreign substances can enter the pipe. The stopper shall be kept in place until pipe laying is again resumed.

Whenever a pipe or fitting requires cutting to fit in the line or to bring it to the required location, the work shall be done in a satisfactory manner so as to leave a smooth end.

Completed water services shall be tested for leakage. No leakage shall be allowed. The minimum test pressure shall be the same as mainline water pressure. Testing shall conform to the requirements of the utility owner within each municipality.

If the service indicates any leakage whatsoever, the Contractor shall repair the leaks or defects and, if so directed, retest the line after the correction of defects. This testing and correcting of defects shall continue until all leaks have been stopped.

Leaks and defects shall be repaired or otherwise remedied by the Contractor to the complete satisfaction of the Engineer, at whatever time leaks or defects become apparent, prior to the final acceptance of the work.

All excess material shall be removed from the Project site or otherwise disposed of as specified in Subsection 106.09. Trench restoration shall include seeding, sodding, or plant replacement, as necessary.

754.04 Method of Measurement. The quantity of water services adjusted will be measured as the actual number of water services adjusted and accepted.

754.05 Basis of Payment. The quantity of water services adjusted will be paid for at the Contract unit price per each. Price and payment will constitute full compensation for furnishing and placing all materials, including couplings and corporation stops for use on copper service; for all excavating, backfilling, compacting, and disposing of excess materials; for trench restoration, which includes seeding, sodding, or plant replacement, if necessary; for repairing leaks and defects, including defects due to settlement; and for all labor, equipment, tools, and incidentals required to complete the work.

MISCELLANEOUS

SECTION 755 – HOT-MIX, HOT-LAID BITUMINOUS CONCRETE CURB

755.01 Description. This work consists of constructing a machine laid hot-mix, hot-laid bituminous concrete curb.

755.02 Materials. All materials including job mix formula, mixing plant, and transportation and delivery of mixture shall conform to the requirements of Section 823, Type D, except that from 0.25 to 0.50% of the total mix weight of an approved synthetic fiber shall be added. The fiber shall not ball or melt during mixing and shall provide sufficient mix cohesion to prevent slumping or breaking of the extruded curb during placement.

CONSTRUCTION METHODS.

755.03 General. Hot-mix, hot-laid bituminous concrete curb shall be constructed by machine methods on an approved surface as shown on the Plans, or as ordered by the Engineer.

The surface where the curb is to be placed shall be kept clean and free from dust until the curb has been placed. Unless otherwise directed, a fog coat of approved bitumen shall be sprayed prior to the placing of the curb.

755.04 Curbing Machine. The curbing machine shall form the curb to the dimensions shown on the Plans, or as directed by the Engineer, by a process of extrusion producing a homogeneous stable curb, free from honeycomb, and which requires no further compaction. The laying temperature and the percentage of bitumen shall be varied within the specified ranges to produce a mixture that passes through the mold without tearing and is stable enough to resist sloughing.

The curbing machine shall be operated in an uphill direction whenever practicable, as an aid to compaction.

755.05 Curb Construction. Curb construction shall be a continuous operation between concrete intake aprons and other concrete structures so as to eliminate curb joints at other locations.

Hand spreading will be permitted only immediately adjacent to the concrete structures and at ends of runs of curb. Hand spreading shall be performed in accordance with the pertinent provisions of Section 401. Contact surfaces of the concrete structures shall be painted with a thin uniform coat of hot bitumen just before the mixture is placed against them.

755.06 Inspection. Hot-mix, hot-laid bituminous concrete curb not constructed to the required lines, grades, or cross-sections, curb placed when the mixture is too hot or too cold, and curb that is otherwise unsatisfactory shall be removed and replaced with satisfactory curbing.

755.07 Method of Measurement. The quantity of hot-mix, hot-laid bituminous concrete curb will be measured in linear feet (linear meters) in place and accepted, measured along the curb from end to end, with appropriate deductions for concrete intake aprons.

755.08 Basis of Payment. The quantity of hot-mix, hot-laid bituminous concrete curb will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for furnishing all materials, for placing the curb, for removing and replacing unsatisfactory curb, and for all equipment, labor, tools, and incidentals required to complete the work.

SECTION 756 – SAND

756.01 Description. This work consists of furnishing and placing sand.

756.02 Materials. Sand shall conform to the requirements of Section 804.

756.03 Sand. After the unsuitable material has been removed and the subgrade has been approved, the sand shall be placed in accordance with the requirements of Section 202.

If sheeting is required, sand shall not be placed until the sheeting has been driven and accepted.

756.04 Method of Measurement. The quantity of sand will be measured as the number of tons (metric tons) of sand placed. The weight of each load will be determined according to Subsection 109.01.

756.05 Basis of Payment. The quantity of sand will be paid for at the Contract unit price per ton (metric ton). Price and payment will constitute full compensation for subgrade preparation; for furnishing, hauling, placing, and spreading all material; and for all labor, equipment, tools, and incidentals required to complete the work.

SECTION 757 – RESERVED

SECTION 758 – REMOVAL OF EXISTING PORTLAND CEMENT CONCRETE PAVEMENT, CURB, AND SIDEWALK

758.01 Description. This work consists of removing portions or all of the existing portland cement concrete pavement, curb, and sidewalk.

758.02 Construction Methods. The material to be removed shall be broken by an approved power breaking machine. A ball type breaker machine shall not be permitted. Extreme care shall be exercised by the Contractor in the operation to ensure that no damage occurs to any existing buried, surface, or aerial utility. The broken concrete materials shall become the property of the Contractor and shall be removed from the Project or otherwise disposed of as specified in Subsection 106.09.

758.03 Method of Measurement. The quantity of removed existing portland cement concrete pavement, curb, and sidewalk will be measured in square yards (square meters) along the top surface of the materials to be removed, as projected on the horizontal plane.

758.04 Basis of Payment. The quantity of removed existing portland cement concrete pavement, curb, and sidewalk will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for all labor, equipment, tools, and incidentals required to complete the work.

All material under existing areas ordered to be removed will be paid for under Section 202.

SECTION 759 – FIELD OFFICE

759.01 Description. This work consists of furnishing, erecting, equipping, maintaining, and removing a field office of Type I, II, or III for the exclusive use of Department engineers and inspectors at a location to be approved by the Engineer.

759.02 Construction and Equipment. The field office shall be erected by the Contractor, be fully operational when work first commences on the Project, shall be available throughout the duration of the Project, and shall be removed upon completion of the Project as defined in Subsection 101.16, or as directed by the Engineer. The field office shall be new or in a like-new condition, of weather-proof construction, tightly floored and roofed, constructed with an air space above the ceiling for ventilation, and shall be supported above the ground. The width of the field office shall be not less than 8′ (2.4 m), and the floor-to-ceiling height shall be not less than 7′- 6″ (2.3 m); however, in the event a trailer type field office is provided, the width shall be not less than 7′ - 6″ (2.3 m), and the floor-to-ceiling height shall be not less than 6′ - 6″ (2.0 m). The inside walls and ceiling shall be constructed of plywood, masonite, gypsum board, or other suitable materials. Exterior walls, ceiling, and floor shall be insulated. The field office structure shall be free of hazardous materials.

The field office shall contain at least three windows, each having an area of not less than 540 in^2 (0.35 m^2), and all of which shall be capable of being easily opened and secured from the inside only. All windows shall have horizontal mini-blinds covering the entire glass area. Two of the required windows must be on opposite walls. Types I and II field offices, shall have at least two exterior passage doors. Type III field offices shall have at least one exterior passage door. Door dimensions shall be not less than 30″ (0.76 m) in width and 78″ (2.0 m) in height. Window and door screens shall be

provided. The exterior passage door(s) shall be equipped with lock(s), and at least two keys which operate the door lock(s) shall be furnished to the Engineer or inspector.

The field office shall have satisfactory lighting, electrical outlets, heating equipment, exhaust fan, and air-conditioner, all connected to an operational power source. At least one of the light fixtures shall be a fluorescent light situated over the plan and drawing table. Electrical current and any necessary fuel for heating equipment shall be furnished by the Contractor.

The Contractor shall furnish and maintain one fire extinguisher for each required exterior passage door. Fire extinguisher(s) may be chemical or dry powder and shall be UL Classification 10-B:C (minimum), suitable for Types A:B:C fires.

The Contractor shall furnish and maintain an adequate supply of cold potable water.

The Contractor shall construct and maintain a stable and unyielding all-weather parking area adjacent to the office and of sufficient size to hold four vehicles.

A suitable indoor or outdoor toilet, conforming to the requirements of the State and Local Boards of Health or of other bodies having jurisdiction in the area, shall be provided. When separate facilities for men and women are not available, a sign with the wording **REST ROOM** (letter heights of 1″ (25 mm) minimum) shall be placed on the door and an adequate positive locking system shall be provided on the inside of the door to ensure privacy.

Maintenance of the field office shall be performed weekly. Maintenance shall include sweeping and mopping floors, emptying waste baskets, cleaning sanitary facilities, and replenishing supplies of paper towels, toilet paper, and drinking cups.

Except for telephone service, the Contractor shall be responsible for performing or for making necessary arrangements for all necessary utility connections, for maintenance of utilities, for payment of all utility service fees and bills, and for final disconnection of utilities. The Department will arrange for installation of direct telephone services for the official and exclusive use of the Engineer and other representatives of the Department.

Field offices will be designated in the Contract bid proposal as Type I, Type II, or Type III. In addition to the general requirements stated herein, the specified field office shall be equipped and maintained with the following:

Type I field office shall have a minimum floor space of 400 ft² (37 m²).

No.	*Item*
1	Double pedestal desk [approximately 60 by 34″ (1.5 by 0.86 m)], 2000 in²(1.3 m²) minimum
2	Work tables [approximately 60 by 34″ (1.5 by 0.86 m)], 2000 in² (1.3 m²) minimum
1	Plan and drawing table [approximately 30 by 96″ (0.76 by 2.4 m)] with adjustable stool
1	Printing calculator with paper, which will add, subtract, multiply, and divide
1	Dry erase board with eraser and markers, 24 by 48″ (600 by 1200 mm)
1	Bulletin board, 24 by 36″ (600 by 900 mm)
1	Built-in plan rack with 12 holders
2	Metal four-drawer file cabinet [15″ (380 mm) drawer width] with lock
1	Four-drawer fire protection file, legal size, UL rating of "Class 350" minimum, with lock
8	Chairs
4	Waste baskets
1	Pencil sharpener
1	First-aid kit, Zee Medical, Model 0155, three-shelf filled metal cabinet or equal

Type II field office shall have a minimum floor space of 200 ft² (19 m²).

No.	*Item*
1	Double pedestal desk [approximately 60 by 34″ (1.5 by 0.86 m)], 2000 in² (1.3 m²) minimum
1	Plan and drawing table [approximately 30 by 72″ (0.76 by 1.8 m)] with adjustable stool
1	Printing calculator with paper, which will add, subtract, multiply, and divide
1	Dry erase board with eraser and markers, 24 by 48″ (600 by 1200 mm)
1	Bulletin board, 24 by 36″ (600 by 900 mm)
1	Built-in plan rack with six holders
1	Metal four-drawer field cabinet [15″ (380 mm) drawer width] with lock
1	Four-Drawer fire protection file, legal size, UL rating of "Class 350" minimum, with lock
6	Chairs
2	Waste basket
1	Pencil sharpener
1	First-aid kit, same as for Type I field office

Type III field office shall have a minimum floor space of 120 ft² (11 m²).

No.	*Item*
1	Double pedestal desk [approximately 42 by 30″ (1.07 by 0.76 m)], 1250 in² (0.81 m²) minimum
1	Plan and drawing table [approximately 30 by 72″ (0.76 by 1.8 m)] with adjustable stool
1	Printing calculator with paper, which will add, subtract, multiply, and divide
1	Metal four-drawer file cabinet [15″ (380 mm) drawer width] with lock
1	Four-drawer fire protection file, legal size, UL rating of "Class 350" minimum, with lock
3	Chairs
1	Waste basket
1	Pencil sharpener
1	First-aid kit, same as for Type I field office

759.03 Method of Measurement. The field office will not be measured.

759.04 Basis of Payment. The field office will be paid for on a monthly basis for the actual number of months that the office is acceptably provided by the Contractor. Partial months will be paid for at 0.033 month per day. Price and payment will constitute full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, utilities, and incidentals required to erect, maintain, and remove the field office and restore the parking and field office area to its original condition.

The Contractor shall reimburse the Department for all telephone installation charges, but monthly charges for telephone service will be paid by the Department.

The field office and equipment shall remain the property of the Contractor.

SECTION 760 – PAVEMENT - MILLING

760.01 Description. This work consists of milling or planing existing bituminous concrete and portland cement concrete pavement.

760.02 Construction Methods. The pavement milling machine shall be one which is suitable for the use in milling and planing bituminous and portland cement concrete pavements.

Milled materials shall be reused or otherwise disposed of as specified in Subsection 106.09.

760.03 Method of Measurement. The quantity of pavement-milling will be measured as the number of square yards per inch of depth (square meters per 25 millimeters of depth) shown on the Plans or as the number of square yards (square meters). Any additional depth, not approved by the Engineer in writing, will not be measured.

760.04 Basis of Payment. The quantity of pavement-milling will be paid for at the Contract unit price per square yard per inch of depth (square meter per 25 millimeters of depth) or at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for milling or planing the existing pavement; for removing and disposing of the milled material; and for all labor, tools, equipment, and incidentals required to complete the work.

SECTION 761 – BUTT JOINTS

761.01 Description. This work consists of constructing butt joints by saw cutting and removing the existing hot-mix, hot-laid bituminous concrete or portland cement concrete pavement to provide an area to butt the new hot-mix, hot-laid bituminous concrete pavement against the existing pavement.

761.02 Construction Methods. Construction methods shall conform to the requirements shown on the Plans. Saw cutting equipment shall conform to the requirements of Subsection 762.02. Any saw cut beyond the limits shown on the Plans shall be filled with approved sealant. Pavement that has been removed in order to construct the butt joint shall be disposed of as specified in Subsection 106.09.

761.03 Method of Measurement. The quantity of butt joints will be measured as the number of square yards (square meters) on the surface of the pavement as defined by the limits shown on the Plans.

761.04 Basis of Payment. The quantity of butt joints will be paid for at the Contract unit price per square yard (square meter). Price and payment will constitute full compensation for saw cutting, removing, and disposing of existing pavement; for sealing overcuts; and for all labor, materials, equipment, tools, and incidentals required to complete the work.

SECTION 762 – SAW CUTTING PORTLAND CEMENT AND HOT-MIX, HOT-LAID BITUMINOUS CONCRETE

762.01 Description. This work consists of mechanically saw cutting patch edges or tie-in joints into existing pavement.

762.02 Construction Methods. The equipment used shall be a saw cutting machine capable of cutting portland cement concrete and hot-mix, hot-laid, bituminous concrete pavements. The machine shall consist of a suitable motor driven diamond blade circular cutter with control devices, mounted on a sturdy frame. The equipment shall be capable of cutting a groove in a straight line to a sufficient depth so that an even, neat joint will be cut to allow removal of material without damage to the adjacent pavement. A continuous water supply shall be supplied to the cutting element either by a water tank on the equipment or by other means. Equipment other than that specified for saw cutting may be used if the material to be cut is hot-mix, hot-laid bituminous concrete. When saw cutting portland cement concrete for removal of pavement, the depth of saw cut shall be the full depth of the pavement.

762.03 Method of Measurement. The quantity of saw cutting portland cement concrete and hot-mix, hot-laid bituminous concrete will be measured as the actual number of linear feet (linear meters) of pavement saw cut and accepted, measured along the cut, end to end.

762.04 Basis of Payment. The quantity of saw cutting will be paid for at the Contract unit price per linear foot (linear meter). Price and payment will constitute full compensation for saw cutting portland cement concrete and hot-mix, hot-laid bituminous concrete and for furnishing all materials, labor, equipment, tools, and incidentals required to complete the work.

SECTION 763 – INITIAL EXPENSE

763.01 Description. This work consists of all operations necessary for the assembling and setting up of the Project, including the initial movement of personnel and equipment to the Project site, the establishment of the Contractor′s offices, shops, plants, storage areas, and sanitary facilities, any other activities required by the Contract documents and by local or State law and regulation, and all other work and operations which must be performed prior to beginning work on compensable items of work at the Project site. This work also includes obtaining the required insurance and bonds, and all other items required for the start of work.

763.02 Materials. Such materials as are required to assemble and set up the Project that are not to be a part of the completed work required by the Contract documents shall be the responsibility of the Contractor. The determination of the adequacy of the Contractor′s facilities, except as noted above, shall be made by the Contractor.

763.03 Construction Methods. All work done in providing the facilities and services under Section 763 shall be done in a safe and workmanlike manner.

763.04 Method of Measurement. Initial expense will not be measured.

763.05 Basis of Payment. When the amount bid for this item exceeds 5% of the total amount bid for the Contract, 2 1/2% of the total amount bid will be paid on each of the first two monthly estimates and that portion exceeding 5% will be paid on the final payment estimate. When the amount bid for this item is 5% or less of the total amount bid for the Contract, 50% of the lump sum Contract price for initial expense will be paid on each of the first two monthly estimates. Price and payment will constitute full compensation for all labor, materials, equipment, tools, and incidentals required to complete the

work. Payment of the Contract lump sum price for initial expense will not be made more than once, regardless of the fact that the Contractor may have for any reason shut down work on the Project or moved equipment away from the Project and then back again.

The cost of required insurance and bonds, and any other initial expense required for the start of work will be included in this Section.

DIVISION 800 – MATERIAL DETAILS

SECTION 800 – MATERIAL DETAILS

Where any Specification or test has an AASHTO or ASTM number followed by the word "Modified", it shall mean as modified by the Delaware Division of Highways Materials Manual in effect on the date of advertisement for bids.

Whenever any material is required for the work, the Contractor warrants and agrees that such material has been tested and shall be suitable, compatible, and useable in the work and for the Project.

QUALITY CONTROL.

The Contractor shall perform all tests required by the Contract and such other tests that the Contractor shall determine are necessary to verify the quality and suitability of all materials used in the Project. For all required tests, the Contractor shall submit test results or samples as requested by the Department, and shall obtain necessary approvals prior to use on the Project. The approval of any material or source of supply of such material shall not relieve the Contractor of the responsibility to supply a material which is compatible with all other materials to be used on the Project, as such materials are normally used, without defect and for the anticipated life of the Project. The Contractor warrants that all materials used in the work or Project shall be made, manufactured, processed, or produced by suitable means, that all materials have been tested with satisfactory results, and that all materials may be compatibly incorporated into the work or Project without defect. The Contractor further warrants with respect to all materials used on the Project that:

(a) The ownership and title to such materials shall be clear when incorporated and used in the work or Project and the Contractor shall have the right to lawfully transfer ownership or title of all materials used in the work to the Department. All materials used in the work shall be free from any security interest, lien, or other incumbrance. It shall be the sole responsibility of the Contractor to resolve any security interest, lien, or other incumbrance placed on materials used in the work or Project.

(b) All materials used in the work shall be merchantable, shall be fit for the ordinary purpose for which such material is used, and shall be fit and useable for the particular purpose for which such material is intended to be used in the work or Project, as such terms are used in the Delaware Uniform Commercial Code.

Any material which is not merchantable, not fit for the ordinary purpose for which such material is used, or which is not satisfactory for use for the particular purpose required in the work or Project shall be considered as defective. It shall be the Contractor′s responsibility to determine that the material meets these criteria, and the Contractor warrants that any and all necessary tests or evaluations of such material have been made to determine material compatibility and suitability for use in the work or Project.

SECTION 801 – PORTLAND CEMENT AND BLENDED HYDRAULIC CEMENTS

This material consists of portland cement and blended hydraulic cements conforming to the following requirements:

(a) *Portland Cement.* Portland cement shall conform to the requirements of AASHTO M 85, except "Fineness" shall be measured by the air permeability test, and a maximum specific surface of 420 m^2/kg will be permitted. Unless otherwise specified, cement shall be either Type I or Type II.

(b) *Blended Hydraulic Cements.* Type IP or Type I(PM) or Type IS or Type I(SM) cement, conforming to the requirements of AASHTO M 240, will be permitted as an alternate to Type I or Type II cement in all classes of concrete, subject to the following conditions:

Type IP or I(PM): (fly ash)	1. The pozzolan that is blended with the portland cement shall conform to Section 822. 2. The pozzolan constituent, fly ash, shall be a minimum 20% by weight of the portland cement and fly ash total weight. 3. the concrete mixture incorporating Type IP or Type I(PM) cement shall conform to the requirements applicable to its use.
Type IP or I(PM): (Silica fume)	1. The silica fume that is blended with the portland cement shall conform to the rquirements of AASHTO M 307. 2. the silica fume shall be a minimum of 7% and a maximum of 10% by weight of the portland cement and silica fume total weight. 3. The concrete mixture incorporating Type IP or Type I(PM) cement shall conform to the requirements applicable to its use.
Type IS or I(SM): (ground granulated blast furnace slag)	1. The ground granulated blast furnace slag that is blended with the portland cement shall conform to the requirements of AASHTO M 302, Grade 100 or Grade 120. 2. the slag shall be a minimum of 35% and a maximum of 50% by weight of the portland cement and slag total weight. 3. The concrete mixture incorporating Type IS or Type I(SM) cement shall conform to the requirements applicable to its use.

Reserved bins shall be sampled by the Department or its authorized representative, and all tests shall be completed before the cement is accepted. Only pretested and accepted cement shall be used.

Orders for cement shall be placed with the manufacturer at least ten days before the first shipment is made.

Railroad cars and truck transports used to transport bulk cement shall be of a design that can be properly and completely unloaded. They shall be loaded and sealed by authorized representatives of the Department, and the seals will be removed by authorized representatives of the Department.

All cement used in any one Contract item shall be of a single brand, from a single mill, unless otherwise authorized in writing by the Engineer.

Upon approval from the Engineer, the preceding requirements for reserved bins and sealed shipments may be waived if the cement manufacturer qualifies for inclusion in the program of certification.

A manufacturer may become qualified by establishing a history of satisfactory quality control of cement produced as evidenced by results of tests performed by the Department and the manufacturer's testing laboratory, and upon approval of production and storage facilities by the Engineer. The manufacturer shall conduct sufficient tests to ensure that adequate quality control is maintained and that cement furnished conforms to the specification requirements. The manufacturer shall maintain a record of all tests for review by the Engineer. Samples for tests of any cement may be taken at any time necessary as determined by the Engineer.

Cement manufacturers will be furnished specific details on requirements; however, the Engineer reserves the right to modify the program for all participants, as required, or to impose additional or special requirements on manufacturers as considered necessary to maintain control.

Any manufacturer who fails to cooperate in a satisfactory manner or cannot furnish cement within the established limits of acceptance will be required to cease participation in the certification program. In such cases, pretesting, reserved bins, and sealed shipments will be required.

The temperature of the portland cement at the time of delivery to the paver or mixer shall not exceed 150 °F (66 °C).

SECTION 802 – NORMAL FINISHING HYDRATED LIME

Finishing hydrated lime shall conform to the requirements of ASTM C 206, Type N.

SECTION 803 – WATER FOR MIXING PORTLAND CEMENT CONCRETE

Water used in mixing, curing, or other designated applications shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water will be tested in accordance with AASHTO T 26. Water known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be enclosed to exclude silt, mud, grass, or other foreign materials.

The water shall conform to the following requirements:

Hydrogen ion concentrations	4.5 to 8.5 pH
Total solids	5000 ppm
Total chlorides	300 ppm
Soluble SO_4	500 ppm
Total alkalis as Na_2 plus $0.658K_2O$	500 ppm
Organic content	2000 ppm
Compressive strength, minimum	90% of control
Time of setting, Vicat	±60 minutes from control and within the specifications of AASHTO M 85

SECTION 804 – FINE AGGREGATE

Fine aggregate for use in portland cement concrete shall conform to the requirements of AASHTO M 6, except the grading shall be:

Sieve Size	*Percent Passing*
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	95 - 100
No. 50 (300 µm)	5 - 30
No. 100 (150 µm)	1 - 10
No. 200 (75 µm)	0 - 4

*Fineness Modulus:*2.3 to 3.1

The organic impurities requirement will be waived for fine aggregate specified for uses other than in portland cement concrete.

SECTION 805 – COARSE AGGREGATE

Coarse aggregate shall conform to the requirements of AASHTO M 80 except no gravel, crushed gravel, or crushed concrete shall be used. Also, the requirements of Section 2.1, percentage of wear, Los Angeles Test, shall not be more than 45%. If air-cooled, blast-furnace slag is used, it shall weigh not less than 70 pounds per cubic foot (1.12 metric tons per cubic meter) when tested according to AASHTO T 19/T 19M.

SECTION 806 – CALCIUM CHLORIDE

Calcium chloride shall be Type S, Grade 1, Class A conforming to AASHTO M 144.

SECTION 807 – MATERIAL FOR RESEALING JOINTS AND CRACKS

This material shall consist of a blend of asphalt cement and 18 ± 2% by weight of a mixture of recycled, reclaimed crumb rubber.

MATERIALS.

(a) *Asphalt.* The asphalt used shall have a maximum penetration of 150 as determined by AASHTO T 49.

(b) *Crumb Rubber.* The recycled, reclaimed crumb rubber used in the mixture:

(1) shall be produced from a process that crushes, tears, grinds, or abrades the used rubber at or above ordinary room temperature, and produces rubber particles with a very ragged, sponge-like surface. Grinding rubber at cryogenic temperatures is prohibited.

(2) shall contain recycled, vulcanized crumb rubber or reclaimed, devulcanized rubber, or both.

(3) shall contain a minimum of 25% natural rubber by weight of the total rubber portion of the mixture.
(4) shall contain no more than a trace of fabric.
(5) shall be free of wire and other contaminating materials, except that up to 4% calcium carbonate or talc may be included to prevent the rubber particles from sticking together.
(6) shall have no rubber particles greater than ¼″ (6 mm) in length.
(7) shall conform to the following gradation requirements:

Sieve Size	*Percent Passing*
No. 10 (2.00 mm)	100
No. 16 (1.18 mm)	90 - 100
No. 30 (600 µm)	40 - 80
No. 80 (180 µm)	0 - 10

MIXTURE REQUIREMENTS.

(a) *Pour Point.* The pour point shall be at least 20 °F (11 °C) lower than the safe heating temperature, which is the maximum temperature to which the material may be heated without exceeding the permitted flow.
(b) *Cone Penetration.* Penetration shall not exceed 90 at 77 °F (25 °C), 150 g, five seconds.
(c) *Flow.* The flow shall not exceed 5 mm at 140 °F (60 °C).
(d) *Bond.* The sealant shall be tested at 0 °F (-18 °C) for five complete cycles. The development at any time during the test procedure of a crack, separation, or other opening that at any point is over ¼″ (6 mm) deep in the sealant or between the sealant and mortar block, shall constitute failure of the test specimen. The depth of the crack, separation, or opening shall be measured perpendicular to the side of the sealant showing the defect. At least two test specimens in a group of three representing a given sample of sealant shall meet this requirement for bond.
(e) *Packaging.* The pre-mixed sealant shall be packaged in units weighing no more than 30 lb (13.6 kg) with a maximum of two 30 lb (13.6 kg) units per shipping container. The plastic film used in packaging the units shall readily melt at normal application temperatures when placed in the installation equipment. Bonding or sticking of the packaged units to each other or to the shipping container or packaging causing unnecessary contamination of the sealant with staples and fasteners, as determined by the Engineer, shall be sufficient cause for rejection of the material.

SECTION 808 – JOINT SEALS AND SEALANTS

808.01 Description. This material shall consist of seals and sealants for portland cement concrete joints.

808.02 Portland Cement Concrete Pavement. Materials for sealing joints in portland cement concrete pavement shall be as follows:
(a) *Hot-Poured Joint Sealant.* Hot-poured joint sealant shall conform to AASHTO M 301 or AASHTO M 282.
(b) *Preformed Elastomeric Compression Joint Seals.* Preformed elastomeric compression joint seals shall conform to the requirements of AASHTO M 220. The lubricant used to install the preformed elastic joint sealant shall be a one-component, polychloroprene compound containing

only soluble phenolic resins blended together with anti-oxidants and acid acceptors in an aromatic hydrocarbon solvent mixture and shall have the following physical properties:

(1) Average net weight per gallon: 7.84 lb (liter:0.94 kg) +5%.
(2) Solids content by weight: 22 to 28%.
(3) Viscosity shall be such that the lubricant performs suitably with the installation equipment.
(4) The lubricant shall remain fluid from 5 to 120 °F (-15 to 49 °C).
(5) Film strength (ASTM D 412): 2300 psi (16 MPa) minimum tensile strength, 750% minimum elongation before breaking.
(6) The lubricant shall be stored at a temperature between 50 and 80 °F (10 and 27 °C). Any lubricant not used within 270 days of its manufacture shall be unacceptable.

(c) *Low-Modulus Silicone Rubber Joint Sealant.* Low-modulus silicone rubber joint sealant to be used on the Project shall be submitted for approval by the Engineer.

808.03 Continuously Reinforced Portland Cement Concrete Pavement. Materials for sealing joints in continuously reinforced portland cement concrete pavement shall conform to AASHTO M 282.

808.04 Portland Cement Concrete Structures. Materials for sealing joints in portland cement concrete structures shall be as follows:

(a) *Preformed Elastomeric Compression Joint Seals.* Preformed elastomeric compression joint seals shall be composed of open cell polychloroprene and conform to AASHTO M 220.

(b) *Rubber Joint Sealant.* Rubber joint sealant shall be a multipart chemically curing polyurethane or polysulfide sealant which meets or exceeds the curing requirements of Federal Specification TT-S-00227E(3), Type I (Flow Type) and Type II (Nonsag Type), Class A, (Compounds resistant to 50% total joint movement). The color shall be grey to match the concrete.

(c) *Bituminous Joint Sealant.* Bituminous joint sealants may be hot applied conforming to AASHTO M 173 or equivalent, or cold applied elastomeric sealant conforming to Federal Specification SS-S-200E(2), Type H.

(d) *Preformed Expansion Joint Material.* Unless otherwise specified on the Plans or in the Special Provisions, preformed expansion joint material for portland cement concrete structures shall conform to the requirements of AASHTO M 153, Type III, self-expanding cork.

808.05 Concrete Slope Paving. Materials for sealing joints in concrete slope paving shall be as follows:

(a) *Hot-Poured Joint Sealant.* Hot-poured joint sealant shall conform to the requirements of Subsection 808.02 (a).

(b) *Preformed Expansion Joint Material.* Preformed expansion joint material shall conform to the requirements of AASHTO M 153, Type I.

808.06 Portland Cement Concrete Curb and Integral Curb and Gutter. Materials for portland cement concrete curb and integral curb and gutter shall be preformed expansion joint material of ½″ (13 mm) nominal thickness and shall conform to the requirements of AASHTO M 153, Type II or Type III. Preformed expansion joint material of other types may be used for portland cement concrete curb and integral curb and gutter provided they are approved by the Engineer.

SECTION 809 – EMULSIFIED ASPHALT FOR STABILIZATION

Asphalt for soil stabilization shall be a high-float, medium setting emulsion conforming to the requirements of AASHTO M 140, Grade HFMS-2s.

SECTION 810 – ASPHALT CEMENT

Asphalt cement shall be prepared by the refining of crude petroleum using methods conforming to industry standards. The asphalt cement shall conform to the requirements of AASHTO M 226, Table 2.

When tested by ignition, the inorganic insoluble residue content of the asphalt cement shall not exceed 0.25% by weight.

SECTION 811 – EMULSIFIED ASPHALT

Emulsified asphalt shall conform to the requirements of AASHTO M 140 for anionic emulsions or AASHTO M 208 for cationic emulsions.

SECTION 812 – PORTLAND CEMENT CONCRETE

812.01 Description. This material consists of portland cement, fine aggregate, coarse aggregate, water, and admixtures mixed in the specified proportions for the various classes of concrete.

812.02 Materials.

(a) *Portland Cement.* Portland cement shall conform to the requirements of Section 801.

(b) *Water.* Water shall conform to the requirements of Section 803.

(c) *Fine Aggregate.* Fine aggregate shall conform to the requirements of Section 804.

(d) *Coarse Aggregate.* Coarse aggregate shall conform to the requirements of Section 805.

(e) *Gradation.* Coarse aggregate shall conform to the requirements of Section 813, No. 57.

(f) *Air Entrainment Agent.* An air-entrainment agent conforming to the requirements of AASHTO M 154 shall be introduced into the mixer by an approved automatic dispenser.

(g) *Chemical Admixtures.* Chemical admixtures shall conform to the requirements of AASHTO M 194 for the seven types as follows:

Type A - Water Reducing
Type B - Retarding
Type C - Accelerating
Type D - Water Reducing and Retarding
Type E - Water Reducing and Accelerating
Type F - Water Reducing, High Range
Type G - Water Reducing, High Range and Retarding

For concrete Classes A and D, calcium chloride or other admixtures containing detrimental amounts of chloride salts shall not be used in the concrete. The chloride content of bridge deck concrete shall not exceed 0.10% by weight of cement.

(h) *Fly Ash.* Fly ash may be used as an additive in concrete in order to promote workability and plasticity. Fly ash shall conform to the requirements of Section 822.

(i) *Curing Materials.* Curing materials shall be as follows:

(1) *Liquid Membrane Compounds.* The material shall conform to the requirements of AASHTO M 148, for Type 2, Class A or B white-pigmented liquid curing compound. Acceptance for continued use will be based upon satisfactory field performance.

(2) *Polyethylene Sheeting.* Polyethylene sheeting shall conform to the requirements of AASHTO M 171.

(3) *Waterproof Paper.* Waterproof paper shall conform to the requirements of AASHTO M 171. The name of the manufacturer shall be marked or imprinted clearly on the paper for proper identification.

(4) *Water Cure.* The water shall conform to Section 803.

(j) *Samples.* The source of fine aggregate, coarse aggregate, cement, additives, and admixtures shall be submitted to the Department's Materials and Research Section prior to any concreting operations in sufficient time so mix design verification may be performed.

Coarse and fine aggregates for use in portland cement concrete mixtures will also be evaluated for potential alkali-silica reactivity using ASTM C 1260 Mortar Bar Method and may be evaluated by ASTM C 295 Petrographic Examination. Furthermore, if available, field service records of the aggregate in concrete will be evaluated. Aggregate sources determined to be reactive with cement alkali will be permitted in concrete mixtures using either low alkali (0.6% or less) cement or Type IP cement. Use of high alkali cement will be permitted with these aggregates provided one of the following options is used to modify the cement matrix:

(1) Substitution of 35 to 50% of the portland cement with ground granulated blast furnace slag conforming to AASHTO M 302, Grade 100 or Grade 120;

(2) Substitution of 7 to 10% of portland cement with silica fume conforming to the requirements of AASHTO M 307; or

(3) A minimum 20% substitution of portland cement with fly ash conforming to Section 822; or

(4) Use of a lithium-based admixture at a dosage rate based upon the sodium oxide equivalent (AASHTO M 85) of the portland cement component of the concrete. The lithium dosage shall be 1 lb (1 kg) of lithium hydroxide monohydrate per 1 lb (1 kg) of sodium oxide equivalent of the portland cement, with a minimum dosage of 0.60% by weight of the portland cement. Other approved lithium compound may be used but shall be dosed in equivalents of lithium hydroxide monohydrate. All lithium salts shall be certified as non-hazardous based on the heavy metal content. Mixing shall be as per manufacturers recommendation.

(k) *Fiber Reinforcement.* Fiber reinforcement shall conform to the requirements of Subsection 824.02(j).

812.03 Handling and Storing Materials.

(a) *Aggregate.* Aggregate stockpiles shall be placed on hard, clean, and well drained surfaces of acceptable materials such as portland cement concrete, or hot-mix bituminous concrete and be of sufficient thickness to withstand the loadings of construction equipment. If, at any time, the surfaces break up so as to possibly contaminate the aggregate stockpiles, the concrete operation shall be immediately stopped until such time that the surfaces may be repaired. Prior to stockpiling aggregates, the Department's Materials and Research Section shall be contacted for approval of the base surface material. Coarse and fine aggregate shall be kept separate during

transportation, handling, and storage until batched. If necessary, suitable partitions shall be constructed to prevent mixing of the fine and coarse aggregates.

Aggregate stockpiles shall be constructed in horizontal layers not exceeding 5′ (1.5 m) in depth in order to avoid segregation. Segregated material shall be removed from stockpiles and disposed of or remixed to the satisfaction of the Engineer.

Fine aggregate shall be stockpiled at the batch plant a minimum of 24 hours prior to batching or longer if required until surplus water has disappeared and the material has a uniform free moisture content. Wet fine aggregate shall not be placed where it becomes mixed with material being used for batching. Suitable partitions shall be constructed to prevent mixing of the wet fine aggregate and the fine aggregate being used for batching. Batching direct from the washing plant will not be permitted.

Haul roads to the concrete plants shall be of such base as to prevent any deleterious materials from being incorporated into the stockpiles and into the concrete itself. If at any time, deleterious materials are found in the stockpiles, the concrete operation shall be immediately stopped.

(b) *Cement.* Reclaimed cement or cement that shows evidence of hydration, such as lumps or cakes, shall not be used. All cement shall be stored in suitable weatherproof structures that protect the cement from dampness.

(c) *Fly Ash.* Fly ash which shows evidence of hydration, such as lumps or cakes, shall not be used. All fly ash shall be stored in suitable weatherproof structures that protect the fly ash from dampness and other contamination.

(d) *Admixtures.* Admixtures shall be stored and handled in such a manner that contamination or deterioration is prevented. Admixtures shall not be used unless thoroughly agitated to the satisfaction of the Engineer or the Engineer′s agent. Partially frozen admixtures shall not be used. When the amount of admixture required to give the specified results deviates appreciably from the manufacturer′s recommended dosage, the use of this material shall be discontinued unless conditions justify a change in the dosage.

812.04 Composition of Mix. The Engineer will determine the proportions of materials to be used that will produce a workable, dense, concrete conforming to the requirements of Table 812-A for the class of concrete specified. ACI design methods will be used as a guide in determining aggregate proportion. Exceptions to these requirements are as follows:

(a) The producers of prestressed, precast reinforced concrete items complying with these specifications shall determine mix design proportions for concrete proposed for use. The mix design proportions shall be submitted to the Department′s Materials and Research Section for approval prior to use.

(b) The Contractor shall submit to the Department′s Materials and Research Section sources of all materials and mix design proposed for production of Class D concrete prior to any work. Such submission shall be made in sufficient time for preparation of laboratory or field trial mixes and 28-day strength determinations. Field trial mixes shall be made at the concrete supply location and shall consist of 3 yd^3 (2.3 m^3) (minimum) batches of concrete. All materials, equipment, and labor required to produce the field trial mixes shall be supplied by the Contractor.

(c) For slip-form paving, concrete shall be Class B with the following restrictions:

(1) The composition of the mix shall be such to produce concrete with a slump of 1 to 2½″ (25 to 65 mm) when tested at the time of placement in accordance with AASHTO T 119.

(2) Concrete shall be "central mixed".

(3) Transportation of the concrete shall be only by approved trucks that demonstrate satisfactory loading at the central mix plant and unloading at the Project site.

(4) The design strength shall be 3500 psi (24 MPa) compressive strength at 28 days.

The Engineer will determine the proportions of materials to be used that will produce a workable, dense concrete conforming to the requirements of this Section, Class B as modified above. Should proportions determined by the Engineer vary due to changes in the material originally submitted, no additional compensation will be made. To improve mix workability and consistency, the Contractor may substitute at its expense up to 50% of the Type I portland cement in the Class B mix with ground granulated blast-furnace slag meeting the requirements of AASHTO M 302, Grade 120. The ground slag-portland cement blend will be approved by the Engineer prior to use and may be adjusted at the discretion of the Engineer as field conditions warrant. ACI design methods will be used as a guide in determining aggregate proportions that will produce a workable, plastic concrete having the specified design strength. Should the proportions determined by the Engineer vary due to changes in the materials originally submitted by the Contractor, no additional compensation will be made.

(d) Producers wishing to use fly ash as an additive or a partial replacement for portland cement, shall determine the mix design proportions for the concrete proposed for use. Fly ash use as partial replacement for portland cement in mixtures containing Type I (PM) or IP cement is prohibited.

For mixes containing fly ash, laboratory testing, which is the responsibility of the producer, shall be performed documenting the design's conformance to all requirements and noting that air entrainment is of special concern. Identification of the sources of materials, the mix design proportions, and the results of the laboratory testing of the proposed mix design shall be submitted to the Department's Materials and Research Section for approval prior to use of the design. The producer shall supply appropriate samples of the design materials. The Contractor shall allow for up to five weeks for evaluation by the Department's Materials and Research Section.

When a mix containing fly ash is used, the Contractor shall perform extra sampling and testing of the concrete mixture, as deemed necessary by the Engineer, in order to detect possible harmful variations in the quality of the mix before forms and supports are removed and loading applied. Samples shall be cured in the same ambient temperature as the placed material, in order to more accurately represent the strength of the placed material. Delays due to slow strength gain from a fly ash mix shall not be considered for an extension of time allowed for the completion of the Project.

The requirements of each class of concrete specified are included in the following table:

Table 812-A

Class of Concrete		*A*	*B*	*C*	*D*
Design Compressive Strength, f'_c at 28 days, (Note1)	psi (MPa)	4500 (30)	3000 (20)	2000 (15)	4500 (30)
Design Cement Content, minimum, (Note 2)	sacks/yd³ (sacks/m²) lb/yd³ (kg/m³)	7 1/2 (9.8) 705 (418)	6 (7.8) 564 (334)	4 1/2 (5.9) 423 (251)	7 1/2 (9.8) 705 (418)
Design Water to Cement Ratio, W/C = Weight Cement (Note 3)		0.40	0.45	0.60	0.40
Required Air Content, % (Note 4)		4-7	4-7	4-7	4-7
Required Slump, (Note 5)	in (mm)	2-4 (50-100)	2-4 (50-100)	2-4 (50-100)	2-4 (50-100)
Required Admixtures (AASHTO M 194) (Notes 6 and 7)		A, D, F, G	A, D, E, F, G	A, D, E, F, G	A, D, F, G
Notes 8, 9, 10, and 11 refer to all classes of concrete.					

Note 1: In addition to meeting the specified f'_c design compressive strength, Class D concrete shall achieve f_{cr}, which is the required average compressive strength for f'_c. The required average compressive strength, f_{cr}, shall be the minimum compressive strength required for mix approval and shall be in excess of the 4500 psi (30 MPa) design compressive strength, f'_c. The degree of excess compressive strength necessary shall depend on expected uniformity of concrete production as per criteria established in the ACI Standard 214. Upon establishment of standard deviation data, the following ACI 318M required average compressive strength values shall govern acceptance of the trial mix proportions:

f_{cr} = 4900 psi (33.8 MPa) if standard deviation is less than 300 psi (2.1 MPa)
= 5050 psi (34.8 MPa) if standard deviation is within 300 to 400 psi (2.1 to 2.8 MPa)
= 5200 psi (35.8 MPa) if standard deviation is within 400 to 500 psi (2.8 to 3.5 MPa)
= 5400 psi (37.2 MPa) if standard deviation is within 500 to 600 psi (3.5 to 4.1 MPa)

If the standard deviation exceeds 600 psi (4.1 MPa), the concrete production facility shall be unacceptable for Class D concrete production. A probability of not more than one in ten tests falling below the specified compressive strength will be used to compute the required compressive strength. The average 28-day compressive strength of two companion molded 6 by 12″ (152 by 305 mm) or 4 by 8″ (102 by 203 mm) cylinders prepared from the same batch of concrete shall be considered a "test".

Note 2: For Class D concrete, the average compressive strength and coefficient of variations shall be computed upon the availability of 28-day compressive strength data comprising a minimum of 15 tests from the concrete production plant. Should these determinations indicate an excessive margin of safety, the concrete mix may be modified to produce a lower average compressive strength as approved by the Department's Materials and Research Section, but in no case shall the cement content be reduced to less than 7 sacks/yd³(658 lb/yd³) [9.2 sacks/m^3 (390 kg/m^3)]. Should determination indicate a lower average compressive strength or a higher coefficient of variation than anticipated, the quality of the concrete will be evaluated, and mix proportions adjusted as required; however, cement content may not exceed 8 sacks/yd³ (752 lb/yd³) [10.5 sacks/m^3 (446 kg/m^3)].

Note 3: Water to cement ratio may be expected to vary ±5% depending on varying atmospheric and other related conditions.

Note 4: Water reducing admixtures shall be required in all concrete. The quantity and AASHTO type or combination of AASHTO types of admixtures shall be determined by the Contractor depending on the ambient temperature,

concrete temperature, time of day, thickness of concrete, concrete mix proportions, etc. and the amount and proper type of superplasticizer and/or retarder necessary. The Contractor shall be responsible for the quality of the concrete placed in any weather or atmospheric condition. Failure to achieve a satisfactory product shall be corrected as directed by the Engineer at the Contractor's expense.

Note 5: If a Type F or G admixture is used, the maximum slump shall be 8″ (200 mm).

Note 6: The total chloride content of concrete mixtures, when tested in accordance with the requirements of AASHTO T 260, shall not exceed the following:

a. Prestressed concrete:0.06%.
b. Conventionally reinforced concrete in a moist environment and exposed to chloride deicing salts or marine conditions:0.10%.
c. Conventionally reinforced concrete in a moist environment or areas with potential moisture condensation but not exposed to chloride:0.15%.

Limits are expressed as a percentage of the total weight of the portland cement and fly ash in the concrete mix.

Note 7: In calculating the "Water to Cement Ratio" for mixes containing cementitious materials other than portland cement, the weight of the portland cement plus the weight of the cementitious material represents the weight of cement.

Note 8: Consistency of the mix shall be determined by AASHTO T 119. Air content shall be determined by AASHTO T 152, Modified, or AASHTO T 196. Making and curing concrete test specimens shall be in accordance with AASHTO T 23 and it shall be the responsibility of the Contractor to ensure that the seven- and 28-day cylinders are cured for the first 24 to 48 hours in an environment to provide satisfactory moisture and temperature control as per AASHTO T 23.

Note 9: Concrete shall be placed only if the surface evaporation rate, as affected by ambient air temperature, concrete temperature, relative humidity, and wind velocity is less than or equal to 0.15 lb/ft² (0.73 kg/m^2) per hour. The Contractor shall determine and document the evaporation rate at the site of the concrete placement, subject to verification by the Engineer. The chart contained in "Plastic Cracking of Concrete" by Delmar Bloem for the National Ready Mixed Concrete Association and published in ACI 305R-89 shall be used to determine the loss of surface moisture for the concrete. The chart may be obtained from the Department's Materials and Research Section.

Note 10: Fixed-form concrete shall meet all requirements of Class B except the 28-day compressive strength shall be 3500 psi (24 MPa).

Note 11: The Contractor has the right to modify their mix design for any class of concrete. The modified mix design will be reviewed by the Engineer prior to approval. The approval will be based upon tests performed by the Contractor and approved by the Engineer.

Note 12: Class D concrete shall have fiber reinforcement added at the rate of 1.5 lb/yd³ (0.90 kg/m³).

812.05 Mix Temperature Limitations. The Contractor shall be responsible for the quality of the concrete placed in any weather or atmospheric conditions.

The concrete shall have a temperature of 70 ± 20 °F (21 ± 11 °C) at the time of placement unless prior permission has been granted to exceed these tolerances; however, concrete for bridge decks shall not exceed 85 °F (30 °C).

In hot weather, the water or aggregate, or both shall be cooled as necessary to maintain the concrete temperature within the specified limits. When the temperature of the plastic concrete reaches 84 °F (29 °C) at the mixing plant, particular attention shall be given to the sprinkling and wetting of the foundation and forms, the maintenance of the coarse aggregate stockpile in a saturated surface-dry condition through use of stockpile sprinklers, the placing and finishing operations, and the prompt starting of the curing operation. When the temperature of the plastic concrete reaches 90 °F (32 °C) at the mixing plant, immediate steps shall be taken to cool the mixing water or aggregate, or both in order to maintain a plastic concrete temperature of 90 °F (32 °C) or less. If such actions are not successful in reducing the concrete temperature, mixing operations shall cease.

812.06 Delivery Restrictions. The time elapsing between the introduction of water to the mix and the placing of the concrete shall be 30 minutes maximum for non-agitating type haul equipment or

60 minutes maximum for agitating type haul equipment. For Class B slip-form concrete, the time elapsing between the introduction of water to the mix and the placing of the concrete shall be 45 minutes maximum for non-agitating type haul equipment of 60 minutes maximum for agitating type haul equipment. Any concrete which has not been placed within these time limits will be rejected for use in the work. These delivery time restrictions may be extended by the Department's Materials and Research Section when an approved water reducing and set retarding admixture is used provided the concrete remains workable for the use intended.

The interval between placing successive loads shall be as directed, however, in no case shall the interval exceed 20 minutes in order that concrete in place shall not have become partially hardened prior to placing successive batches, unless approved in writing by the Engineer.

The method and time of delivery shall be controlled by plant slips signed by the Engineer and issued to the truck driver. The slips shall indicate the name and location of the plant, the size and proportions of the batch, type of admixture used, and the time the mixer is charged. Upon arrival on the job, each slip shall be delivered to the Engineer and will be completed to show the time the concrete is discharged from the truck.

The Contractor shall notify the Department's Project and plant inspectors at least 24 hours prior to the placement of any concrete so that inspection services can be provided.

812.07 Plant and Equipment Requirements

(a) *General Requirements.* All concrete batch plants offered for Department approval shall be equipped for automatic batching and proportioning of all cement, aggregates, and water and for visual observation of automatic insertion of admixtures.

All currently approved concrete batch plants shall retain approved status, unless the approval is rescinded for failure to comply with the batch plant requirements specified herein and the requirements of the current version of AASHTO M 157 for concrete batch plants. In the case where approval is rescinded, reinstatement shall be on the basis of the requirements for automation as specified for approval of plants in the previous paragraph.

The batch plant and all equipment and facilities necessary for performing the work will be inspected and approved by the Engineer as to design, capacity, and condition well in advance of the start of construction. The batch plant shall conform to the requirements of AASHTO M 157, except as modified herein.

A laboratory of 150 ft² (14 m^2) minimum shall be provided for the exclusive use of the Engineer at all portland cement concrete facilities. The producer shall furnish all heat, lights, air conditioning, telephone, electric, bottled drinking water, tables, desk, chairs, file cabinets, and all testing equipment or devices to control the production and quality of the concrete. Approved sanitary facilities shall be furnished and maintained.

Inspection of all equipment incidental to the production and transportation of concrete will be performed by the Engineer either on an annual basis or prior to commencement of work on the Contract. If at any time during construction, the equipment is not performing satisfactorily, it shall be repaired prior to re-use. If the concrete plant is to be used for night pours, ample lighting shall be provided to satisfactorily illuminate the aggregate stockpiles along with all areas where the Engineer or the Engineer's representative will be performing testing.

(1) *Bins and Hopper.* The bins shall be in good condition and have adequate separate compartments for fine aggregates and for each required size of coarse aggregate. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the

weighing hopper is being approached, the material may be added slowly and shut off with precision.

The hopper and its appurtenances shall be constructed to eliminate the retention of varying tare materials on any of its parts and operated to ensure a rapid and complete discharge without shaking and jarring the scales.

(2) *Weighing Equipment.* The scales for weighing material shall be either of the horizontal beam or the springless dial type and shall be the product of an established manufacturer. They shall be of rugged design, constructed to support the hopper or hoppers and with minimum adjustments consistent with the accuracy required. Scale levers shall be of such design, construction, and material to permit frequent handling without damage.

Pivots shall be of steel, sufficiently hardened and tempered to ensure minimum wear under a heavy volume of weighing. They shall be accurately set in substantial mountings to ensure a permanent spacing of the knife edges under all conditions of loading and to prevent them from being loosened by the vibration incident to usage.

Multiple weigh beams on scales to be used for weighing more than one kind of material shall have as many beams as there are different kinds of material to be weighed on the scales. All weigh beams shall be horizontal. The trig loop shall allow movement of the weigh beam above and below the horizontal position for proper operations of the telltale dial as hereinafter specified. The free end of the weigh beam shall be equipped with a suitable device for indicating clearly and accurately the horizontal position of the weigh beam.

Provisions such as a telltale dial shall be made for indicating to the scale operator that the required load in the weighing hopper is being approached. Such a device shall indicate at least the last 200 lb (90 kg) of load.

Poises shall be constructed so they cannot be easily removed from the beam and shall be equipped with a device to hold them firmly in place. Poises and weigh beam shall be made of noncorrosive material and shall be of sufficient hardness to prevent excessive wear.

Graduated dials shall be provided with suitable markers placed outside the glass cover and set closely in front of the dial for use in determining the position of the dial indicator for predetermined loads in the weigh hopper. Provisions shall be made to prevent dirt from collecting in and around the dial mechanism. Means shall be provided for obtaining and maintaining proper alignment between the dial and the part of the scale which transmits the load to the dial. The dial face shall be of a material which is not affected by moisture. The value of the graduations of scales weighing 5000 lb (2250 kg) or less shall not be greater than 5 lb (2.25 kg). The value of the graduations of scales used in weighing over 5000 lb (2250 kg) shall not be greater than 0.1% of the rated capacity of the scales.

Scales shall be so constructed that they are maintained within a maximum tolerance of 0.5% of the net load in the hopper.

Clearance shall be provided between the scale parts and the hopper or bin structure to prevent displacement of or friction between the scales due to vibration or any other cause.

Each scale installation shall be provided with at least 10 standard 50 lb (eleven standard 20 kg, one standard 5 kg, and two standard 1 kg) weights, available for use at the plant at all times for checking scale accuracy. These weights shall be checked for true weight at the Engineer's discretion.

The weights shall be made of high quality cast iron and shall be cast and finished in such a manner that foreign material will not adhere to the surface.

All batching controls shall be positioned so as to allow the operator full view of all scales and admixture dispensers.

The weighing equipment, including dials, weigh beams, bins, and operating levers shall be so arranged that the Department's representatives have a clear and unobstructed view of the weighing operations at all times.

All working parts of the scales, particular knife edges, shall be protected to prevent any material, except windborne material, from falling upon or against them. Suitable windbreaks shall be constructed, when necessary, to prevent variation of the scale mechanism by winds. All working parts of the scales shall be readily accessible for inspection and cleaning.

The individual aggregates, as weighed, shall be within 1% of the required weight, and the total weight of the aggregates shall be within 1% of the required total weight.

All scales shall be checked regularly as determined by the Engineer.

(3) *Water Supply.* Water shall be measured by volume or by weight. The device for the measurement of water shall be readily adjustable and shall under all operating conditions be accurate within 1% of the quantity of water required for each batch. The device shall be so arranged that the measurements are not affected by variable pressure in the supply line. Measuring tanks shall be equipped with outside taps and valves to provide for calibration unless other means are provided.

(4) *Admixture Dispensers.* Equipment for dispensing air entrainment or other admixtures shall be of approved design and calibrated prior to being approved. Recalibrations will be made as required by the Engineer.

The flasks and discharge hoses shall be transparent and so arranged that the Engineer has a clear and unobstructed view of the dispensing operation at all times.

(5) *Automatic Batch Selector.* The automatic batch plant shall be controlled by means of an approved automatic batch selector set to deliver accurately, and in proper sequence, the designated weight of cement and aggregates, and the weight or volume of water and admixtures required for the concrete mixture. The batch selector controls shall be locked or sealed during the operation, and no changes in selector controls or weight settings shall be made except in the presence of the inspector.

For safety reasons, pozzolans, if used, shall be weighed and added after the portland cement has been weighed and added.

Provisions may be included to vary the size of the batch without affecting the basic proportions of the concrete mix being produced.

(6) *Interlocks.* All batching equipment in automatic plants shall be interlocked so that a new weighing cycle cannot be started until the weigh hopper is empty, the scales are in balance, and the discharge gates and the supply valves included in the system are closed.

(7) *Mixer.* The mixer shall be of approved design and shall be operated as recommended by the manufacturer. The pickup and throw-over blades shall be replaced or repaired when any part or section is worn 1″ (25 mm) or more below the original height of the manufacturer's design. The mixer shall be kept free from accumulations of hardened concrete inside the mixing drum.

The mixer shall be equipped with an approved timing device or, in the case of truck mix concrete, the use of revolution counters or other methods acceptable to the Engineer.

(b) *Specific Requirements.*

(1) *Central Mixed Portland Cement Concrete.*

a. *Description.* Central mixed portland cement concrete shall consist of portland cement concrete manufactured from previously approved materials, proportioned and mixed in a central mixing plant and transported to the Project in approved vehicles.

b. *Mixing.* Concrete shall be mixed in a batch mixer, as previously described, for a period of not less than 60 seconds for mixers with capacities of 10 yd^3 (7.65 m^3) or less. For mixers of greater capacity, the Engineer shall determine the mixing time, based on mixing efficiency. The Engineer reserves the right to adjust the mixing time to any extent necessary to obtain concrete of desired uniformity. Mixing time starts when all the materials, excluding water, are in the mixer. The batch shall be so charged into the drum that some water shall enter in advance of the aggregates and shall continue to flow for a period of not less than five nor more than ten seconds after all aggregates are in the drum. The entire contents shall be removed from the drum before succeeding batches are introduced. Unless otherwise permitted, the maximum batch size shall be the manufacturer′s rated capacity for that mixer.

c. *Moisture Meter.* An automatic electrical moisture meter, equipped with adjustable controls, shall be installed at the Engineer′s discretion to measure accurately and continuously the moisture content of the fine aggregate. The meter probe shall be kept cleaned and maintained at all times.

(2) *Truck Mixed Portland Cement Concrete.*

a. *Description.* Truck mixed portland cement concrete shall be proportioned and dry batched using previously approved materials, with water added for mixing at the plant. Delivery shall be made in approved mixer trucks. Batching and mixing shall be under the supervision of the Engineer.

b. *Mixer Truck.* Truck mix units shall be designed for both mixing and agitation and shall be equipped with a watertight drum suitably mounted and powered, and fitted with properly designed blades. The mixing unit shall be capable of combining the aggregates into a thoroughly mixed and uniform mass of concrete and of transporting and discharging the concrete without segregation. The pickup and throw-over blades shall be replaced or repaired when any part or section is worn 1″ (25 mm) or more below the original height of the manufacturer′s design. The inside of the mixer drum shall be kept free from accumulations of hardened concrete.

Water supply equipment for truck mixers shall include a water storage compartment of sufficient capacity to hold mixing water for concrete and wash water required to wash the mixer after depositing concrete in all cases. The equipment shall include an external water gauge calibrated to 1 gal (5 L) intervals and suitable cut-off valves to regulate the quantity of water delivered to the mixer. These cut-off valves must be maintained in first class working order. A truck mixer with a leaky valve will not be permitted on the Project.

The size of the batch which may be charged into the truck mix unit shall not exceed the manufacturer′s rated capacity for the unit when operated as a mixer. If the manufacturer′s rating is not stamped on each mixing unit, the rated capacity will be determined by the Engineer. Any mixer which shows a variation

in consistency of concrete of more than 1″ (25 mm) slump during the discharge of any single batch shall not be permitted to operate until repaired so as to produce concrete of the required uniformity.

c. *Mixing.* Each batch of concrete mixed in truck units shall be mixed not less than 70 nor more than 100 revolutions of the mixer and at the rate of rotation specified by the manufacturer as the mixing speed. Additional mixing of more than 100 revolutions, if required, shall be done at the rate of rotation specified by the manufacturer as agitation speed. Immediately prior to the addition of water, the drum shall be operated at mixing speed. The mixing period shall be started at the time the cement and water come in contact and there shall be a minimum of 30 revolutions. This operation will be supervised by the Engineer who will indicate on the delivery ticket the time the mix started, the time that the drum is empty, and the time that the entire batch is in place.

d. *Inspection Platform.* An inspection platform of suitable dimensions and with reasonable access and safety shall be provided at the plant for the viewing of truck mix concrete by the inspector.

(c) *Transportation.*

(1) *Vehicle.* The vehicle in which portland cement concrete is transported shall be an approved type of agitator truck, equipped with a watertight revolving drum, suitably mounted and powered, and fitted with properly designed blades capable of transporting and discharging the concrete without excessive abrasion and segregation.

The agitator unit shall be so constructed as to ensure rapid delivery of the concrete without loss of ingredients and to effect complete discharge of each batch.

Low slump portland cement concrete as used in slip-form paving may also be transported in open trucks designed for that purpose and may be either agitator or non-agitator types, provided that no segregation or loss of water detrimental to the mix, as determined by the Engineer, occurs during transportation and that the concrete delivered to the Project meets the requirements specified.

Both agitator and non-agitator truck types shall be capable of having the dump end elevated so that the concrete will be discharged at sufficient height to permit chuting without segregation.

(2) *Size of Batch.* The size of the batch which may be transported in these units shall not exceed the manufacturer′s rating for the unit when used as an agitator. If the manufacturer′s rating is not stamped on each mixing unit, the rated capacity will be determined by the Engineer.

(d) *Portland Cement Concrete Made by Volumetric Batching and Continuous Mixing.*

(1) *Description.* Portland cement concrete made by the volumetric batching and continuous mixing method is permissible for concrete used in bridge deck overlays using latex concrete, headwalls, steps, utility encasement, manhole and inlet bottoms, gutters, curbs, headers, barrier curbs, sidewalks, island pavements, fence and sign post footings, signals, light standard and meter cabinet footings, junction boxes, and small pour items as approved by the Engineer.

(2) *Mixing on the Project in a Continuous Mixing Type Truck Mixer.* Continuous mix concrete shall consist of materials accurately proportioned by volumetric measurement from bins on the truck mixer and shall be hydrated and mixed on the truck mixer at the site of the work.

The concrete shall be mixed in an approved type mixing unit that is part of the truck carrying the dry ingredients. The mixing unit shall be an auger type mixer incorporated in the truck's discharge chute or other suitable mixing mechanism approved by the Engineer, shall produce concrete of uniform consistency, and shall discharge the mix without segregation.

A metal plate or plates shall be attached to the truck mixer in a prominent place. The plate or plates shall be plainly marked with the gross volume of the unit in terms of mixed concrete, operating speed, and the cement constant of the mixer in terms of a revolution count required to deliver 94 lb (42.6 kg) of cement, all as rated by the manufacturer.

The truck mixer shall be equipped with a cement bin of sufficient capacity to store and supply the quantity of dry cement required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer. The cement bin shall be free of moisture and contamination at all times.

The truck mixer shall be equipped with aggregate bins of sufficient capacity to store separately the quantities of fine and coarse aggregates required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer. Suitable means, approved by the Engineer, shall be provided to prevent contamination or intermixing of the fine and coarse aggregates during loading and transporting. Aggregate bins shall be covered when there exists a possibility of moisture entering the bins.

The truck mixer shall be equipped with water tanks of sufficient capacity to store the quantity of water required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer and at the slump specified for each concrete section.

If concrete additives are to be used in the mix, suitable means, approved by the Engineer, shall be provided for storing the additives on the truck and incorporating them in the mix. Suitable means shall also be provided on the truck mixer to permit the Engineer to check the rate of flow of the additive into the mix.

The truck mixer shall include a feeder unit mounted under the compartment bins to deliver the ingredients to the mixing unit.

Each bin on the truck shall have an accurately controlled individual gate or feeding mechanism to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. The cement bin feeding mechanism shall be set to discharge continuously and at a uniform rate a given volumetric weight equivalent of cement during the concrete mixing operation. The gates of the aggregate bins shall be calibrated at the various openings to discharge the volumetric weight equivalent of aggregate required for various concrete mixes.

The truck mixer shall be so constructed as to allow the Engineer to check the calibration of the gate openings and meters by means of weight test samples.

The calibration of the gate openings and meters shall be checked and certified either on a semi-annual basis or prior to work on the Contract. A copy of the Certification shall accompany the truck mixer at all times. If, at any time during construction, a piece of equipment is not performing satisfactorily, it shall be repaired satisfactorily prior to reuse.

A ¼ yd^3 (0.19 m^3) box constructed of suitable rigid materials shall be with the machine at all times for calibration purposes.

Each truck mixer shall be equipped with an accurate revolution counter indicator permitting the reading of the volumetric weight equivalent of cement discharged during the concrete mixing operation.

Each truck shall be equipped with fine and coarse aggregate dials to permit accurate adjustments of the gates of the aggregate bins for volumetric proportioning of aggregates.

Each truck mixer shall be equipped with a water meter or gauge to register the discharge rate of water by volume entering the mix.

Each truck mixer shall be equipped with positive automatic means of maintaining the operating speed of the proportioning and mixing operation independent of the drive engine of the truck, and within 8% above or below that established by the manufacturer and noted on the aforementioned metal plate as the speed at which the machine will accurately proportion concrete. Such positive automatic means shall automatically shut down the proportioning and mixing operation when the operating speed varies by more than the above tolerance. A tachometer shall be mounted on the unit to indicate the operating speed.

All indicators, dials, meters, tachometer, and controls shall be in full view and near enough to be accurately read or adjusted by the operator while mixing concrete.

Handling, measuring, and batching of materials shall conform to the applicable requirements of the Section in which the concrete is being placed.

Cement and aggregates shall be proportioned, measured, and batched by a volumetric weight equivalent method. Separate batching equipment and storage bins will not be required and the materials shall be batched in a continuous mixing truck type mixer.

The concrete will be rejected if there is any evidence of improper batching, mixing, excessive segregation, use of excessive mixing water, or if the amount of entrained air is other than as specified.

Tolerances in proportioning the various ingredients are as follows:

Cement (weight percent)	0 to +4
Fine aggregate (weight percent)	±2
Coarse aggregate (weight percent)	±2
Admixtures (weight or volume percent)	±3
Water (weight or volume percent)	±3

Each truck load of ingredients shall be accompanied by a sufficient number of delivery tickets such that the operator may supply one copy of the delivery ticket to the Engineer for each project and for each kind of concrete delivered. The delivery tickets shall show the brand name and type of cement, the calibrated cement constant of the machine in terms of the revolution indicator count, the source of aggregates, and the size of the coarse aggregate. The delivery tickets shall be signed by the mixer operator. The mixer operator shall enter on the tickets the name of the Project, the name of the Contractor, the revolution counter readings indicating the volumetric weight equivalent of cement discharged during that mixing operation, the aggregate dial settings, and the section for which the concrete is delivered. The operator shall sign each completed ticket and furnish one copy to the Engineer.

812.08 Placing and Curing. Placement and curing of portland cement concrete shall conform to the requirements of the Section for which it is being used.

SECTION 813 – GRADING REQUIREMENTS MINIMUM AND MAXIMUM PERCENTAGES PASSING

	Sieve Size (square openings), millimeters except where noted													
Del. No.	*4″ (100)*	*3½″ (90)*	*3″ (75)*	*2½″ (63)*	*2″ (50)*	*1½″ (37.5)*	*1″ (25)*	*3/4″ (19)*	*½″ (12.5)*	*3/8″ (9.5)*	*No. 4 (4.75)*	*No. 8 (2.36)*	*No. 16 (1.18)*	*No. 100 (150 µm)*
1	100	90 - 100		25 - 60		0 - 15		0 - 5						
2			100	90 - 100	35 - 70	0 - 15		0 - 5						
3				100	90 - 100	35 - 70	0 - 15		0 - 5					
57						100	95 - 100		25 - 60		0 - 10	0 - 5		
67							100	90 - 100		20 - 55	0 - 10	0 - 5		
8									100	85 - 100	10 - 30	0 - 10	0 - 5	
10										100	85 - 100			10 - 30

	Sieve Size (square openings), millimeters except where noted				
	3/8″ (9.5)	*No. 4 (4.75)*	*No. 10 (2.00)*	*No. 40 (425 µm)*	*No. 200 (75 µm)*
"RICE"	100	70 - 100	0 - 20	0 - 10	0 - 5

SECTION 814 – TIMBER PRESERVATIVES

Timber preservatives shall conform to the requirements of AASHTO M 133 and the following:

(a) *Oil-Borne Preservative.* Oil-borne preservatives shall be creosote oil-tar conforming to the requirements of the AWPA preservative standards specified therein. The treatment shall consist of 12 lb/ft³ (190 kg/m^3) of creosoting oil retained for other than marine environments. For marine environments, 20 lb/ft³ (320 kg/m^3) of creosoting oil shall be retained. The treating shall be done according to the requirements of AWPA Standard C1, the empty-cell process.

(b) *Waterborne Preservative.* Waterborne preservatives shall be CCA Type A, Type B, or Type C solutions conforming to the requirements of AWPA Standard P5. The treatment shall consist of applying CCA solution at a retention rate of 0.8 lb/ft³ (13 kg/m^3) of timber for other than marine environments. For marine environments, CCA solution shall be applied at a retention rate of 2.5 lb/ft³ (40 kg/m^3). The treating shall be done according to the requirements of AWPA Standard C1, the full-cell process.

(c) *Pentachlorophenol (Penta).* The heavy oil type of Penta, otherwise known as Penta Type A, is the synthetic pesticide that shall be used on glulam timber for the Department's bridges. Glulam timber shall be treated with 5% Penta Type A applied at a retention rate of 0.6 lb/ft³ (9.6 kg/m^3) of wood. The process involved for preservation treatment shall conform to the applicable requirements of the AWPA. Douglas fir shall be mechanically incised in accordance with the

lumber industry accepted practice before preservative treatment. Once treated, the surface of the member shall not be painted nor shall it come in contact with human or animal skin.

SECTION 815 – BITUMINOUS COLD-MIX (COLD-PATCH)

815.01 Description. This material consists of a uniform mixture of compatible mineral aggregate and bituminous material.

815.02 Material Requirements. Coarse aggregate shall conform to the requirements of Section 805.

Fine aggregate shall be crushed stone screenings and up to 15% washed concrete sand conforming to the requirements of Section 804. The 15% limit is based on the total dry weight of the sand compared to the total dry aggregate weight in the mixture.

Bituminous material shall conform to the requirements of Section 817. The antistripping additive shall conform to the requirements of Section 829.

The sources of all materials shall be submitted, and representative samples of the proposed bituminous material with additive and aggregate shall be provided to the Department's Materials and Research Section.

Material shall not be produced for the Contract, nor any mixture accepted, until the proposed job mix formula has been approved by the Department's Materials and Research Section. The producer shall submit a written proposal indicating the single definite percentage of each sieve fraction of aggregate and percentage of asphalt residue. Expected temperature ranges for component materials and the completed mixture shall also be provided with the job mix formula submission.

The job mix formula shall be within the following limits, however, the Department's Materials and Research Section reserves the right to make adjustments to the formula:

Sieve Size	*Percent Passing*	*Production Tolerance (±)*
3/8" 9.5 mm	100	0
No. 4 (4.75 mm)	55 - 90	7
No. 8 (2.36 mm)	10 - 40	4
No. 200 (75 µm)	0 - 3	2

Asphalt residue, including additive, shall be 4.5 to 6.5% of the total aggregate weight. When tested according to procedures described herein, the allowable production tolerance from the approved mix design is ±0.4%.

Note: There is a substantial difference between "% residue by volume" and "% residue by weight". The Department's Materials and Research Section can assist the producer in determining the proper amount of bituminous material to add to meet the job mix asphalt residue target.

815.03 Mixing Methods. The aggregate shall be heated to a temperature between 185 and 225 °F (85 and 107 °C), and the asphalt shall be heated to a temperature between 135 and 175 °F (57 and 79 °C). The completed mix shall have a temperature not to exceed 180 ° (82 °C).

The proposed mixing facility shall be approved by the Department's Materials and Research Section for mixing these materials. Any type mixer other than a batch type mixer will be approved for use only after careful evaluation of the mixing capabilities.

The producer shall notify the Department's Materials and Research Section of the mixing schedule at least one full working day before any mixing.

Mixing shall be continuous until all aggregates are thoroughly coated with the bituminous material.

815.04 Acceptance of Materials. Samples of the component materials and the produced mixture shall be provided to the Department's Materials and Research Section in order to test the materials' qualities. Acceptance of the materials and the produced mixture will be based on an evaluation of asphalt-aggregate compatibility using a boiling strip test and a coating test, and extraction analysis of the mixture.

815.05 Performance Requirements. The aggregate shall be uniformly coated with no stripping of the bituminous material from the aggregate. The mixture shall be capable of being stored in a stockpile for a period of at least six months without hardening or striping and shall remain workable during all expected weather conditions during this storage.

SECTION 816 – POLYMER MODIFIED BITUMINOUS COLD-PATCH MATERIAL

816.01 Description. The polymer modified bituminous cold-patch material shall be a uniform mixture of compatible mineral aggregate and a polymer modified cutback asphalt. The aggregate shall be uniformly coated with no stripping of the bituminous material from the aggregate. The mixture shall be capable of being stored in a stockpile for a period of at least six months without hardening or stripping and shall remain workable during all expected weather conditions during this storage.

816.02 Submission and Approval. Written documentation of current approval by the supplier of the bituminous material of the mix design and the proposed mixing facility must be submitted to and approved by the Department's Materials and Research Section prior to production.

816.03 Material Requirements. The aggregate shall be clean, crushed limestone or stone of equal quality, free from any foreign or deleterious material.

The polymer portion of the polymer modified cutback asphalt shall be blended with a cutback asphalt. The formulation shall be at the discretion of the manufacturer. The polymer modified cutback asphalt shall be piped directly from the transporting tanker into the mixing plant without an intermediary holding tank.

816.04 Job Mix Formula. It is the responsibility of the producer to submit a written proposal indicating the single definite percentage of each sieve fraction of aggregate and percentage of asphalt residue. Expected temperature ranges for component materials and the completed mixture shall also be provided with the submission.

The polymer modified cutback asphalt shall be added at a rate of 5.25 to 6.25% by weight, with an allowable production tolerance of ±0.4% based on the total weight of the mix.

816.05 Mixing Requirements. The mixing facility must be a batch type mixer. Any type other than a batch type mixer will be approved for use only after careful evaluation of its mixing capabilities. All aggregate must be free of excess surface moisture prior to mixing. If some drying is required, heating must not exceed 150 °F (66 °C). Mixing shall be continuous until all aggregates are thoroughly coated with the bituminous material. After mixing, the material shall be stockpiled for a minimum of 48 hours

in order to allow curing to occur. During this period of time, the stockpile will be examined for runoff and workability.

816.06 Performance Requirements. Samples of the component materials and the produced mixture will be obtained by the Department's Materials and Research Section in order to test their qualities. Acceptance of the materials and the produced mixture will be based on, but not necessarily totally on, the following described tests and considerations:

Coating Test
Extraction Analysis
Boiling Strip Test

The initial approval of the material sources, mix design, plant facilities, or mixture based on the above tests shall in no way preclude further examination and testing if unsatisfactory results or performance are encountered. The acceptance at any time shall not bar future rejection. Performance will be judged at the time of materials use.

SECTION 817 – CUT-BACK ASPHALTS

Cut-back asphalts shall conform to the requirements of AASHTO M 81 for rapid curing (RC) types and AASHTO M 82 for medium curing (MC) types.

In addition, medium curing (MC) types shall conform to the following requirements:

Test	*Minimum*	*Maximum*
Kinematic Viscosity at 140 °F (60 °C), m^2/s	0.0004	0.0008
Flash Point, Tag Open Cup, °F (°C)	66	---
Water, %	---	0.2

Distillation Test	*Minimum*	*Maximum*
Distillate, percentage by volume		
to 437 °F (225 °C)	0	7
to 500 °F (260 °C)	10	45
to 600 °F (315 °C)	55	85
Residue from Distillation to 680°F (360 °C), volume percentage of sample by difference	70	---

Tests on Residue	*Minimum*	*Maximum*
Absolute Viscosity at 140 °F (60 °C), Pa·s	30	120
Ductility 5 cm/min. at 77°F (25 °C), cm	100	---
Solubility, %	99	---

SECTION 818 – MORTAR SAND

Mortar sand shall conform to the requirements of AASHTO M 45 and the following grading:

Sieve Size	*Percent Passing*
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	95 - 100
No. 100 (150 µm)	0 - 25

No. 200 (75 µm)	0 - 10

*Fineness Modulus:*1.6 to 2.5

The organic impurities requirement will be waived for uses other than masonry mortar.

SECTION 819 – SOLID CONCRETE BLOCK

Solid concrete block shall conform to the requirements of ASTM C 139, except that absorption shall have a maximum value of 15 lb/ft³ (240 kg/m^3). Units less than 5″ (125 mm) in thickness shall have a minimum compressive strength of 2000 psi (15 MPa). A concrete masonry unit may be either a concrete block or what is commonly referred to as a concrete brick.

SECTION 820 – COATINGS FOR STEEL STRUCTURES

820.01 Description. This material consists of the designated systems of coatings for steel structures. If no system is designated, the material shall conform to the requirements of Subsection 820.02 (a).

820.02 Material Requirements.

(a) *Inorganic Zinc-Epoxy Urethane System.* Individual coats shall consist of an inorganic zinc-rich primer conforming to the requirements of AASHTO M 300, Type I or II; an epoxy-polyamide intermediate coat conforming to the requirements of SSPC-Paint 22 (pigmented to contrast with both the primer and topcoat); and an aliphatic urethane topcoat conforming to the requirements of SSPC-PS Guide 17.00, Type II. The topcoat color of the structural steel shall match color chip No. 24172 (green) of FED-STD-595B, unless otherwise indicated on the Plans.

(b) *Moisture-Cured Urethane System.* All paint used on any one structure shall be produced by a single manufacturer; and the coating system shall conform to the minimum requirements as noted below.

Primer

Generic Type:	Micaceous Iron Oxide/Zinc-rich, single-component, moisture-cured polyurethane
Vehicle Type:	Moisture-cured polyurethane
Volume of Solids:	60% minimum
Pigment Type:	Micaceous Iron Oxide/Zinc dust
Coverage:	3 mils (75 µm) DFT minimum
VOC:	Not to exceed 2.84 lb/gal (0.34 kg/L)
Weight:	Minimum 19.00 lb/gal (2.28 kg/L)

Intermediate Coat

Generic Type:	Micaceous Iron Oxide-filled, single-component, moisture-cured polyurethane
Vehicle Type:	Moisture-cured polyurethane
Volume of Solids:	60% minimum
Pigment Type:	4.00 lb/gal (0.48 kg/L) Micaceous Iron Oxide, tinted to distinguish from primer and topcoat
Color:	Tinted to distinguish from primer and topcoat
Coverage:	3 mils (75 µm) DFT minimum

VOC:	Not to exceed 2.84 lb/gal (0.34 kg/L)
Weight:	Minimum 16.00 lb/gal (1.92 kg/L)

Finish Coat

Generic Type:	Micaceous Iron Oxide-filled, single-component, moisture-cured polyurethane
Vehicle Type:	Moisture-cured polyurethane
Volume of Solids:	60% minimum
Pigment Type:	3.50 lb/gal (0.42 kg/L) Micaceous Iron Oxide
Finish:	Flat (low gloss)
Color:	To be specified in the Plans
Coverage:	3 mils (75 µm) DFT minimum
VOC:	Not to exceed 3.00 lb/gal (0.36 kg/L)
Weight:	Minimum 16.00 lb/gal (1.92 kg/L)

Each single coat of paint shall be a color different from the others. The color of the primer and intermediate paint shall be at the Contractor's option and shall provide contrast with the underlying substrate or previously applied paint. The color of the finish paint shall be as specified in the Plans.

Successive time interval for coating in between prime coat, intermediate coat, and finish coat shall be a minimum of four and a maximum of 14 days. If the Contractor fails to complete the painting during the established period, the surface are shall be cleaned if necessary as determined by the Engineer.

The Contractor may use one of the following approved paint systems:

(1) *Wasser High-Tech Coatings, Kent, WA 98032*

Primer:	Wasser MC-MIO Zinc (spot) [3 mils (75 µm), DFT]
Intermediate:	Wasser MC-Miomastic Iron Oxide [3 mils (75 µm), DFT]
Finish:	Wasser Ferrox A [3 mils (75 µm), DFT]

(2) *Xymax Coatings, Inc., Oakland, FL 33311*

Primer:	Bridge Zinc 336 (spot) [3 mils (75 µm), DFT]
Intermediate:	Mono-Ferro [3 mils (75 µm), DFT]
Finish:	Bridge Finish [3 mils (75 µm), DFT]

All components of the system (primer, intermediate, and finish coats) will be accepted on the basis of the manufacturer's written certification that the batch(s) produced meets their product specification.

Only paint arriving at the work site in new, unopened containers shall be used.

Containers of paint shall be labeled with the manufacturer's name, product name, component part, batch number, date of manufacturer, and shelf life date. Paint in containers having expired shelf life dates shall be immediately removed from the work site.

(c) *Moisture-Cured Aluminum System.* The moisture-cured aluminum paint must follow the following requirements:

One-Coat System

Generic Type:	Aluminum filled aromatic moisture-cured urethane
Vehicle Type:	Moisture-cured aromatic polyurethane
Pigment Type:	Minimum 2.00 lb/gal (0.24 kg/L) non-leafing aluminum
Coverage:	2 mils (50 µm) DFT minimum
VOC:	Not to exceed 3.50 lb/gal (0.42 kg/L)
Weight:	9.2 lb/gal (1.1 kg/L)

Volume of Solids:	52.0 ± 1.0%
Shelf Life:	Six months from date of shipment, in unopen original containers stored at temperatures below 86°F (30 °C).

SECTION 821 – GRADED AGGREGATES

821.01 Description. This material consists of coarse crushed stone, crushed slag fragments or portland cement concrete fragments blended with crushed particles of the same origin.

821.02 Applicable Testing Methods.

AASHTO T 2
AASHTO T 27
AASHTO T 96

821.03 Material Details.

(a) *Submissions.* Samples from the source of the material shall be supplied as directed by the Engineer.

(b) *Material Properties.* The graded aggregate blend shall be uniform in quality and free of silt, clay, decomposed fragments, overburden material, soil, reinforcement, and other deleterious debris.

(c) *Gradation.* Graded aggregate material shall conform to the following gradation requirements for the appropriate type:

WEIGHT PERCENTAGE PASSING

Sieve Size	***Type A (CR-1)***	***Type B (Crusher Run)***
2 1/2″ (63 mm)	100	---
1 1/2″ (37.5 mm)	---	100
1″ (25.0 mm)	50 - 80	---
3/4″ (19.0 mm)	---	50 - 95
No. 4 (4.75 mm)	20 - 50	20 - 50
No. 10 (2.00 mm)	---	15 - 40
No. 20 (850 µm)	10 - 30	---
No. 100 (150 µm)	2 - 20	2 - 20

The percentage of wear as determined by the Los Angeles machine shall not exceed 45%.

SECTION 822 – FLY ASH

822.01 Description. This material consists of fly ash, which is a by-product of coal combustion. Fly ash may be used as a mineral additive in concrete and as a partial replacement for portland cement within Section 812 and other Sections of these Specifications.

822.02 Materials Requirements. Fly ash shall conform to the requirements of AASHTO M 295, Class C or F as modified herein. The requirements of Table 1 "Chemical Requirements" shall be modified to establish the maximum "Loss on Ignition" at 4.0%. Table 2 "Supplementary Optional Chemical Requirement" and Table 4 "Supplementary Optional Physical Requirements" shall apply. In

Table 3 "Strength Activity Index" the minimum activity index at seven days shall be 85% of the control and the minimum at 28 days shall be 100% of the control. Traces of ammonia and oil shall be absent from the fly ash.

Transport containers for fly ash shall be of a design that provides for proper and complete unloading. Dedicated and reserved storage bins of fly ash shall be sampled and tested by the Engineer. All tests shall be completed and shall show that the material conforms with all requirements prior to any use.

Upon approval of the Engineer, the preceding requirement for dedicated and reserved storage bins of fly ash may be waived if the fly ash supplier is qualified for inclusion in a certification program. The Program of Certification involves acceptable supplier quality control procedures.

For an acceptable Program of Certification, the supplier must establish a history of satisfactory quality control of fly ash produced as evidenced by the results of tests performed by the Department and the supplier's testing laboratory. The supplier shall conduct sufficient tests to ensure that adequate quality is maintained in regard to the material specifications. The supplier must maintain a record of all tests for review by the Engineer. The Engineer reserves the right to modify the program as considered necessary to maintain quality. Samples for tests by the Department may be taken at any time as determined by the Engineer. In addition, the handling and storage facilities must be approved by the Engineer.

SECTION 823 – HOT-MIX, HOT-LAID BITUMINOUS CONCRETE

823.01 Description. This material consists of hot-mix, hot-laid bituminous concrete bases and surface courses.

MATERIALS.

823.02 Asphalt Cement. The asphalt cement shall be AC 20 with a viscosity grade conforming to the requirements of Section 810. Tank trucks used to deliver asphalt cement shall be equipped with an approved sampling device. The delivery temperature of the material shall not exceed the maximum mixing temperature.

823.03 Fine Aggregate. Fine aggregate is defined as all material passing the No. 8 (2.36 mm) sieve and shall consist of clean, hard, durable crushed stone.

In Job Mix Formula Types B, C, and D, which are defined in Subsections 823.19, 823.20, and 823.21, up to 15% of the fine aggregate may be washed concrete sand, conforming to the requirements of Section 804. If the stability, as determined by the Laboratory Marshall Method in accordance with AASHTO T 245, is less than 1200 lb (5.3 kN), the fine aggregate sand percentage shall be reduced or excluded. All carbonate and serpentine aggregate shall be prohibited in the final roadway wearing surface course on any roadway having a minimum average daily traffic volume (ADT) of 8000 vehicles and a posted speed of 35 mph (60 km/h) or greater.

823.04 Coarse Aggregate. Coarse aggregate shall be all material retained on the No. 8 (2.36 mm) sieve and shall conform to the requirements of Section 805. All carbonate and serpentine aggregate shall be prohibited in the final roadway wearing surface course on any roadway having a minimum average daily traffic volume (ADT) of 8000 vehicles and a posted speed of 35 mph (60 km/h) or greater.

823.05 Antistripping Additive. When specified for use by the Engineer, or when the Tensile Strength Ratio (TSR) is less than 80 as determined in accordance with AASHTO T 283, a heat-stable, antistripping chemical additive conforming to the requirements of Section 829 shall be blended with the asphalt cement in accordance with Subsection 823.16.

823.06 Laboratory. At all batch and dryer drum mixing plants, the Contractor shall provide a building suitable for a field laboratory in which to house and use the equipment necessary to carry on the various tests required, including bituminous extractions and gradations.

The building shall be for the use of the Engineer and inspectors for testing and recording purposes and shall be so located that activities at the plant are plainly visible from one window of the building.

The building shall have a minimum of 600 ft² (55 m^2) of floor space and be of acceptable dimensions. It shall be weatherproof and have at least two windows and a door, all equipped with acceptable latches and locks. The building shall be maintained to the satisfaction of the Engineer. Satisfactory lighting, heating, and air conditioning shall be supplied. The air conditioning equipment shall be capable of maintaining the room temperature throughout the laboratory at 77 ° (25 °C) at all times.

The Contractor shall furnish all water, including drinking water, fuel, telephone, heat, and power to conduct all necessary tests. Tables, desks, chairs, and work tables shall be provided and maintained as required. Approved sanitary facilities shall be furnished and maintained.

If approved, the laboratory may be a part of another building, in which case it shall be completely partitioned off from the remainder of the building.

823.07 Testing Equipment. All production plants shall be equipped with all the necessary equipment from the equipment list supplied by the Department′s Materials and Research Section. The Contractor shall ensure that the laboratory contains equipment of approved make and design and shall maintain the equipment to the satisfaction of the Engineer.

Approval of the plant will be contingent upon meeting the requirements of Subsection 823.06 and this Subsection.

823.08 Inspection of Mixing Plant Operations. The Engineer or the Engineer′s representative shall have access at all times to all parts of the mixing plant for checking the adequacy of the equipment in use, inspecting the conditions and operation of the plant, verifying the weights or proportions and character of materials, and determining and checking the temperatures being maintained in the preparation of the mixtures.

MIXING PLANTS.

The two types of mixing plants are Batch Type and Continuous Mixing Type.

823.09 Batch Type. Bituminous concrete plants will not be approved unless they are automated.

The automatic batch plant shall be controlled by means of an approved automatic batch selector. The batch selector shall control and deliver, accurately and in proper sequence, the designated weight or volume of bituminous material and aggregates required for the bituminous concrete mixture and shall automatically time the mixing operation. The batch selector controls shall be locked or sealed during the operation, and no changes in selector control or setting shall be made except in the presence of the Engineer′s representative.

(a) *Interlocks.* The plant shall be equipped with interlocking cut-off circuits to interrupt and stop the automatic cycling of the operation at all times when errors in weighing or proportioning occur, or when there is a malfunction of any portion of the control system.

(b) *Equipment Failure.* If the automatic proportioning devices become inoperative, the plant may be permitted to batch and mix bituminous materials for a period of not more than 48 hours from the time of the breakdown, if approved by the Engineer. Written permission of the Engineer shall be required for a period of operation longer than 48 hours without automatic proportioning.

823.10 Plant and Machinery. The mixing plant used by the Contractor in preparation of the bituminous concrete shall be capable of producing a minimum of 75 tons (68 metric tons) per operating hour and shall comply with the following requirements:

(a) *Cold Feed.* The plant shall be provided with a separate cold bin or tunnel opening for each size and type of mineral aggregate used in the mix. In addition, each cold bin or tunnel opening shall be equipped with a calibrated gate and mechanical feed to provide a uniform and concurrent flow of aggregates prior to their introduction into the drier.

(b) *Drier.* The drier shall be a rotating cylinder type suitably designed to heat and dry the aggregates, and shall continually agitate the aggregates during heating. The drier shall be capable of preparing aggregate to the full rated capacity of the paving plant.

(c) *Burner.* The burner shall be of an approved design and shall be automatically controlled.

(d) *Sieves.* All plant sieves shall be designed, constructed, and operated so that all aggregates are sieved to their specified sizes and proportions, and shall have a capacity, when operated at normal speed, slightly in excess of the maximum capacity of the mixer.

(e) *Bins.* The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to ensure separate and adequate storage of appropriate fractions of the mineral aggregates, and the plant shall be equipped to feed such material into the mixer within ±0.5% of the total batch weight. Separate dry storage shall be provided for filler or hydrated lime when used, and the plant shall be equipped to feed such material into the mixer within ±0.5% of the total batch weight. Each bin shall be provided with overflow pipes, sized and located to prevent material backing up into other compartments or bins. Each compartment shall be provided with an individual outlet gate that prevents leakage when closed. The gates shall cut the flow off quickly and completely. Bins shall be constructed so that samples can be readily obtained. Bins for continuous mix plants shall be equipped with adequate telltale devices to indicate the position of the aggregates in the bins at the lower quarter points. Each compartment shall be designed to prevent the overflow of material into other bins.

(f) *Weigh Box or Hopper.* The plants shall have a weigh box of sufficient capacity to hold the maximum amount of the aggregate material for one batch. The weigh box or hopper shall be supported on fulcrums and knife edges, and constructed such that it can not be easily thrown out of alignment or adjustment. Weighing hoppers must be free from contact with all edges, ends, sides, supporting rods or columns, or with other equipment that will in any way affect their proper functioning. In addition, there must be sufficient clearance between the hopper and supporting devices so that foreign materials will not accumulate. The discharge gate of the weigh box must be positioned to prevent aggregate separation when dumping in the mixer. If necessary, baffles shall be inserted or other means provided to discharge the materials in a blended condition.

(g) *Aggregate Scales.* Scales for the weighing of aggregates shall be of standard make and design and shall be accurate to 0.5% throughout their range. The scale shall consist of a digital readout connected to a load cell. All digital readouts shall be so located that they will be in plain view

of the operator and the Engineer or the Engineer's agent. No weighing of aggregates shall be permitted where vibration from the plant mechanisms or any other source prevents accurate reading of the scale. The value of the gradations of scales weighing over 5000 lb (2250 kg) shall not be greater than 0.1% of the rated capacity of the scale.

(h) *Bitumen Scales.* The digital scale shall have a capacity of at least 15% in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be locked at any setting and automatically reset to the reading after the addition of bituminous material to each batch. The readout shall be in full view of the mixer operator and the Engineer and the Engineer's agent and shall be graduated in increments not greater than 1 lb (0.45 kg). The flow of bituminous material shall be automatically controlled. All of the bituminous material required for one batch shall be discharged in not more than 20 seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

The equipment used to measure the bituminous material shall be accurate to ±0.5%. The bituminous material bucket shall be a non-tilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be adequately heated. The capacity of the bituminous material bucket shall be at lease 15% in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated, quick acting, non-drip, charging valve located directly over the bituminous material bucket.

(i) *Test Weights.* The Contractor shall provide and have readily available at least 10 standard 50 lb weights (eleven standard 20 kg, one standard 5 kg, and two standard 1 kg weights), for checking the scales during operations.

The weighing equipment, in addition to complying with the above requirements, must have adjusting devices which will provide for the readjustment of any part that, being out of adjustment or balance, prevents the scale from functioning properly.

(j) *Asphalt Control System.* The proper amount of bituminous material in the mix, within the tolerance specified for the job mix, shall be provided by either weighing or metering.

Heating of asphalt cement shall be by steam coil, hot oil, or other approved methods. Under no circumstances shall a flame from oil or other fuel be permitted to come in direct contact with the heating tanks. The asphalt circulating system shall be sized to give proper and continual circulation of asphalt cement throughout the operating periods.

(k) *Thermometric Equipment.* An armored thermometer, reading within the ranges used, shall be fixed in the asphalt line at a suitable location near the weigh bucket discharge valve.

The plant shall also be equipped with an approved dial scale thermometer and an electric pyrometer or other approved thermometric instrument placed at the discharge chute of the drier to automatically register and record the temperature of the heated aggregates. This device shall also be in full view of the burner controller or the head feeder.

The Engineer reserves the right to judge the efficiency of the above instruments and direct the replacement of the instruments with some approved temperature recording apparatus. Further, the Engineer may require the Contractor to submit daily charts of the recorder's readings.

(l) *Mixer Unit.* The mixer shall be a heat-jacketed, insulated, batch mixer, of the standard pugmill type, or an approved heat-jacketed, insulated, rotary drum-type mixer. Rotary mixers shall be equipped with a sufficient number of paddles or blades set in position to produce properly mixed batches of any material required under these Specifications. When the clearance in the twin pugmill exceeds 1″ (25 mm), either the shortened blades or the worn liners (or both) shall be

replaced to reduce the clearance to less than the allowable 1″ (25 mm) maximum. The mixer shall be provided with an approved, accurate time lock that will lock the discharge gates until the specified mixing time has elapsed. In no case shall the rated capacity of the mixer specified on the manufacturer′s name plate be exceeded. If sufficient mixing and coating is not obtained, the Engineer reserves the right to direct the Contractor to increase the mixing time.

Deviations in sizes of batches will be permitted to provide for mixing batches 25% below the rated capacity of the mixer. When slag coarse aggregate is used, no increase will be permitted in the size of the batch above the rated capacity of the mixer.

(m) *Dust Collector.* All plants shall be equipped with an approved dust collector system. Provisions shall be made to waste the collected material or to return it uniformly to the aggregate mixture as directed. All State and local air pollution control regulations and ordinances shall be followed.

(n) *Safety Requirements.* An adequate and safe stairway to the mixer platform and guarded ladders shall be placed at all points required for accessibility to all plant operations. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading space, and this space shall be kept free of drippings from the mixing platform. A platform shall be located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. The platform and steps shall have safety handrails. Easy and safe access shall be provided to the location above the mixer where sampling of the aggregate in the bins is to take place. Adequate overhead protection shall be provided where necessary. All other Federal, State, or local safety requirements shall be followed.

(o) *Platform Truck Scales.* All plants shall be equipped with platform truck scales to weigh empty and loaded trucks. Truck scales shall be of approved design and kept in good condition. Scales shall be mounted in a concrete foundation that will ensure their remaining level and plumb. Scales shall be mounted to weigh the entire truck. All platform truck scales shall be approved by the appropriate Sealer of Weights and Measures and have seals attached at the beginning of each season or at such other times, as may be deemed necessary. Manufacturer′s Certified Scale Checks may be accepted. Split weighing will not be approved.

823.11 Continuous Mixing Type. The use of continuous mixing plants will be permitted for the preparation of hot-mix bituminous concrete, provided such plants conform to the requirements listed below and to the general requirements for all plants.

(a) *Gradation Control Unit.* The plant shall include a means for accurately proportioning each size of aggregate by either weighing or volumetric measurement. When gradation control is by volume, the plant shall include feeders mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to provide an orifice for volumetrically measuring the material drawn from each bin compartment. The orifice shall be rectangular with one dimension adjustable by a positive mechanical means, and shall be provided with a lock. Indicators shall be provided in each gate to show the gate opening in millimeters.

Mineral filler, if specified, shall be proportioned separately and added to the mix to obtain uniform distribution.

(b) *Weight Calibration of Bitumen and Aggregate Feed.* The plant shall include a means of calibrating gate openings and meters using weight test samples. The aggregate fed out of the bins through individual orifices shall be bypassed to a suitable test box, confining the material from each compartment in a separate box. The plant shall be equipped to conveniently handle

test samples weighing up to 800 lb (360 kg) and to weigh them on accurate scales. Means shall be provided for calibrating the flow of bitumen.

(c) *Synchronization of Aggregate and Bitumen Feed.* Positive interlocking control between the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source shall be provided. This device shall include a mechanical interlock or other positive method of accurate control.

(d) *Mixer Unit Continuous Method.* The plant shall include a continuous mixer of an approved twin pugmill type, heat-jacketed, and capable of producing a uniform mixture within the permissible variations from the job mix specifications. The angular position of the paddles on the shafts shall be adjustable, and the paddles shall be reversible to retard the flow of the mix. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge and the rate of feed of aggregate per minute at plant operating speed.

Unless otherwise required, determination of mixing time shall be by the weights method under the following formula. The weights shall be determined for the job by tests made by the Engineer

$$\text{Mixing Time (s)} = \frac{\text{Pugmill Dead Capacity In Pounds (kg)}}{\text{Pugmill Output In Pounds per Second (kg/s)}}$$

The production capacity of the continuous mix plant shall be not less than 75 tons (70 metric tons) per hour 42 lb/s (19 kg/s).

(e) *Discharge Hopper.* The discharge end of the pugmill shall be equipped with a hopper, or other approved device for truck loading, that will eliminate segregation of the mixed material.

PROCEDURE FOR BATCH OR CONTINUOUS TYPE PLANTS.

823.12 Preparation of Asphalt Cement. All asphalt cement shall be uniformly heated in tanks to a temperature of 250 to 350 °F (120 to 175 °C). Asphalt shall be maintained within these temperature limits.

823.13 Preparation of Mineral Aggregates. Before entering the mixer, the aggregates shall be dried and heated to a temperature of not more than 375 °F (190 °C), except for recycled mixes. Flames used for drying and heating shall be properly adjusted to avoid injury to the aggregate.

Immediately after heating, the aggregates shall be screened into separate bins, ready for batching and mixing with asphalt cement.

823.14 Preparation of the Mixture. Each size of hot aggregate and the asphalt cement shall be weighed separately to accurately determine the correct portion of each constituent in the mix. The mixing temperature and tolerance will be given by the Department's Materials and Research Section for the type of material being produced.

The mixture shall consist of coarse aggregate, fine aggregate, mineral filler if required, and asphalt cement. The exact proportions within the limits specified shall be regulated to produce a satisfactory non-boiling mixture with all the particles fully coated.

After the hot fine and coarse aggregates are introduced into the twin pugmill, a minimum dry mix time of 6 seconds shall be required unless otherwise directed by the Engineer. The asphalt cement shall be added in an even sheet the full width of the mixing chamber. After the asphalt cement is added,

mixing shall be continued for a minimum of 30 seconds, or until the aggregates are coated and well mixed.

The processed bituminous concrete mixture may be held in an approved storage system in accordance with Subsection 823.17.

823.15 Dryer-Drum Mixers. The plant shall be specifically designed for dryer-drum mixing and shall be capable of satisfactorily heating, drying, and mixing the bituminous mixtures. The aggregate shall enter the drum from the burner-end and shall travel parallel to the flame and the exhaust air stream. The system shall be equipped with automatic burner controls. Heating shall be controlled to prevent damage to the aggregate or the asphalt cement. The temperature of the mixture when discharged from the mixer shall be within the range specified by the Department's Materials and Research Section for the type mix being produced. The rate of flow through the drum shall be controlled to obtain a homogeneous mixture with uniformly-coated particles. In no case shall the quantity of mixture produced exceed the manufacturer's rated capacity.

Each cold feed bin shall have an adjustable gate with an indicator to reference the opening setting. A device shall be installed on each of the aggregate feeders to indicate when the flow of material from the bin is not sufficient to allow accurate proportioning through the feeder gates. These indicators shall be positive in action and shall actuate a clearly visible or audible signal to attract the plant operator's attention, and they shall stop the flow of materials to the drum when the level of material in the bin is too low for accurate proportioning. In addition, for those particular cold bins in which aggregate material tends to either bridge or lump together causing temporary interruptions in feeds, a vibrator or other suitable means shall be provided to ensure uniform flow out of bins so that aggregate material does not bridge or lump. All cold feed bins including mineral filler silos shall be accurate to 0.5% of the total weight delivered by that particular bin or silo. The order of aggregate feed onto the composite cold feed belt shall be from coarse to fine. An independently mounted scalping screen shall be installed if directed by the Engineer.

Asphalt cement shall be introduced through a continuously registering, cumulative indicating meter by a pump specifically designed for dryer-drum plants. The meter shall be located in the asphalt line to continuously register the asphalt discharge to the mixer and arranged to allow diversion of the discharge through the meter to a container for measurement. The meter shall be equipped with a nonsetback register and shall have an accuracy within 1% by weight of the material actually being measured in any given period of time. The temperature of the asphalt shall be monitored by a thermocouple which shall be calibrated prior to the annual asphalt feed calibration to within 4 °F (2 °C) of a certified mercury thermometer and shall have a digital display on the control panel. The accuracy of the pump and meter shall be verified annually and whenever designated by the Engineer with the Engineer's agent present to document the calibration.

The aggregate feed and the asphalt flow systems shall be interlocked by a blending system that automatically regulates the asphalt flow and immediately corrects for variations in aggregate flow. The system shall provide positive weight measurement of the combined cold aggregate feed by use of a belt scale. The combined cold aggregate feed shall be continuously recorded on a nonsetback register. Feed of material to the belt scale shall be controlled to ensure that the combined aggregate flow is between 50 and 100% of the rated capacity of the scales at normal operation. The plant shall be equipped so that the proportion of each aggregate can be individually varied. The plant shall also be equipped so that the total aggregate rate can be varied without affecting the proportions. The plant shall be equipped with a moisture compensating device in the control panel to automatically correct for the moisture in the aggregate passing over the belt scale. The plant shall be required to use the most recent moisture values obtained to ensure accurate asphalt proportioning. Moisture determinations for the combined aggregate

will be made periodically during each day's operation. The plant shall also be equipped with a device in the control panel to automatically correct for the specific gravity of the asphalt.

Safe, adequate, and convenient facilities shall be provided for obtaining representative asphalt and aggregate samples. The plant shall be equipped with a sampling device capable of providing a sample of sufficient size from the full width of the combined aggregate cold feed flow. The sampling device shall be designed so that samples may be taken while the plant is operating at normal production rates. Safe, adequate, and convenient facilities shall be provided for calibrating the asphalt flow and the aggregate flow. The manufacturer's recommendations shall be followed for calibration. To calibrate the aggregate flow system, means shall be provided to permit a positive and uniform diversion of the aggregate in sufficient quantity to accurately check the weight of aggregate per period of time. To calibrate the asphalt metering system for proper proportioning, an asphalt distributor or other equipment approved by the Engineer shall be made available so that accurate tare, gross, and net weights may be obtained for the diverted asphalt discharge. The rate of flow of the total aggregate and asphalt flow shall not vary by more than 2.0% by weight from the required quantity of each.

The dryer-drum mixer shall be capable of simultaneously heating and mixing the introduced aggregate and asphalt to produce an acceptable, thoroughly coated mix meeting the required temperature and mix designs. Pyrometers or other thermometric instruments shall be located at the discharge chute of the dryer-drum mixer to automatically register the temperature of the mix.

Prior to mixing of hot-mix bituminous concrete in drum mix plants, the gradation of all stockpiled aggregate material shall be checked for grading requirements conforming to Section 813 and shall be approved prior to use. Aggregate from the approved stockpiles shall be selected based on a percentage of the stockpile sizes to meet the appropriate job mix formula gradation according to Subsections 823.20, 823.23, and 823.24. Samples from the cold feed conveyor shall be taken to ensure that the proper gradation requirements are being met prior to the addition of asphalt for production of hot-mix.

823.16 Antistripping Additive Blending - All Plants. Blending of the additive and asphalt cement shall be accomplished at the bituminous concrete production plant during the production of bituminous material, through the use of an approved in-line metering and blending system. The holding tank shall be thermostatically controlled for heat and shall have a recirculating line for uniform heat control. The additive temperature shall be maintained at a uniform mix temperature at least 24 hours prior to production to ensure uniform additive viscosity. There shall be a diverter valve in the recirculating line from the pump for calibration purposes, which shall deliver a full stream from the additive pump at a height equivalent to the addition input to the main asphalt line. Additive pumps shall be calibrated on a daily basis or whenever deemed necessary by the Engineer. The calibration shall be done by plant personnel and witnessed by a representative of the Department's Materials and Research Section.

823.17 Storage Systems - All Plants. The system shall be capable of conveying the hot-mixture from the plant to the storage bins and storing the hot-mixture without a reduction in temperature and with no segregation of the mix or oxidation of the asphalt. The mixture, as delivered for the work, shall comply with all specified quality requirements.

The conveyor system may be either a continuous or skip bucket type. The continuous type shall be enclosed and heated to effectively control the mix temperature. The skip bucket type must be large enough to transport and mass dump an entire batch into the bins.

The storage bins shall be designed to prevent segregation of the mix during discharge from the conveyor into the bins. The bin discharge gates shall be designed to prevent segregation of the hot-mixture while loading into trucks.

Approval for the use of storage bins may be withdrawn when excessive heat gain or loss, uneven heating, segregation of the aggregate, or migration or oxidation of the asphalt occurs due to the operation or use of storage bins. Mixtures may be retained in heated storage bins for 12 hours, provided that material and mixture qualities are maintained.

MIXTURE REQUIREMENTS.

823.18 Applicable Testing Methods. The following standards shall be used to test the qualities of the mixture.

AASHTO T 164	Method A, Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
AASHTO T 166	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
AASHTO T 209	Maximum Specific Gravity of Bituminous Paving Mixtures
AASHTO T 245	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
AASHTO T 269	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
AASHTO T 283	Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
AASHTO T 287	Asphalt Cement Content of Asphalt Concrete Mixtures by the Nuclear Method

Samples of the actual mixture in use will be taken as many times daily as determined by the Engineer. The mixture must be maintained uniform throughout the Project within the above tolerances. Should the mix produced not meet the above requirements or the Contract performance needs, changes in the mix design or mixing procedure shall be made immediately in a manner approved by the Engineer.

If an additional source of supply for materials is submitted and approved, the job mix formula shall be readjusted as necessary by the Contractor and submitted to the Engineer. All job mix formulas submitted and found unacceptable shall be readjusted to the satisfaction of the Engineer.

823.19 Job Mix Formula Types A, B, C, D, and E. The general composition limits prescribed in this Section are master ranges of tolerance to govern mixtures made from all raw materials conforming to the requirements of Sections 804 and 805. The composition limits are maximum and minimum in all cases. Closer control may be required for job materials used for specific projects according to the job mix formula. No work shall be started on the Contract, and no mixture will be accepted for the work, until the proposed job mix formula has been approved. The Contractor shall submit a written proposal indicating the single definite percentage for each sieve fraction of aggregate and for the asphalt that the Contractor chooses as the fixed percentage for each component in the mix. The proposal shall also indicate the temperature at which the Contractor shall furnish the mixture at the plant. The approval of the job mix formula shall bind the Contractor to furnish paving mixtures that not only meet the master ranges, but also meet the exact formula set for the Project, within the allowable tolerances.

823.20 Gradation for Job Mix Formula Types A, B, C, D, and E.

Sieve Size	Type A (%)	Type B (%)	Type C (%)	Type D & E (%)	Job Mix Tolerance (%)
2½" (63 mm)	100	---	---	---	±7
2" (60 mm)	90 - 100	---	---	---	±7
1½" (37.5 mm)	60 - 90	---	---	---	±7
1¼" (31.5 mm)	---	100	---	---	±7
1" (25.0 mm)	40 - 75	95 - 100	---	---	±7
3/4" (19.0 mm)	---	75 - 95	---	---	±7
1/2" (12.5 mm)	30 - 65	50 - 85	100	---	±7
3/8" (9.5 mm)	---	45 - 70	85 - 100	100	±7
#4 (4.75 mm)	20 - 45	30 - 50	50 - 75	80 - 100	±7
#8 (2.36 mm)	---	22 - 38	33 - 59	70 - 90	±4
#30 (600 µm)	---	9 - 23	14 - 32	30 - 55	±4
#50 (300 µm)	---	6 - 18	7 - 26	15 - 40	±4
#200 (75 µm)	2 - 10	3 - 10	3 - 10	5 - 15	±2
A.C., %	2.0 - 4.0	3.5 - 5.5	4.5 - 6.5	6.0 - 8.5	±0.4
Temp. °F	225 - 275	275 - 325	275 - 325	275 - 325	±20°F
Temp. °C	(107 - 135)	(135 - 163)	(135 - 163)	(135 - 163)	±11

The percentages for aggregates are based on the total weight of aggregate. The percentages for asphalt cement are based on the total weight of the mix.

Washed gradations of final products shall be used to determine the amount of No. 200 (75 µm) material. The washed dust to effective asphalt ratio shall be between 0.6 and 1.2 for the final mixture.

823.21 Marshall Properties for Job Mix Formula Types A, B, C, D, and E.

Specification Requirements	*Mix Type*			
	A	*B*	*C*	*D & E*
Air Voids, % (Compacted Specimen)	---	3.0 - 5.0	3.0 - 5.0	3.0 - 5.0
Stability, (Minimum)	750 lb (3.4 kN)	1000 lb (5.3 kN)	1000 lb (5.3 kN)	1000 lb (5.3 kN)
Flow, 0.01 in (0.25 mm)	8.0 - 20.0	8.0 - 20.0	8.0 - 20.0	8.0 - 20.0
Voids in Mineral Aggregate (VMA)*, % (Minimum)	11.5	13.0	16.0	18.0

* The VMA shall be calculated from the combined bulk specific gravities of the aggregate and the actual asphalt cement content determined by the laboratory testing.

823.22 General Uses for Job Mix Formula Types A, B, C, D, and E.

Type A - Open plant mix base course
Type B - Dense graded base and binder course
Type C - Dense graded surface course
Type D - Fine, dense graded surface course
Type E - Curb mix

823.23 Bituminous Concrete Base Course Mixture. Mix and gradation requirements for the base course mixture shall be as follows:

(a) Mix Requirements:

Asphalt Content	3.0 - 4.5% of total mixture weight
Air Voids	3.0 - 6.0
Stability	1000 lb. (4.5 kN), minimum
Flow-	8.0 - 18.0 (0.01 in) [0.25 mm]

(b) Gradation Requirements:

Sieve Size	*Percent Passing*
1½″ (37.5 mm)	100
3/4″ (19.0 mm)	75 - 100
3/8″ (9.5 mm)	48 - 80
No. 8 (2.36 mm)	20 - 48
No. 30 (600 µm)	10 - 30
No. 50 (300 µm)	7 - 25
No. 200 (75 µm)	3 - 10

During production of the base course mixture, the gradation of the aggregates may vary between the specified limits, but such variations shall be gradual. Sudden variation from coarse to fine and fine to coarse on any sieve will not be tolerated.

823.24 Plant Mix Open-Graded Wearing Surface Mixture. The open-graded wearing surface shall be composed of a mixture of approved aggregate and asphalt cement. Gradation shall be as follows:

Sieve Size	*Master Range Percent Passing*	*Tolerance from Job Mix (±)*
½″ (12.5 mm)	100	0
3/8″ (9.5 mm)	88 - 98	3
No. 4 (4.75 mm)	25 - 42	5
No. 8 (2.36 mm)	5 - 15	3
No. 200 (75 µm)	2 - 5	1.5

Asphalt cement shall be from 6.0 to 8.0% of the total mixture weight (to be determined by Laboratory Tests). The temperature of the asphalt cement shall not be greater than 310 ± 10 °F (154 ± 6 °C) when introduced into the mixer.

A heat-stable, antistripping additive conforming to the requirements of Subsection 823.05 shall be added to all asphalt cement used for open-graded surface course. The amount of the additive used shall be between 0.25 and 1.0% by weight of the asphalt cement as recommended by the additive manufacturer and approved by the Department's Materials and Research Section.

The additive shall be thoroughly and uniformly blended with the asphalt cement at the hot-mix production plant in accordance with Subsection 823.16.

The target temperature (± 10 °F) [±6 °C] of the mix leaving the mixer shall be established by the Department on the basis of laboratory tests. A target temperature of 240 ± 10 °F (116 ± 6 °C) is typical.

Aggregate shall conform to the requirements of Section 805, except slag will not be permitted. The use of limestone or serpentine aggregate or natural sand, washed or unwashed, is prohibited. The use of washed concrete sand is also prohibited.

823.25 Reclaimed Asphalt Pavement (RAP). This material consists of existing asphalt cement concrete pavement material removed by cold milling, or removed and processed such that 100% passes the 1″ (25 mm) sieve. If the Contractor has a supply of RAP meeting the approval of the Engineer, a percentage of this material, meeting the requirements of Subsection 823.26 may be substituted for the new materials required to produce bituminous base, binder, or dense surface courses.

The stockpile of RAP shall be free of topsoil, debris, foreign matter, and other contaminants.

823.26 Recycled Asphalt Concrete Mixture. The recycled mixture shall be a blend of RAP, new aggregate, and asphalt cement conforming to the mixture requirements of this Section for the type mix specified. The new aggregate shall conform to the requirements of Subsections 823.03 and 823.04. The new asphalt shall conform to the requirements of Subsection 823.02. The percentage of new aggregate is not fixed by this Subsection; however, limitations are placed on the RAP percentage permitted in the recycled mix. A job mix formula must be submitted to the Engineer per Subsection 823.19 and approved prior to initiation of work and for any subsequent changes in the blend of the mixture. The approved ratio of RAP to new aggregate and the percentage of new asphalt cement to be incorporated into the recycled asphalt concrete mixture will be determined by laboratory tests performed on representative samples of stockpiled RAP and new aggregate.

The physical properties of the RAP asphalt cement will be determined by extraction, recovery, and testing. The testing of the physical properties will govern the percentage of RAP permitted in the recycled mix. In all mixture types, the contribution of the RAP asphalt cement shall not exceed 50% of the design asphalt content for the recycled mix.

In addition, the following plant limitations shall apply to all recycled mixtures:

Table 823-A
Maximum Percentage of RAP

Plant Type	*Mixtures*		
	Deep Lift	*Type B*	*Type C*
Dryer-Drum	20	10	10
Batch Plant	20	10	10

Results of single extractions and sieve tests shall not be used as the sole basis for acceptance or rejection of the mixture. Any variation from the job mix formula in the gradation of the aggregate or in the asphalt content that exceeds the tolerances noted below shall be investigated, and the conditions causing the variation shall be corrected.

The following tolerances for the job mix formula will be allowed per single test:

Sieve Size	*Percent Passing*
½″ (12.5 mm) and larger	±8
No. 4 (4.75 mm) and 3/8″ (9.5 mm)	±7
No. 100 (150 µm) to No. 8 (2.36 mm) (inclusive)	±5
No. 200 (75 µm)	±3
Asphalt content, weight percent of total mixture	±0.4

823.27 Recycled Mix Production. Recycled mixtures may be produced in batch or dryer-drum type plants.

Batch plants shall use the heat transfer method, by introducing the RAP into the plant weigh box at the ambient temperature of the stockpile. With this method, the uncoated, virgin aggregate, shall be superheated in the dryer and transfer its heat to the cold RAP in the plant mixer. A conveying system shall be used to introduce the proper amount of RAP per batch into the weigh box in sequence with the superheated aggregates from the plant hot bins. The mixing cycle shall include a minimum 15-second dry mix cycle prior to introduction of the hot asphalt cement. The mixture produced shall be of uniform, specified temperature, evenly coated, unsegregated, and shall have all the characteristics typical of a virgin aggregate-asphalt mixture for the type mix produced.

Dryer-drum plants used in the production of recycled mixtures shall be specifically designed and equipped by the manufacturer to provide for entrance of the RAP material into the drum with subsequent heating, and for mixing the RAP with the new aggregate and asphalt without direct flame contact, excessive asphalt hardening, or violation of air quality standards. The mixture produced shall be uniform, at the specified temperature, evenly coated, unsegregated, and have all the characteristics typical of a virgin aggregate-asphalt mixture for the type mix produced.

823.28 Use of Recycled Mixtures. Unless prohibited by the Contract, the use of recycled mixtures for the mix types specified by the Contract shall be at the option of the Contractor. All provisions of Sections 401 and 823, except as modified in Subsections 823.25, 823.26, and 823.27, shall govern materials, production, storage, transportation, spreading, finishing, and compaction of recycled materials for the appropriate mix type provided.

SECTION 824 – EMBEDDED REINFORCEMENT AND HARDWARE

824.01 Description. This material consists of bar reinforcement, wire mesh reinforcement, tie bars, dowel bars, hook bolts, W-bolts, and load transfer assemblies.

824.02 Material Requirements.

(a) *Bar Reinforcement.* Bar reinforcement shall conform to the requirements of AASHTO M 31/M 31M, Grade 40 or Grade 60, (Grade 300 or Grade 400), as specified on the Plans.

(b) *Epoxy Coated Bar Reinforcement.* Epoxy coated bar reinforcement shall conform to the requirements of AASHTO M 284/M 284M.

(c) *Wire Mesh Reinforcement.* Wire mesh reinforcement shall conform to the requirements of AASHTO M 55.

(d) *Tie Bars.* Tie bars shall conform to the requirements of AASHTO M 31M.

(e) *Hook Bolts.* Hook bolts used in lieu of deformed tie bars shall conform to the Plans and the Standard Construction Details.

(f) *W-Bolts.* W-bolts shall conform to the Plans and the Standard Construction Details.

(g) *Coated Dowel Bars.* Coated dowel bars shall be round, steel bars of the diameter and length shown on the Plans, with a corrosion-resistant coating over a plain steel bar core, conforming to AASHTO M 255/M 255M, Grade 65 (Grade 450). The coating shall conform to AASHTO M 254 and be either Type A0, 25 ± 5 mils (635 ± 130 µm), multi-layer, low-bond plastic coating, or Type B, 7 ± 2 mils (180 ± 50 µm), fusion-bonded epoxy coating, requiring graphite application.

(h) *Load Transfer Assemblies.* The load transfer device shall be fabricated from corrosion-resistant, coated dowel bars conforming to AASHTO M 254, Type A or Type B coating described in (g) above.

(i) *Splice Couplers.* Splice couplers shall conform to the requirements specified on the Plans and shall be submitted to the Engineer for approval.

(j) *Fiber Reinforcement.* Alkali resistant fiber reinforcement shall conform to the requirements of ASTM C 1116, Type III with a minimum fiber length of ½″ (12 mm) and a maximum length of 1½" (38 mm).

SECTION 825 – FENCE

825.01 Description. This material consists of right-of-way fence and chain-link fence.

825.02 Right-Of-Way Fence. Right-of-way fence material shall conform to the following requirements:

(a) *Metal Posts.* Tubular steel posts and braces shall conform to the requirements of AASHTO M 281 and shall be galvanized in accordance with AASHTO M 111.

Steel posts of tee, channel, wide flange, or U-bar shapes, shall be formed structural steel, hot-rolled carbon steel, or hot-rolled rail steel, having a minimum yield strength of 40,000 psi (280 MPa) and a minimum ultimate strength of 70,000 psi (480 MPa). Steel posts shall be either galvanized in accordance with AASHTO M 111, painted with weather resistant paint that is specifically designed for steel, or painted with enamel that has been shop or factory baked.

(b) *Barbed Wire.* Barbed wire shall be galvanized steel conforming to the requirements of AASHTO M 280 and shall consist of two-strand 12½ gage (2.51 mm) wire with tightly wrapped, sharp, four-point barbs formed of 14 gage (2.03 mm) wire spaced evenly at not more than 5" (130 mm) intervals. Galvanizing shall be Class 3.

(c) *Woven Wire Fencing.* Woven wire fencing or woven wire fabric shall be 9 gage (3.77 mm) galvanized wire conforming to the requirements of AASHTO M 279, Class 3 coating or 9 gage (3.77 mm) aluminum coated steel wire conforming to the requirements of ASTM A 584 with a minimum coating weight of 0.4 oz/ft² (120 g/m²).

825.03 Chain-Link Fence. Chain-link fence shall be either galvanized steel fabric fence, aluminum-coated steel fabric fence, or aluminum alloy fabric fence, conforming to the appropriate requirements of AASHTO M 181.

SECTION 826 – STRUCTURAL STEEL

826.01 Description. This material consists of structural steel, fasteners, bearings, and related materials fabricated, painted, and inspected in a shop environment. Related field activities such as erection and

field painting are specified in Section 605. Requirements for working drawings are specified in Subsection 105.04.

MATERIAL REQUIREMENTS.

826.02 Structural Steel. Materials shall be stored in accordance with Subsection 605.03. Structural steel for bolted and welded steel structures shall be furnished according to the following specifications unless otherwise specified:

(a) Structural carbon steel for bolted or welded construction conforming to AASHTO M 183/M 183M shall be furnished.

(b) Steel for eyebars shall be of weldable grade. These grades include:
  (1) Structural steel conforming to AASHTO M 183/M 183M,
  (2) Structural steel conforming to AASHTO M 222/M 222M,
  (3) High-strength low-alloy structural manganese vanadium steel conforming to AASHTO M 223/M 223M, and
  (4) High-strength low-alloy structural steel conforming to AASHTO M 270/M 270M.

(c) High-strength low-alloy structural steel shall conform to:
  (1) AASHTO M 222/M 222M, or
  (2) AASHTO M 223/M 223M, or
  (3) AASHTO M 244/M 244M.

(d) High-strength low-alloy structural steel for welding shall conform to:
  (1) AASHTO M 223/M 223M, Grades 42 and 50 (Grades 290 and 345). Structural shapes shall be limited to Groups 1, 2, and 3 of AASHTO M 160/M 160M. Plates and bars of Grade 42 (Grade 290) shall be limited to thicknesses through 4″ (100 mm). Plates and bars of Grade 50 (Grade 345) shall be limited to thicknesses through 1½″ (38 mm).
  (2) AASHTO M 222/M 222M. The following supplemental requirements for impact properties shall be met:
    a. *Impact Tests.* The Contractor shall provide the heat qualification results for one impact test from the thickest material and one impact test for the thinnest material for each heat and product furnished. The impact test shall be the longitudinal Charpy V-Notch (CVN) test conforming to the requirements of AASHTO T 244. Products are defined as plates, shapes, and bars. If less than 50 tons (45 metric tons) of a product are supplied using a given heat, only one impact test for the thickest material is required for that heat.

For a heat to qualify, the average energy absorbed at 40 °F (4 °C) on the test specimens shall not be less than 15 foot pounds (20 J), except when sub-size specimens are required. The minimum average energy absorption for sub-size test specimens shall be as follows:

Size	*Energy Absorption*
10 by 7.5 mm	12 ft·lb (16 J)
10 by 5 mm	8 ft·lb (11 J)

One impact test consists of the average value of three adjacent specimens. The results for a single specimen may be below the above specified minimum values, but in no case below two-thirds of the value. If more than one value is below the specified minimum, or if one specimen is below two-thirds of the specified minimum, a retest of three additional specimens shall be made. Each retest must equal or exceed the specified minimum. If the thickest or thinnest

material tested fails to qualify, the thickness or those thicknesses shall be rejected. However, the next thinner or thicker material to be furnished may be tested. If the retest results meet the requirements, the heat will be considered qualified for those thicknesses represented by the retest.

The governing thickness for beams, tees, and channels shall be the average flange thickness. The governing thickness for angles shall be the specified leg thickness. Test specimens for these sections shall be taken at a point one-third the distance from the outer edge of the flange or leg to the web or heel of the section.

b. *Requirements for Notch Toughness.* Requirements are provided herein for notch toughness of the steel. These are mandatory for material designated as main load carrying member components subject to tensile stress.

The material supplied shall meet the longitudinal CVN tests specified in Table 826-A. Sampling and testing procedures shall be in accordance with AASHTO T 243/T 243M.

Table 826-A
Charpy V-Notch Test Requirements

Steel Designation	*Thickness*	*Equivalent Absorbed Energy*	*Frequency of Testing*
AASHTO M 183/M 183M	Up to 4″ (100 mm)	15 ft·lb @40 °F (20 J @ 4 °C)	H**
AASHTO M 222/M 222M	Up to 2″ (50 mm), welded	15 ft·lb @ 40 °F (20 J @ 4 °C)	H
	over 2 to 4″ (51 to 100 mm), welded	20 ft·lb @ 40 °F (27 J @ 4 °C)	
	Up to 4″ (100 mm), mechanically fastened	15 ft·lb @ 40 °F (20 J @ 4°C)	
AASHTO M 223/M 223M*	Up to 2″ (50 mm), welded	15 ft·lb @ 40 °F (20 J @ 4 °C)	H
	Up to 4″ (100 mm), mechanically fastened	15 ft·lb @ 40 °F (20 J @ 4 °C)	
AASHTO M 244/M 244M	Up to 2½″ (64 mm), welded	25 ft·lb @ 0 °F (34 J @ -18 °C)	P***
	2½ to 4″ (65 to 100 mm), welded	35 ft·lb @ 0 °F (47 J @ -18 °C)	
	Up to 4″ (100 mm), mechanically fastened	25 ft·lb @ 0 °F (34 J @ -18 °C)	

* If the yield point of the material exceeds 65 ksi (450 MPa), the temperature for the CVN value for acceptability shall be reduced by 15 °F (8 °C) for each increment of 10 ksi (70 MPa) above 65 ksi (450 MPa).

** "H" (Heat Testing)

***"P" (Piece Testing)

The materials subject to the notch toughness requirements are the main load carrying components under tensile stress. The main load carrying member components are the flanges, webs, and splice plates of the steel girders.

(e) High-strength structural steel for bolted construction shall conform to:

(1) AASHTO M 222/M 222M, or
(2) AASHTO M 223/M 223M, or
(3) AASHTO M 244/M 244M.

826.03 Fasteners. The Contractor shall provide a supplier's certification for all bolts, nuts, and washers. This certification shall include origin of all materials, result of the rotational-capacity tests, date and location of tests, and zinc thickness on galvanized fasteners. Lot numbers of fasteners shall be listed on the certificate and the shipping papers.

Bolts, nuts, and circular washers shall conform to the requirements of AASHTO M 164 (M 164M), Type 1 including suitable nuts and plain hardened washers. Bolts manufactured to AASHTO M 164M are marked on the top of the head with three radial lines and the symbol **A325 (A 325M)**. Nuts are marked on one face with three similar circumferential markings, 120 degrees apart, or alternatively, with **C**, **2**, **D**, **2H**, or **DH**. Bolt and nut dimensions shall conform to Table 826-B for heavy hexagon structural bolts and for heavy semi-finished nuts, except as allowed in the following paragraph.

Bolts	*Nuts*
A 325 (A 325M) A 490 (A 490M)	ASTM A 563 (A 563M)

When specified on the Plans, or at the option of the Contractor, bolts, nuts, and circular washers conforming to the requirements of AASHTO M 253 (M 253M), Type 1, quenched and tempered shall be used. Alloy steel bolts for structural steel joints shall be furnished.

Subject to the approval of the Engineer, other fasteners which meet the chemical composition requirements of AASHTO M 164 (M 164M) and which meet the mechanical requirements of the same specifications in full-size tests, and which have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of these same nominal dimensions referenced in Table 826-B, may be used. Such alternate fasteners may differ in other dimensions from those specified for AASHTO M 164 (M 164M) bolts and nuts.

Table 826-B
Bolt and Nut Dimensions - US Customary Unit

Nominal Bolt Size (D)	*Bolt Dimensions, in Inches Heavy Hexagon Structural Bolts*			*Nut Dimensions, In Inches Heavy-Semi-Finished Hexagon Nuts*	
	Width Across Flats (F)	*Height (H)*	*Thread Length (T)*	*Width Across Flats (W)*	*Height (H)*
1/2	7/8	5/16	1	7/8	31/64
5/8	1-1/16	25/64	1-1/4	1-1/16	39/64
3/4	1-1/4	15/32	1-3/8	1-1/4	47/64
7/8	1-7/16	35/64	1-1/2	1-7/16	55/64
1	1-5/8	39/64	1-3/4	1-5/8	63/64
1-1/8	1-13/16	11/16	2	1-13/16	1-7/64
1-1/4	2	25/32	2	2	1-7/32
1-3/8	2-3/16	27/32	2-1/4	2-3/16	1-11/32
1-1/2	2-3/8	15/16	2-1/4	2-3/8	1-15/32

Table 826-B
Bolt and Nut Dimensions - Metric Units

Nominal Bolt Size (D)	*Heavy Hexagon Structural Bolt Dimensions (mm)*			*Nut Dimensions (mm)*	
	Width Across Flats (F)	*Height (H)*	*Thread Length (T)*	*Width Across Flats (W)*	*Height (H)*
13	22	8	25	22	12
16	27	10	32	27	15
19	32	12	35	32	19
22	36	14	38	36	22
25	41	15	44	41	25
28	46	17	50	46	28
32	50	20	50	50	31
35	55	21	57	55	34
38	60	24	57	60	37

Circular washers shall be flat and smooth and their nominal dimensions shall conform to dimensions referenced in Table 826-C.

Beveled washers for American Standard Beams and Channels shall be square or rectangular, shall taper in thickness, and shall conform to the dimensions given in Table 826-C.

Where necessary, washers may be clipped on one side to a point not closer than seven-eighths of the bolt diameter from the center of the washer.

Table 826-C
Washer Dimensions [a] - US Customary Units

Circular Washers					*Square or Rectangular Beveled Washers for American Standard Beams and Channels*		
Bolt Size (D)	*Nominal Outside Diameter* [b]	*Nominal Diameter of Hole*	*Thickness*		*Minimum Side Dimension*	*Mean Thickness*	*Slope of Taper in Thickness*
			Minimum	*Maximum*			
1/2	1-1/16	17/32	.097	.177	1-3/4	5/16	1:6
5/8	1-5/16	21/32	.122	.177	1-3/4	5/16	1:6
3/4	1-15/32	13/16	.122	.177	1-3/4	5/16	1:6
7/8	1-3/4	15/16	.136	.177	1-3/4	5/16	1:6
1	2	1-1/16	.136	.177	1-3/4	5/16	1:6
1-1/8	2-1/4	1-1/4	.136	.177	2-1/4	5/16	1:6
1-1/4	2-1/2	1-3/8	.136	.177	2-1/4	5/16	1:6
1-3/8	2-3/4	1-1/2	.136	.177	2-1/4	5/16	1:6
1-1/2	3	1-5/8	.136	.177	2-1/4	5/16	1:6
1-3/4	3-3/8	1-7/8	.178[c]	.28[c]	---	---	---
2	3-3/4	2-1/8	.178	.28	---	---	---
Over 2 to 4 inc.	2D-1/2	D+1/8	.24 [d]	.34 [d]	---	---	---

[a] Dimensions in inches
[b] May be exceeded by 1/4 in.
[c] 3/16 in. nominal
[d] 1/4 in. nominal

Table 826-C
Washer Dimensions [a] - Metric Units

Circular Washers					*Square or Rectangular Beveled Washers for American Standard Beams*		
Nominal Bolt Size (D)	*Nominal Outside Diameter* [b]	*Nominal Diameter of Hole*	*Thickness*		*Minimum Side Dimension*	*Mean Thickness*	*Slope of Tape*
			Minimum	*Maximum*			
13	27	13	3	5	44	8	1:6
16	33	17	3	5	44	8	1:6
19	37	21	3	5	44	8	1:6
22	44	24	4	5	44	8	1:6
25	50	27	4	5	44	8	1:6
28	57	32	4	5	57	8	1:6
32	63	35	4	5	57	8	1:6
35	69	38	4	5	57	8	1:6
38	75	41	4	5	57	8	1:6
44	85	47	5 [c]	7 [c]	---	---	---
50	94	53	5	7	---	---	---
51 to 100	2D-13	D-3	6 [d]	9 [d]	---	---	---

[a] millimeters
[b] May be exceeded by 6 mm
[c] 5 mm nominal
[d] 6 mm nominal

Unless otherwise specified on the Plans, all high-strength bolts, nuts, and washers shall be mechanically galvanized in accordance with AASHTO M 298. Coating thickness, adherence, and quality requirements, however, shall conform to Class C of AASHTO M 232. Type 3, AASHTO M 164 (M 164M) and AASHTO M 253 (M 253M), bolts, nuts, and washers specified for use with unpainted, AASHTO M 270/M 270M, GRADE 345W connections shall not be galvanized. Ungalvanized AASHTO M 253 (M 253M) bolts and hardware will not be used for hot-dipped galvanized connections. In addition, hot-dip galvanizing of Type 3, AASHTO M 164 (M 164M) or AASHTO M 253 (M 253M), bolts will not be permitted.

826.04 Shear Connectors. Shear connector studs shall conform to the requirements of AASHTO M 169 for cold-finish carbon steel bars and shafting, and cold-drawn bars, Grades 1015, 1018, or 1020, either semi-kilned or fully-kilned. If flux-retaining caps are used, the steel for the caps shall be of a low-carbon grade suitable for welding and shall comply with ASTM A 109 (A 109M) for cold-rolled, carbon-steel strip.

Tensile properties as determined by tests of bar stock after drawing or of finished studs shall conform to the following requirements:

Tensile strength (minimum) . . . . . 60 ksi (415 MPa)
Yield strength * (minimum) . . . . . 50 ksi (345 MPa)
Elongation (minimum) . . . . . 2″ (50 mm)
Reduction in area (minimum) 50%

* As determined by a 0.2% offset method

Tensile properties shall be determined according to the applicable sections of AASHTO T 244 for mechanical testing of steel products. Tensile tests of finished studs shall be made on studs similar to those shown in Table 826-D.

If fracture occurs outside the middle half of the gage lengths, the test shall be repeated.

Finished studs shall be of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, or other injurious defects. Finishing shall be as produced by cold-drawing, cold-rolling, or machining.

The studs shall conform to the dimensions given in the following table:

Table 826-D
Shear Connector Studs
standard dimensions and tolerances in inches (millimeters)

Shank			*Head*	
Diameter (c)		*Length* (L)*	*Diameter (H)*	*Thickness (T)*
3/4 +0.000 0 -0.015	(19) (+0.00) (0) (-0.5)	4+0.062 (100+1.6) -0.125 (-3.2)	1¼ + 1/64 (32 +0.5)	3/8 minimum (9.5 minimum)
7/8 +0.000 0 -0.015	(22) (+0.00) (0) (-0.5)	4+0.062 (100 +1.6) -0.125 (-3.2)	1 3/4 + 1/64 (44 +0.5)	3/8 minimum (9.5 minimum)

* Length includes thickness of head. Standard length is 4″ (100 mm) but other lengths may be obtained by special order.

The Contractor shall furnish the manufacturer′s certification that the studs as delivered are in accordance with the material requirements of this Section. Certified copies of in-plant quality control test reports shall be furnished to the Engineer upon request.

It shall be the Contractor′s responsibility to comply with all requests of the inspector to correct improper workmanship and to remove and replace, or correct as instructed, all welds found defective or deficient. The Department will inspect all welds using visual inspection or nondestructive testing.

826.05 Forgings and Castings.

(a) *Carbon Steel Forgings.* Steel forgings shall conform to AASHTO M 102, Class C, unless otherwise specified.

(b) *Cold Finished Carbon Steel Shafting.* Cold finished carbon steel shafting shall conform to AASHTO M 169, Grade Designation 1016-1030, inclusive, unless otherwise specified.

(c) *Alloy Steel Forgings.* Alloy steel forgings shall conform to AASHTO M 102, Class G, unless otherwise specified.

(d) *Steel Castings for Highway Bridges.* Steel castings for use in highway bridge components shall conform to AASHTO M 192/M 192M, Class 70 (Class 485), Grade 70-36 (Grade 485-250) steel, or AASHTO M 103/M 103M.

(e) *Chromium Alloy-Steel Castings.* Chromium alloy-steel castings shall conform to AASHTO M 163/M 163M, Grade CA-15, unless otherwise specified.

(f) *Iron Casting.* Iron casting shall be gray-iron castings conforming to AASHTO M 105, Class No. 30, unless otherwise specified.

(g) *Ductile Iron Castings.* Ductile iron castings shall conform to ASTM A 536, Grade 60-40-18, unless otherwise specified.

(h) *Malleable Castings.* Malleable castings shall conform to ASTM A 47M, Grade No. 22010, unless otherwise specified.

(i) *Workmanship, Finish, and Cleaning for Iron Castings, Ductile Iron Castings, and Malleable Castings.* Castings shall be true to pattern in form and dimensions, and free from pouring faults, sponginess, cracks, blow holes, or other defects in positions affecting their strength and value for the service intended.

The castings shall be boldly filleted at angles. The arrises shall be sharp and perfect.

All castings must be sandblasted or otherwise effectively cleaned of scale and sand to present a smooth, clean, and uniform surface.

(j) *Bronze Castings.* Bronze castings shall conform to AASHTO M 107, Alloy UNS No. C91300 or C90500 modified with up to 2.5% lead maximum.

826.06 Bearing Materials.

(a) *Elastomeric Bearing Pads.* The elastomeric bearing pads shall be cast in a single, integral layer. Multiple-layer pads, separated by non-elastic sheets to resist deformations in thick pads, may be permitted. The variation in thickness in the longitudinal direction (taper) shall not exceed 5% of the length of the pads. The least horizontal dimension of the pads shall not be less than five times the thickness (shape factor l.25 minimum).

(b) *Copper-Alloy Plates.* Copper-alloy plates shall conform to AASHTO M 108, Copper Alloy UNS No. C51000 or C65500.

(c) *Polytetraflourethylene - Stainless Steel Structural Bearings.* The polytetrafluorethylene (TFE) self-lubricating bearing element shall be composed of 100% virgin (unfilled) TFE polymer, bonded to a rigid confining substrate. The substrate shall limit the flow (elongation) of the confined TFE to not more than 0.009″ (225 μm) under a load of 2000 lb (14 MPa) for 15 minutes at 78 °F (26 °C) for a 2 by 3″ (50 by 75 mm) test sample. The virgin (unfilled) TFE shall have a thickness of not less than 1/32″ (1 mm). The properties of the TFE shall conform to the requirements of following table:

Table 826-E
TFE Properties

Requirements	*Test Method*	*Value*
Hardness at 78 °F (26 °C)	ASTM D 2240	50-65 Durometer D
Tensile Strength, psi (MPa)	ASTM D 1457	2800 (20) (min. avg.)
Elongation, %	ASTM D 1457	200 (min. avg.)
Deformation under load, % at 78° F (26 °C), 2000 psi (14 MPa) 1/2 x 1/2 x 1/32" (13 by 13 by 1 mm)	ASTM D 621	4 (max.)
Specific Gravity	ASTM D 792	2.14 to 2.21

The preformed fabric bearing pad shall consist of multiple layers of 8 oz (227 g) duck impregnated with high quality rubber, capable of withstanding loads of 10 ksi (70 MPa) perpendicular to the plane of lamination without detrimental reduction in thickness and without extrusion. Actual dimensions are determined by the design criteria noted on the structural drawings. The bearing pad shall meet the environmental requirements of MIL-STD-810E(2).

The stainless steel shall be no less than 16 gage (1.5 mm) meeting the AISI Type 304 (ASTM A 240) requirements and have a mirror finish of less than 10 microinches Root-Mean-Square (0.25 μm) on the side in contact with the TFE. The stainless steel shall be 1/8″ (3 mm) smaller than the sole plate all around. The stainless steel shall be mechanically bonded to the sole plate.

The coefficient of friction between the self lubricating bearing element (TFE) and the stainless steel shall not be more than 0.06 at 800 psi (5.6 MPa) compressive loading.

The sole plate and base plate shall be the same type of structural steel specified for the steel structure. The dimensions shall comply with the details as shown on the structural drawings. All exposed surfaces shall be given the coating specified for the steel structure. Unless otherwise specified, a base plate shall be used for each bearing.

The bearing pad shall have a shore "A" hardness of 90 ± 5. The expansion bearing total thickness will be ±10%. The TFE thickness shall be -0, + 0.015″ (-0, +0.4 mm).

(d) *Steel - Bronze Bearings and Rocker Bearings.* The steel used for bearings shall be the same type of steel designated for the steel structure unless otherwise specified. All exposed surfaces, except sliding surfaces, shall receive the same coating used for the structural steel.

Steel surfaces of the sole plate, rocker plate, and web and bearing plates in contact with other surfaces, shall be machine finished to at least 250 microinches Root-Mean-Square (6.4 μm). Surfaces of the sole plate and masonry plate in contact with the bronze plate shall have a machine finish of at least 125 microinches Root-Mean-Square (3.2 μm). The sliding surfaces shall be coated with a multipurpose grease before shipment. Prior to erection, the coating shall be removed using a solvent.

The bearing shall be shop assembled and match-marked to ensure proper fit.

Bevel the sole plate to match the grade if the grade exceeds 1%. For low profile fixed bearings, bevel the sole plate if grade exceeds 3%.

Self-lubricating bronze bearing plates shall conform to the requirements of AASHTO M 107, Alloy C91100 unless otherwise specified. The sliding surfaces of the plates shall be polished and provided with annular grooves or cylindrical recesses, or a combination thereof, filled with a lubricating compound. The compound shall be free of any material that could cause abrasive or corrosive action upon the metal surfaces and also shall be able to withstand extremely high pressures and the atmospheric elements over long periods of time. The lubricating compound shall be compressed into the recesses under sufficient pressure to form a non-plastic, lubricating inset. The lubricating inset shall comprise not less than 25% of the total area of the plate. The frictional coefficient shall not exceed 0.10 during the first 1000 cycles at the design dead load.

(e) *Elastomeric Bearings.* Elastomeric bearings shall conform to the AASHTO Standard Specifications for Highway Bridges, Section 18, Division II. The elastomer having a durometer hardness of 70 shall not be used in laminated bearings.

To prevent any relative movement between the bearing pad and the sole plate or the masonry, the Contractor shall perform one of the following:

(1) Use epoxy and grit on the bottom surface of the sole plate and roughen the bridge seat, or

(2) Use bonding compound approved by the Engineer to bond the contact surfaces. The beam and bearing pad shall be set in place before the bonding compound hardens.

The relative motion may be prevented using other methods recommended by the Contractor or the manufacturer, subject to the Engineer′s approval.

826.07 Galvanizing. When galvanizing is shown on the Plans or specified in the Special Provisions, most ferrous metal products shall be galvanized in accordance with AASHTO M 111. High-strength bolts and other small, highly-stressed parts shall be mechanically galvanized as specified in Subsection 826.03.

826.08 Sheet Zinc. Sheet zinc shall conform to ASTM B 69, Type II.

SHOP FABRICATION.

826.09 Quality of Workmanship. Fabrication of primary load carrying members will require AISC Category I or III shop certification.

826.10 Connections Using High Strength Bolts. Connections using high-strength bolts shall conform to the requirements of Subsection 605.15.

826.11 Plate Cut Edges. Plate cut edges shall conform to the requirements of Subsection 605.16.

826.12 Welding and Oxygen Cutting. Temporary or permanent welds not shown on the Plans or permitted by this Section or Subsection 605.17 shall not be made without specific written authorization by the Engineer.

All welding and oxygen cutting shall conform to AWS D1.1 and ANSI/AASHTO/AWS D1.5.

Welding of steel structures and nondestructive testing of welds shall conform to ANSI/AASHTO/AWS D1.5. All nondestructive testing required shall be done by the Contractor in the presence of the Department's inspector.

(a) *Welding Processes.* Manual shielded metal arc and submerged arc welding procedures covered in ANSI/AASHTO/AWS D1.5 are approved for use without procedure qualification tests.

Vertical submerged arc, electrogas arc, and electroslag welding processes shall not be used unless called for in the Plans or Special Provisions. The Contractor may request permission to use these processes from the Engineer by written notification. The Engineer will make the final decision as to the suitability of such processes.

The Engineer will not authorize the use of gas shielded, metal arc welding processes for welding of primary stress members (main girders, transverse beams, sign bridges, bridge bearings, etc.) or for any welded connections on either primary or secondary stress members. Consideration and authorization to use other welding processes may be given for welding of secondary stress members such as diagonal bracing to gusset plates, gusset plates to stiffeners, bridge railing posts, railing splices, grates, grate frames, and drain pipes.

Processes outlined in ANSI/AASHTO/AWS D1.5 and authorized for use in fabrication shall conform to the applicable provisions of the Contract.

(b) *Inspection of Welding.* The Contractor shall notify the Engineer at least 30 calendar days in advance of the beginning of work at the steel fabrication shop. The Engineer or the Engineer's authorized representative will be under no obligation to accept any shop work performed before the 30th day after such notice.

Nondestructive inspection includes radiographic, magnetic particle, dye penetrant, and ultrasonic methods, as well as any other type of inspection the Contractor proposes to use with the Engineer's approval.

Edges of flange butt welds in tension areas shall be magnetic particle (yoke method) or dye penetrant tested.

Ultrasonic testing may be used, when approved, in lieu of radiographic testing and shall be in accordance with AWS/AASHTO specifications.

Nondestructive testing in addition to visual inspection shall be performed by the Contractor and shall be in compliance with the requirements of AWS D1.1 and as modified by ANSI/AASHTO/AWS D1.5.

All inspections shall be performed by a firm or agent employing qualified welding inspection personnel and using equipment approved by the Department. The Contractor shall inform the Department's inspector (or the Department's inspection agency) of the name of its inspecting firm and the identity of the equipment to be used. No fabricated steel shall be inspected or accepted until the firm and its equipment have been approved.

All radiographing, magnetic particle, ultrasonic and other nondestructive testing inspection shall be performed in the presence of the Department's representative. All radiographing, magnetic particle, ultrasonic, and other nondestructive testing inspection performed without the Department's representative present will not be accepted and shall be repeated with the Department's representative present. The Contractor's inspector and the Department's representative shall jointly ascertain that each radiograph is photographically marked with a suitable identification indicating exactly where the image was taken on the beam or girder.

(c) *Prequalification of Welding Operators.* All fabrication shop welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1, as modified by ANSI/AASHTO/AWS D1.5. The Contractor shall ensure that the fabricator retains certified copies of the qualification test records (AWS D1.1, Appendix E) and requalification tests, if appropriate, for use by the Department's authorized representative upon demand. In addition, records shall be maintained by the Contractor to ensure compliance with AASHTO and AWS requirements for the period of effectiveness as indicated in AWS D1.1, Section 5.30.

826.13 Assembly.

(a) *Shop Assembly.* The field connections of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing. While the connections are assembled the subsize holes shall be reamed to the specified size. Assembly shall be *Full Truss or Girder Assembly* unless *Progressive Truss or Girder Assembly*, *Full Chord Assembly*, *Progressive Chord Assembly*, or *Special Complete Structure Assembly* is specified in the Special Provisions or on the Plans.

A camber diagram shall be furnished to the Engineer by the Contractor showing the camber at each panel point of each truss, arch rib, continuous beam line, plate girder, or rigid frame. When the shop assembly is *Full Truss or Girder Assembly* or *Special Complete Structure Assembly*, the camber diagram shall show the camber measured during assembly. With any of the other methods of shop assembly, the camber diagram shall show the calculated camber.

Each assembly, including camber, alignment, accuracy of holes, and fit of milled joints, shall be approved by the Engineer before reaming is commenced.

(b) *Full Truss or Girder Assembly.* This shall consist of assembling all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at one time.

(c) *Progressive Truss or Girder Assembly.* This shall consist of initially assembling for each truss, arch rib bent, tower face, continuous beam line, plate girder, or rigid frame at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices) and not less than 150′ (45 m) in the case of structures longer than 150′ (45 m). At least one shop section or panel or as many panels as are associated

with a chord length shall be added at the advancing end of the assembly before any member is removed from the rearward end so that the assembled portion of the structure is never less than that specified above.

(d) *Full Chord Assembly.* This shall consist of assembling, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch, or each leg of each bent or tower and then the reaming the field connection holes while the members are assembled and reaming the web member connections to steel templates set at the geometric (not cambered) angular relation to the chord lines.

Field connection holes in web members shall be reamed using steel templates. At least one end of each web member shall be milled or shall be scribed normal to the longitudinal axis of the member. The templates at both ends of the member shall be accurately located from one of the milled ends or scribed lines.

(e) *Progressive Chord Assembly.* This shall consist of assembling contiguous chord members in the manner specified for *Full Chord Assembly* and in the number and length specified for *Progressive Truss or Girder Assembly*.

(f) *Special Complete Structure Assembly.* This shall consist of assembling the entire structure including the floor system. This assembly is ordinarily needed only for complicated structures such as those having curved girders or extreme skews in combination with severe grades or cambers.

826.14 Match-Marking. Connecting members assembled in the shop for the purpose of reaming holes in field connections shall be match-marked. A diagram showing such marks shall be furnished to the Engineer.

826.15 Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall conform to the surface roughness requirements as defined in ANSI/ASME B46.1, Part 1, as follows:

Steel slabs	2000 microinches (50 µm)
Heavy plates in contact in shoes to be welded	1000 microinches (25 µm)
Milled ends of compression members, stiffeners, and fillers	500 microinches (12.5 µm)
Bridge rollers and rockers	250 microinches (6.3 µm)
Pins and pin holes	125 microinches (3.2 µm)
Sliding bearings	125 microinches (3.2 µm)

826.16 Fabrication of Members. Unless otherwise shown on the Plans, steel plates for main members and splice plates for flanges and main tension members shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile compressive stress.

826.17 Annealing and Stress Relieving. Structural members which are indicated in the Contract to be annealed or normalized shall have finish machining, boring, and straightening done subsequent to heat treatment. Normalizing and annealing (full annealing) shall be as specified in ASTM E 44. The temperatures during the heating and cooling process shall be maintained uniformly throughout the furnace so that the temperature at any two points on the member will not differ by more than 100 °F (56 °C) at any one time.

A record of each furnace charge identifying the pieces in the charge and showing the temperatures and schedule actually used shall be provided. Proper instruments, including recording

pyrometers, shall be provided for determining the temperatures of members in the furnace at all times. The records of the treatment operation shall be available to and meet the approval of the Engineer.

Members such as bridge shoes, pedestals, or other parts that are built up by welding sections of plate together shall be stress relieved, when required by the Plans, this Section, or Special Provisions governing the Contract, in accordance with procedures established by ANSI/AASHTO/AWS D1.5.

826.18 Pins and Rollers. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws.

Pins and rollers more than 9″ (230 mm) in diameter shall be forged and annealed.

Pins and rollers 9″ (230 mm) or less in diameter may be either forged and annealed, or fabricated from cold-finished, carbon-steel shafting.

In pins larger than 9″ (230 mm) in diameter, a hole not less than 2″ (50 mm) in diameter shall be forged full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions, to prevent injury by too rapid cooling, and before being annealed.

826.19 Boring Pin Holes. Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles to the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside to outside of end holes in tension members and inside to inside of end holes in compression members shall not vary from that specified more than 1/32″ (1 mm).

826.20 Pin Clearances. The diameter of the pin hole shall not exceed that of the pin by more than 1/50″ (0.5 mm) for pins 5″ (125 mm) or less in diameter, or 1/32″ (1 mm) for larger pins.

826.21 Threads for Bolts and Pins. Thread for all bolts and pins for structural steel construction shall conform to the Unified Standard Series UNC-ANSI B1.1, Class 2 A for external threads and Class 2 B for internal threads, except that pin ends having a diameter of 1 3/8″ or more shall be threaded 6 threads to the inch. (Threads for all bolts for structural steel construction shall conform to ANSI/ASME B1.13M, Class 6H. Class 6G threads for pin ends having a diameter of 35 mm or more shall be threaded.)

826.22 Pilot and Driving Nuts. Two pilot nuts and two driving nuts for each size of pin shall be furnished, unless otherwise specified.

826.23 Notice of Beginning of Work. The Contractor shall give the Engineer 30 days notice prior to the beginning of work at the mill or in the shop so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the Engineer has been so notified.

826.24 Facilities for Inspection. The Contractor shall furnish equipment, material, and work space for the inspection of material and workmanship in the mill and shop. The inspectors shall be allowed free access to the necessary areas of the mill and shop.

826.25 Identification of Steels During Fabrication. The Engineer shall be furnished with complete certified mill test reports showing chemical analysis and physical tests for each heat of steel for all members, unless excepted by the Engineer. Each piece of steel to be fabricated shall be properly identified for the Engineer.

Shop drawings shall specifically identify each piece that is made of steel. Pieces made of different grades of steel shall not be given the same assembling or erecting mark even though they are of identical dimensions and detail.

The Contractor's system of assembly marking individual pieces made of steel other than AASHTO M 183/M 183M steel and the issuance of cutting instructions to the shop (generally by cross-referencing the assembly marks shown on the shop drawings with the corresponding item covered on the mill purchase order) shall maintain the identity of the mill test report number.

The Contractor may furnish from stock any acceptable material that it can identify by heat number and mill test report.

During fabrication, up to the point of assembling members, each piece of steel other than AASHTO M 183/M 183M steel shall show clearly and legibly its specification identification color code shown in Table 826-F.

Individually marked pieces of steel that are used in the furnished size, or reduced from the furnished size only by end or edge trimming, in a manner that does not disturb the heat number or color, or leave any usable piece, may be used without further color coding provided that the heat number or color code remains legible.

Pieces of steel, other than AASHTO M 183/M 183M steel, that are to be cut to smaller size pieces shall, before cutting, be legibly marked with the AASHTO M 160/M 160M specification identification color code.

Individual pieces of steel, other than AASHTO M 183/M 183M steel, that are furnished in tagged lifts or bundles shall be marked with the AASHTO M 160/M 160 M specification identification color code immediately upon being removed from the bundle or lift.

Pieces of steel, other than AASHTO M 183/M 183M steel, that prior to assembling into members, will be subjected to fabricating operations such as blast cleaning, galvanizing, heating for forming, or painting, which might obliterate paint color marking, shall be marked for grade by low stress, steel die stamping, or by a substantial tag firmly attached.

The identification colors indicated in Table 826-F shall be used to mark materials meeting the individual specifications listed in Table 826-F.

Table 826-F
Identification Color Codes

AASHTO	*ASTM*	*Color*
M 244/M 244M	A 514/A 514M	Red
	A 517/A 517M	Red and Blue
M 223/M 223M	A 572/A 572M	Grade 345 Green and Yellow
M 222/M 222M	A 588/A 588M	Blue and Yellow

Other steels, except AASHTO M 183/M 183M steel, that are not covered in Table 826-F and are not included in the AASHTO M 160/M 160M specification shall have an individual color code established and recorded for the Engineer.

Upon request, the Contractor shall furnish an affidavit certifying that throughout the fabrication operation it has maintained the identification of steel in accordance with this Subsection.

826.26 Tests for Structural Members.

(a) *Full Size Tests.* When full size tests of fabricated structural members or eyebars are required by the Contract, the Contract will state the number and nature of the tests, the results to be attained,

and the measurements of strength, deformation, or other parameters that are to be performed and recorded. The Contractor shall provide suitable facilities, material, supervision, and labor necessary for performing and recording the tests.

(b) *Non-Destructive Testing.* When non-destructive tests of fabricated structural members are required by the Contract, they shall be done in accordance with Subsection 826.12 (b).

826.27 Erection Marking and Shipping. Each member shall be painted or marked with an erection mark for identification. An erection diagram shall be furnished with erection marks shown thereon.

The Contractor shall furnish the Engineer with three copies of material orders, shipping statements, and erection diagrams as the Engineer may direct. The weights of the individual members shall be shown on the statements. Members weighing more than 3 tons (2.75 metric tons) shall have the weights marked thereon. Structural members shall be loaded on carriers, transported, and unloaded at their destination, without being excessively stressed, deformed, or otherwise damaged.

Bolts of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts, and packages of bolts, washers, and nuts shall be shipped in boxed, crates, kegs, or barrels. The gross weight of any package shall not exceed 300 lb (135 kg). A list and description of the material enclosed shall be plainly marked on the outside of each shipping container.

SHOP PAINTING.

826.28 Urethane Paint System. The Contractor shall select a complete coating system from one manufacturer conforming to the requirements of Subsection 820.02 (a). This selected coating system must be submitted to the Department's Materials and Research Section for approval prior to coating.

The topcoat color of the structural steel shall match color chip No. 24172 (green) of FED-STD-595B, unless otherwise indicated on the Plans. The Contractor shall supply the Engineer with the product data sheets before any painting is done. The product data sheets shall indicate the mixing and thinning directions, the recommended spray nozzles and pressures and all other coating related information.

826.29 General Requirements. Shop painting of metal structures shall consist of shop cleaning, and shop application of the coating system on new structural steel and fasteners with the provision for field application of the topcoat at the option of the Contractor. Included is the cleaning and repair of surfaces damaged in shipping, handling, and erecting the structural steel in accordance with this Specification and as directed by the Engineer.

The coating system shall consist of a coat of inorganic zinc-rich primer, a coat of high-build epoxy, and a urethane topcoat. Terminology used herein is in accordance with the definitions used in Volume 2, Systems and Specifications of the SSPC Steel Structures Painting Manual.

With the exception of abutting joints and base plates, machine finished surfaces shall be painted as soon as practicable after being accepted, and before removal from the shop, with a layer of material meeting the requirements of MIL-C-16173E, automotive grease, or other approved corrosion preventing material.

All structural steel painting will be performed in the shop, except the final coat (topcoat) may be applied in the field after erection. There will be no separate payment for any additional costs of any kind associated with field painting.

826.30 Provisions for Inspection. During fabrication and shop coating, scaffolding shall be furnished and erected, meeting the approval of the Engineer to permit inspection of the steel prior to and after coating.

Rubber rollers, or other protective devices meeting the approval of the Engineer shall be used on scaffold fastenings. Metal rollers or clamps and other types of fastenings which will mar or damage freshly coated surfaces shall not be used.

826.31 Preparation for Shop Coating. All areas shall be blast cleaned to a near-white finish as defined in SSPC-SP 10 for which reference should be made to SSPC Visual Standards. Areas of oil and grease on surfaces to be coated shall be cleaned with clean petroleum solvents prior to blast cleaning. Prior to blast cleaning a beam, the top of the bottom flange shall be scraped to remove any accumulated dirt.

All fins, tears, slivers, and burred or sharp edges that are present on any steel member, or that appear during the blasting operations, shall be removed by grinding and the area reblasted to give a 1 to 2½ mil (25 to 63 μm) surface profile. Scaling hammers may be used to remove heavy scale, but heavier type chipping hammers which would excessively scar the metal shall not be used.

The abrasive used for blast cleaning shall be in accordance with Subsection 605.45, and shall have a gradation such that the abrasive will produce a uniform profile of 1 to 2½ mil (25 to 63 μm), as measured with Testex Replica Tape.

All abrasive and paint residue shall be removed from steel surfaces with a good commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. If the double blowing method is used, the exposed top surfaces of all structural steel, including flanges, longitudinal stiffeners, splice plates, hangers, etc., shall be vacuumed after the double blowing operations are completed. The air line used for blowing the steel clean shall have an in-line water trap and the air shall be free of oil and water as it leaves the air line. The steel shall then be kept dust free, and primed within eight hours after blast cleaning.

Care shall be taken to protect freshly coated surfaces from subsequent blast cleaning operations. Blast damaged primed surfaces shall be thoroughly wire brushed or, if visible rust occurs, reblasted to a near-white condition. The wire brushed or blast cleaned surfaces shall be vacuumed and reprimed.

All areas where field welding is required, shall be masked prior to applying the primer. Areas where shear stud connectors will be welded to the top flange shall be masked after the primer coat has been applied, but before the epoxy coat is applied.

826.32 Painting Conference. Before fabrication of the structural steel begins the appropriate parties involved shall attend a "Post-Award Painting Conference".

Present at the conference shall be the following:

(a) Contractor.
(b) Steel fabricator and its coating specialist.
(c) Paint and coating material supplier including local technical and sales representative plus any other experienced personnel.
(d) Engineer.

The purpose of the conference is to discuss the specifications in detail and ensure that the painting work conforms to the manufacturer's product data sheets and application instructions as well as the requirements of this Section.

The discussions shall include:

(a) Equipment use and servicing.
(b) Material storage.

(c) Application techniques (including thickness tolerances).
(d) Definition of the degree of cleaning, i.e., SSPC Pictorial Standards.
(e) Surface preparation of shop-primed surfaces by shotblasting or sandblasting, describing abrasive to be used, necessary air pressure at the blast nozzle, etc.
(f) Inspection requirements including surface preparation, wet and dry film thickness checking, techniques, and equipment to be used.
(g) Inspection Reports.
(h) Safety precautions stated in the manufacturer's printed instructions.
(i) Availability of the work for inspection by the Engineer.

826.33 Painting.

(a) *Mixing the Paint.* The paint shall be mixed with a high shear mixer such as Jiffy Mixer, in accordance with the manufacturer's directions, to a smooth, lump-free consistency. Paddle mixers or paint shakers are not allowed. Mixing shall be done thoroughly, in the original containers, and shall be continued until all the metallic powder or pigment are in suspension.

Care shall be taken to ensure that all of the paint solids that may have settled to the bottom of the container are thoroughly dispersed. The paint shall then be strained through a screen having openings no larger than those specified for a No. 50 (300 µm) sieve in AASHTO M 92. After straining, the mixed paint shall be kept under continuous agitation up to and during the time of application.

(b) *Thinning the Paint.* In general the paints are supplied for normal use without thinning. If it is necessary to thin the paint for proper application in cool weather, or to obtain better coverage of the urethane topcoat, the thinning shall be done in accordance with the manufacturer's recommendations and shall be subject to the Department's approval.

(c) *Conditions for Painting.* Paint shall be applied only when the following conditions have been met:

(1) *Temperature.* The temperature of the air and the steel shall be above 50 °F (10 °C) for paint other than the topcoat. This 50 °F (10 °C) minimum temperature shall be maintained throughout the minimum time between coats as listed in the Qualified Products List. For the urethane topcoat, the temperature of the air and steel shall be above 40 °F (4 °C). Coatings shall not be applied if the temperature is high enough to cause blistering. The surface temperature of the steel shall be at least 5 °F (3 °C) higher than the dew point.

(2) *Humidity.* The paint shall not be applied when the relative humidity is greater than 90%, nor when a combination of temperature and humidity conditions are such that moisture condenses on the surface being painted.

(d) *Applying the Paint.* After the surface to be coated has been cleaned and approved by the Engineer, the primer shall be applied so as to produce a uniform even coating bonded with the metal. Succeeding coats shall be applied when approved by the Engineer. The minimum curing time between coats shall be according to the manufacturer's specifications. Depending on site conditions, additional time may be required for proper curing before applying succeeding coats. Cure time for proper application of succeeding coats shall not be less than the minimum nor exceed the maximum as recommended by the paint manufacturer. The Contractor shall provide the Engineer written documentation of manufacturer recommended cure times and any pre-treatments of existing coats prior to application of succeeding coats. It is the applicator's responsibility to determine the condition of each coat prior to application of succeeding coats. Any oxidation products, chalking, salts, residue or other surface condition that form on existing

paint surfaces and interfere with proper adhesion shall be completely removed in accordance with manufacturer recommendations or as directed by the Engineer. Removal shall be accomplished through water blasting, solvent wiping, brush-off blasting or other means as necessary to properly prepare the surface for coating.

The coatings shall be applied with the spray nozzles and pressures recommended by the producer of the coating system, so as to attain the film thicknesses specified. All surfaces, including faying (contact) surfaces, and flange tops, shall be shop primed by spray in accordance with SSPC-PA 1. The intermediate coat shall also be applied in the shop in accordance with SSPC-PA 1. The topcoat shall be shop applied or field applied after steel erection at the Contractor's option. Faying surfaces and surfaces to be in contact with Portland cement concrete shall not receive the intermediate and topcoats.

Flange tops shall receive a fog coat of between ½ and 3/4 mils (12 and 19 µm) of inorganic zinc primer. The dry film thickness of the primer coat on the bolted friction splices on the main members shall not be less than 1 mil (25 µm) or greater than 2½ mils (63 µm). The faying surfaces of bolted field splices, bolted shop splices, or any other bolted faying surfaces, shall be masked during subsequent coating operations. In the areas of field bolted connections (including the outside surface of splice plates), the outside surfaces shall be primed a minimum of 4 mils (100 µm). On all other areas, the minimum dry film thickness for the primer coat shall also be 4 mils (100 µm), for the epoxy coat it shall be 3½ mils (88 µm), and for the urethane protective coat it shall be sufficient to provide a uniform color and appearance but in no case shall be less than 1 mil (25 µm).

The dry film thickness will be determined by the use of a magnetic dry film thickness gage. The gage shall be calibrated on the blasted steel with plastic shims approximately the same thickness as the minimum dry film thickness. A Tooke film thickness gage may be used to verify the coating thickness when requested by the Engineer. If the Tooke gage shows the primer coat to be less than the specified minimum thickness, the total coating system will be rejected even if the total dry film thickness exceeds the total of the minimum for each coat of the three-coat system.

All bolted shop connections and shop bolted cross frames or diaphragms shall be removed and disassembled prior to the blasting and coating of the girders or beams. The parts shall be blasted separately, primed, then reassembled and the bolts fully tightened in accordance with the applicable specifications.

All galvanized components in bolted shop connections, including mechanically galvanized nuts, bolts, and washers, shall be solvent cleaned, given a tie coat, if recommended by the paint manufacturer, and then coated with both the epoxy coat and the urethane protective coat.

If the application of the coating at the required thickness in one coat produces runs, bubbles, or sags, the coating shall be removed and reapplied in multiple passes of the spray gun, the passes separated by several minutes. Where excessive coating thickness produces "mud-cracking", such coating shall be scraped back to soundly bonded coating and the area recoated to the required thickness.

In areas of deficient primer thickness, the areas shall be thoroughly cleaned with power washing equipment, as necessary, to remove all dirt; the areas shall then be wire brushed, vacuumed, and recoated.

All coating shall be done in a neat and workmanlike manner as described in SSPC-PA 1, producing a uniform, even coating which is bonded to the underlying surface.

Erection marks, for the field identification of members, and weight marks shall be transferred or preserved.

All metal coated with impure, unsatisfactory, or unauthorized coating material, or coated in an unworkmanlike or objectionable manner, shall be thoroughly cleaned and recoated or otherwise corrected as directed by the Engineer.

All dry spray shall be removed, by sanding if necessary, prior to the application of the succeeding coat.

Material shall not be loaded for shipment until the shop coating has been adequately cured and inspected. The components will be stamped "Recommended for Use" only after the loading has been completed and approved.

826.34 Stenciling Requirement. At the completion of the painting work, the completion date (month and year) and the bridge number, shall be stenciled on the structure in 3″ (75 mm) numbers. The paint used for this marking shall be the same as the topcoat except the color shall be black. The numbers shall be stenciled on the outside of each fascia beam at the approaching traffic end of the structure, on a location designated by the Engineer.

826.35 Handling Steel. Extreme care shall be exercised in handling the steel in the shop, during shipping, during erection, and during subsequent construction of the bridge. The steel shall be insulated from the binding chains by softeners approved by the Engineer. Hooks and slings used to hoist steel shall be padded. Diaphragms and similar pieces shall be spaced in such a way that no rubbing will occur during shipment that may damage the coatings. The steel shall be stored on pallets at the job site, or by other means approved by the Engineer, so that it does not rest on the dirt or so that components do not fall or rest on each other. All shipping and job site storage details shall be presented to the Engineer at the "Post-Award Painting Conference" and they must be approved prior to shipping the steel.

826.36 Field Repair and Field Coating. The Contractor shall furnish and erect scaffolding meeting the approval of the Engineer and shall provide a time mutually agreed upon for inspecting the structural steel prior to and after coating.

Rubber rollers, or other protective devices meeting the approval of the Engineer, shall be used on scaffold fastenings. Metal rollers or clamps and other types of fastenings which will mar or damage freshly coated surfaces shall not be used.

All field repairs shall be made in strict accordance with the coating supplier′s recommendations and shall be approved by the Engineer. All coatings applied to repair areas shall be applied using recommended spray equipment only. The coating supplier′s recommendations are to be supplied to the field personnel by the fabricator of the steel. Such field repairs shall include the application of the following coating system; e.g., on rusted areas: the zinc-rich primer, the epoxy intermediate coat, and the urethane protective coat; on non-rusted areas (where the primer is at least equal to the minimum required dry film thickness): the epoxy intermediate coat and the urethane protective coat; and on galvanized components: the tie coat, the epoxy intermediate coat, and the urethane protective coat.

Surfaces which will be inaccessible for coating after erection shall be repaired and/or recoated prior to erection.

When the erection work has been completed, including all connections and the straightening of any bent metal, the steel shall be prepared for repairs. All adhering scale, dirt, grease, form oil, or other foreign matter shall be removed by appropriate means and any rusted or uncoated areas blast cleaned to a near-white finish in accordance with SSPC-SP 10. All abrasive and paint residue shall be removed from steel surfaces by vacuuming or by double blowing, except that if the double blowing method is used, the top surfaces of all structural steel, including top and bottom flange, splice plates, hangers, etc., shall be vacuumed after the double blowing operations are completed. The coating surrounding the

blasted area shall be thoroughly wire brushed, vacuumed, and the area recoated with the same coating system used in the shop. When spraying a blasted area or an area of insufficient primer thickness, the surrounding area will be coated with primer. Prior to the application of the intermediate coat, the area around the area where the primer has been repaired shall be adequately rubbed to remove the primer from the surrounding epoxy or urethane. The requirements specified herein for provisions for inspection, mixing the coating, thinning the coating, temperature, and humidity requirements for coating, and applying the coatings, shall govern application of the topcoat and application of the coating to the repaired areas. The requirements for the dry film thickness of the topcoat and the repair coats are the same as for the shop coats. Proper curing conditions will be required prior to application of the topcoat and between applications of the repair coats as previously specified herein.

Mechanically galvanized nuts, bolts, and washers shall be coated in accordance with the recommendations of the manufacturer of the coating system. This procedure shall include the removal of any lubricant or residuals on the surface and the application of a tie coat prior to application of the field coats. This tie coat shall be brushed or sprayed as specified by the manufacturer. The epoxy and urethane shall then be applied to the bolts and the surrounding connection surfaces.

Any temporary attachments or supports for scaffolding or forms shall not damage the coating system. (In particular, on the fascias where bracing is used, sufficient size support pads must be used.) Any damage that occurs from such devices shall be repaired by the same procedure as for a field repair.

If the stenciling which was applied at the completion of the shop coating is marred or damaged, the marking shall be repaired as directed by the Engineer. The paint used for this marking repair shall be the same as the urethane protective coat used in the field repairs except the color shall be black.

826.37 Protection of the Work. Pedestrian, vehicular, and other traffic upon or underneath the structure shall be protected in accordance with Section 107. All portions of the structures (superstructure, substructure, slope protection and highway appurtenances) shall be protected against splatter, overspray splashes, and smirches of coating or coating material by means of protective covering suitable for the purpose. The Contractor shall be responsible for any damage caused by his operations to vehicles, persons or property.

Whenever the intended purposes of the protective devices are not being accomplished, work shall be suspended until corrections are made.

SECTION 827 – GEOTEXTILE

827.01 Description. This material consists of geotextile for use in constructing silt fence; reinforced silt fence; inlet sediment control; sediment trap outlet, riser pipe; riprap ditch; perimeter dike/swale; earth dike; temporary slope drain; stilling well; sump pit; stabilized construction entrance; portable sediment tank; geotextile lined channel diversion; dewatering basin; sediment basin outlet structure, corrugated metal; and other soil sediment and erosion control applications.

827.02 Silt Fence. The geotextile shall be a minimum of 36″ (900 mm) wide and shall be a woven fabric consisting of long chain polymeric filaments, or yarns such as polypropylene, polyethylene, polyester, polyamide, or polyvinylidene-chloride, formed into a stable network such that the filaments or yarns retain their relative position to each other. The geotextile shall be inert to commonly encountered chemicals and shall meet the requirements listed in the following table:

Table 827-A

Property	*Test Method*	*Value (Average Minimum Roll Value)*
Grab Tensile Strength	ASTM D 4632	489 N
Grab Tensile Elongation	ASTM D 4632	20%
Mullen Burst Strength	ASTM D 3786	1.4 kPa
Trapezoid Tear Strength	ASTM D 4533	222 N
Slurry Flow Rate	VA DOT, VTM 51	200 mL/sec/m^2
Weight	ASTM D 3776	0.02 lb/ft^2 (0.1 kg/m^2)
Ultraviolet Stability (Strength Retained)	ASTM D 4355 after 500 hours of Xenon-Arc Type Apparatus	70%

827.03 Reinforced Silt Fence. The geotextile shall conform to the requirements of Subsection 827.02.

827.04 Inlet Sediment Control. The geotextile shall be Mirafi 140N, Linq GTF 130D, Amoco 4545, or an equal approved for use by the Department's Materials and Research Section. Table 827-B illustrates the flow rates of the various fabrics. Any material submitted as an equal must have a flow rate equal to or exceeding the minimum flow rate of those listed in the following table:

Table 827-B

Geotextile Manufacturer	*Geotextile Style*	*Flow Rate*	
		gal/min/ft^2	*(L/sec/m^2)*
Mirafi	140 N	120	(82)
	4030 A	145	(99)
Amoco	4545	150	(102)
	4535	155	(105)
Linq	103 EX	140	(95)
	125 EX	150	(102)

827.05 Riser Pipe Assembly for Sediment Trap. The geotextile shall conform to the requirements of Subsection 827.04.

827.06 Riprap Ditch. The geotextile shall be Mirafi 700X or Erosion 1 manufactured by Synthetic Industries, Linq GTF 400E or Poly-Filter X manufactured by Carthage Mills, TerraTex Ep manufactured by WEBTEC, Inc., or an equal approved by the Department's Materials and Research Section.

827.07 Perimeter Dike/Swale. The geotextile shall conform to the requirements of Subsection 827.06.

827.08 Earth Dike. The geotextile shall conform to the requirements of Subsection 827.06.

827.09 Temporary Slope Drain. The geotextile shall conform to the requirements of Subsection 827.06.

827.10 Stilling Well. The geotextile shall conform to the requirements of Subsection 827.06.

827.11 Sump Pit. The geotextile shall conform to the requirements of Subsection 827.04.

827.12 Stabilized Construction Entrance. The geotextile shall be woven or nonwoven and shall consist only of continuous chain polymer filaments or yarns of polyester. The geotextile shall be inert to commonly encountered chemicals and hydrocarbons, be mildew and rot resistant, and shall conform to the properties of the following table:

Table 827-C

Fabric Properties	*Traffic ≤ 3 Axles*	*Traffic > 3 Axles*	*Test Method*
Grab Tensile Strength	890 N	980 N	ASTM D 4632
Elongation at Failure	50%	220%	ASTM D 4632
Mullen Burst Strength	845 N	1.9 kN	ASTM D 3786
Puncture Strength	178 N	556 N	ASTM D 751, Modified
Equivalent Opening Size	180 to 425 µm	180 to 425 µm	Standard Sieve CW-02215

827.13 Portable Sediment Tank. The geotextile shall conform to the requirements of Subsection 827.04.

827.14 Geotextile Lined Channel Diversion. The geotextile shall conform to the requirements of Subsection 827.06.

827.15 Dewatering Basin. The geotextile shall conform to the requirements of Subsection 827.06.

827.16 Sediment Basin Outlet Structure, Corrugated Metal. The geotextile shall conform to the requirements of Subsection 827.04.

SECTION 828 – GUARDRAIL

828.01 Description. This material consists of guardrail, structural steel posts, and related hardware.

828.02 Material Requirements.

(a) *Steel Posts, Steel Offset Blocks, and Steel Shapes.* Steel posts, offset blocks, shapes, and all structural steel parts shall conform to the requirements of AASHTO M 183/M 183M, or shall be fabricated sections conforming to the requirements of ASTM A 769/A 769M. All shapes, except beams, shall be hot-dipped galvanized in accordance with AASHTO M 111.

The Contractor may elect to use either hot-dipped galvanized rolled H sections or fabricated sections, that conform to the requirements of ASTM A 769/A 769M, Grade 36 (Grade 250).

(b) *Beams.* All beams shall conform to the requirements of AASHTO M 180, Class A, Type I or Type II.

(c) *Hardware.* Bolts, nuts, and washers shall be the manufacturer′s standard shoulder bolts for the purpose intended and shall conform to the requirements of AASHTO M 180. All hardware shall have a zinc coating conforming to the requirements of AASHTO M 232.

(d) *Rods and Turnbuckles.* Rods and turnbuckles shall have a minimum tensile strength of 60,000 lb (270 kN). Rods, nuts, turnbuckles, and washers shall be hot-dipped galvanized according to the requirements of AASHTO M 111.

(e) *Swaged Cable Assembly for Guardrail End Tre.* Threads for the stud shall be manufactured according to ANSI B1.13M, M24 x 3 - 6g. The cable shall be swaged into the fitting. The stud shall conform to ASTM F 568, Class C or AASHTO M 298 (ASTM B 695), Class 50. The 3/8″ (10 mm) slot for the locking pin shall be milled into the stud end prior to the application of the zinc coating.

The swaged fitting shall be machined from hot-rolled carbon steel conforming to ASTM A 576, Grade 1035, and zinc-coated according to AASHTO M 111 (ASTM A 123) before swaging. The material shall be annealed suitably for cold swaging. A lock pin hole to accommodate a ¼″ (6 mm) plated spring-steel pin shall be drilled through the head of the swaged fitting to retain the stud in the proper position.

The wire rope shall be 3/4″ (19 mm) diameter, 6 by 19 wire stem+core or independent wire rope core (IWRC), zinc-coated, right regular lay wire rope conforming to AASHTO M 30. The wire rope steel shall be improved steel with a minimum breaking strength of 42,000 lb (190 kN). The swaged fitting, stud, and nuts shall develop the breaking strength of the wire rope.

(f) *Reflectorized Washers.* Reflectorized washers for guardrail posts shall consist of double-faced reflectorized washer units. Washers shall be fabricated from aluminum plates conforming to the requirements of ASTM B 209M, Alloy 5052-H32. Retroreflectorized sheeting conforming to the requirements of AASHTO M 268 shall be applied to the washer.

(g) *Timber Post, Blocks and Offset Blocks*. Timber post, blocks, and offset blocks shall conform to the dimensiions shown on the Standard Construction Details. Timber used for post, blocks and offset blocks shall conform to the requirements of Section 601 and the preservative treatment requirements of Section 814(b). Offset blocks made of composite material tested and approved under National Cooperative Highway Research Program (NCHRP) Report 350 Criteria will also be acceptable..

Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

SECTION 829 – ANTISTRIPPING ADDITIVES

The antistripping additive shall be oil soluble and, when added to asphalt cement, shall promote strong adhesion characteristics with aggregates, shall be compatible with the asphalt cement in which it is to be added, shall not change the basic characteristics of the asphalt cement, and shall be heat-stable when added at the manufacturer′s recommended dosage for a minimum of 96 hours at the bituminous materials normal storage temperature.

The antistripping additive for bituminous concrete shall be evaluated according to the requirements of AASHTO R 15. Testing shall conform to the requirements of AASHTO T 283. The TSR shall be a minimum of 80.

APPENDIX

ABBREVIATIONS

The abbreviations, where used on the Plans, the Engineer's estimates, or in bid documents and/or bid tabulations, shall be construed the same as respective expressions stated below:

Item, Word, or Phrase	*Abbreviation*
Abutment	Abut.
Adjust	Adj.
Aggregate	Agg.
Bituminous	Bit.
Bridge	Br.
Concrete	Conc.
Conduit Junction Well	Cond. Junct. Well
Continuously Reinforced	Cont. Reinf.
Corrugated Aluminum Pipe	CAP
Corrugated Metal Pipe	CMP
Double	Dbl.
Drainage Inlet	DI
Embankment	Embank.
Excavation	Excav.
Footing	Ftg.
Galvanized	Galv.
Galvanized Corrugated Steel Pipe	GCSP
Guardrail	GR
Hydrants	Hyd.
Junction Box	JB
Manhole	MH
Modified	Mod.
Pavement	Pav't.
Perforated	Perf.
Permanent	Perm.
Portland Cement Concrete	PCC
Reinforced Concrete Pipe	RCP
Right-Of-Way	ROW
Roadway	Rdwy.
Sanitary	San.
Surface	Surf.
Temporary	Temp.
Temporary Roadway Material	TRM
Vehicular	Veh.
Water Valve	WV

APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	*When You Know*	*Multiply By*	*To Find*	*Symbol*
		LENGTH		
	mils	0.025 4	millimeters	mm
in	inches	25.4	millimeters	mm
ft	feet	0.304 8	meters	m
yd	yards	0.914 4	meters	m
mi	miles	1.609 344	kilometers	km
		AREA		
in^2	square inches	645.16	millimeters squared	mm^2
ft^2	square feet	0.092 903	meters squared	m^2
fl oz	fluid ounces	29.573 53	milliliters	mL
yd^2	square yards	0.836 127 4	meters squared	m^2
ac	acres	0.404 685 6	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.573 53	milliliters	mL
gal	gallons	3.785 412	liters	L
ft^3	cubic feet	0.028 316 85	meters cubed	m^3
yd^3	cubic yards	0.764 555	meters cubed	m^3
Note: Volumes greater than 1 000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.349 52	grams	g
lb	pounds	0.453 592	kilograms	kg
T	short tons (2 000 lb)	0.907 184	metric tons	t
		OTHER		
°F	Fahrenheit temperature	5(F - 32)/9	Celsius temperature	°C
ΔT°F	Change in Fahrenheit temperature	0.555 556	Change in Celsius temperature	ΔT°C
psi	pounds per square inch	6 894.757	pascals	Pa

APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	*When You Know*	*Multiply By*	*To Find*	*Symbol*
		LENGTH		
mm	millimeters	39.370 08	mils	
mm	millimeters	0.039 37	inches	in
m	meters	3.280	feet	ft
m	meters	1.093	yards	yd
km	kilometers	0.621 371 2	miles	mi
		AREA		
mm^2	millimeters squared	0.001 155	square inches	in^2
m^2	meters squared	10.763 91	square feet	ft^2
mL	milliliters	0.033 814	fluid ounces	fl oz
m^2	meters squared	1.195 99	square yards	yd^2
ha	hectares	2.471 054	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.033 814	fluid ounces	fl oz
L	liters	0.264 172	gallons	gal
m^3	meters cubed	35.314 662 5	cubic feet	ft^3
m^3	meters cubed	1.307 750	cubic yards	yd^3
		MASS		
g	grams	0.035 273 9	ounces	oz
kg	kilograms	2.204 624 4	pounds	lb
t	metric tons	1.102 312 2	short tons (2 000 lb)	T
		OTHER		
°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F
ΔT°C	Change in Celsius temperature	1.8	Change in Fahrenheit temperature	ΔT°F
Pa	pascals	0.000 145 037	pounds per square inch	psi

STATE OF DELAWARE
CONSTRUCTION ITEMS UNITS OF MEASURE

English Code	English Description	Metric Code	Metric Description
ACRE	Acre	ha	Hectare
BAG	Bag	Bag	Bag
C.F.	Cubic Foot	m^3	Cubic Meter
C.Y.	Cubic Yard	m^3	Cubic Meter
EA-DY	Each Day	EA-DY	Each Day
EA-MO	Each Month	EA-MO	Each Month
EA/NT	Each Night	EA-NT	Each Night
EACH	Each	EA	Each
GAL	Gallon	L	Liter
HOUR	Hour	h	Hour
INCH	Inch	mm	Millimeter
L.F.	Linear Foot	m	Linear Meter
L.S.	Lump Sum	L.S.	Lump Sum
LA-MI	Lane Mile	LA-km	Lane-Kilometer
LB	Pound	kg	Kilogram
MFBM	Thousand Feet of Board Measure	m^3	Cubic Meter
MGAL	Thousand Gallons	kL	Kiloliter
MILE	Mile	km	Kilometer
S.F.	Square Foot	m^2	Square Meter
S.Y.	Square Yard	m^2	Square Meter
SY-IN	Square Yard-Inch	m^2-25 mm	Square Meter-25 Millimeter
TON	Ton	t	Metric Ton (1000kg)
N.A.*	Kip	kN	Kilonewton
N.A.*	Thousand Pounds per Square Inch	MPa	Megapascal

*Not used for units of measurement for payment.

STANDARD CONSTRUCTION ITEMS

This list of Standard Construction Items is developed for tracking all the possible pay items covered under the Standard Specifications for Road and Bridge Construction, using computer techniques. A similar list is being developed separately for the Special Provisions items.
The first three digits of the Item Number represent the Section Number and the last three digits reflect the sequential number under that Section. The descriptions under Item Description is the title of the construction item. The last column lists the method of measurement for the item.

Item No.	*Item Description*	*Pay Unit*
	DIVISION 200 – EARTHWORK	
201000	Clearing and Grubbing	L.S.
	Clearing and Grubbing	L.S.
202000	Excavation and Embankment	C.Y.
	Excavation and Embankment	m^3
203000	Channel Excavation	C.Y.
	Channel Excavation	m^3
204000	Muck Excavation	C.Y.
	Muck Excavation	m^3
205000	Rock Excavation for Roadway	C.Y.
	Rock Excavation for Roadway	m^3
206000	Rock Excavation for Structures and Trenches	C.Y.
	Rock Excavation for Structures and Trenches	m^3
207000	Excavation and Backfill for Structures	C.Y.
	Excavation and Backfill for Structures	m^3
208000	Excavation and Backfill for Pipe Trenches	C.Y.
	Excavation and Backfill for Pipe Trenches	m^3
209001	Borrow, Type A	C.Y.
	Borrow, Type A	m^3
209002	Borrow, Type B	C.Y.
	Borrow, Type B	m^3
209003	Borrow, Type C	C.Y.
	Borrow, Type C	m^3
209004	Borrow, Type D	C.Y.
	Borrow, Type D	m^3
209005	Borrow, Type E	C.Y.
	Borrow, Type E	m^3
209006	Borrow, Type F	C.Y.
	Borrow, Type F	m^3
209007	Borrow, Type G	C.Y.
	Borrow, Type G	m^3
210000	Furnishing Borrow Type C for Pipe, Utility Trench, and Structure Backfill	C.Y.
	Furnishing Borrow Type C for Pipe, Utility Trench, and Structure Backfill	m^3

Item No.	*Item Description*	*Pay Unit*
210001	Furnishing Borrow Type F for Pipe, Utility Trench, and Structure Backfill Furnishing Borrow Type F for Pipe, Utility Trench, and Structure Backfill	C.Y. m^3
210002	Furnishing Borrow Type B for Pipe, Utility Trench, and Structure Backfill Furnishing Borrow Type B for Pipe, Utility Trench, and Structure Backfill	C.Y. m^3
211000	Removal of Structures and Obstructions Removal of Structures and Obstructions	L.S. L.S.
211002	Removal of Structures and Obstructions (Guardrail) Removal of Structures and Obstructions (Guardrail)	L.F. m
211004	Removal of Structures and Obstructions (Pipe) Removal of Structures and Obstructions (Pipe)	L.F. m
212000	Undercut Excavation Undercut Excavation	C.Y. m^3
212001	Undercut Excavation, Patching Undercut Excavation, Patching	C.Y. m^3
250000	Sediment Removal Sediment Removal	C.Y. m^3
251000	Silt Fence Silt Fence	L.F. m
251001	Reinforced Silt Fence Reinforced Silt Fence	L.F. m
252000	Inlet Sediment Control, Drainage Inlet Inlet Sediment Control, Drainage Inlet	EACH EA
252001	Inlet Sediment Control, Curb Inlet Inlet Sediment Control, Curb Inlet	EACH EA
254000	Stone Check Dam Stone Check Dam	TON t
255000	Sediment Trap Sediment Trap	C.Y. m^3
256000	Riser Pipe Assembly for Sediment Trap Riser Pipe Assembly for Sediment Trap	EACH EA
257000	Riprap Ditch Riprap Ditch	C.Y. m^3
258000	Temporary Swale, Type A-1 Temporary Swale, Type A-1	L.F. m
258001	Temporary Swale, Type A-2 Temporary Swale, Type A-2	L.F. m
258002	Temporary Swale, Type A-3 Temporary Swale, Type A-3	L.F. m
258003	Temporary Swale, Type B-1 Temporary Swale, Type B-1	L.F. m
258004	Temporary Swale, Type B-2 Temporary Swale, Type B-2	L.F. m

Item No.	*Item Description*	*Pay Unit*
258005	Temporary Swale, Type B-3 Temporary Swale, Type B-3	L.F. m
259000	perimeter Dike/Swale, Type A-1 Perimeter Dike/Swale, Type A-1	L.F. m
259001	perimeter Dike/Swale, Type A-2 Perimeter Dike/Swale, Type A-2	L.F. m
259002	Perimeter Dike/Swale, Type A-3 Perimeter Dike/Swale, Type A-3	L.F. m
260000	Earth Dike, Type A-1 Earth Dike, Type A-1	L.F. m
260001	Earth Dike, Type A-2 Earth Dike, Type A-2	L.F. m
260002	Earth Dike, Type A-3 Earth Dike, Type A-3	L.F. m
260003	Earth Dike, Type B-1 Earth Dike, Type B-1	L.F. m
260004	Earth Dike, Type B-2 Earth Dike, Type B-2	L.F. m
260005	Earth Dike, Type B-3 Earth Dike, Type B-3	L.F. m
261000	Temporary Slope Drain, 12″ Temporary Slope Drain, 300 mm	L.F. m
261001	Temporary slope Drain, 18″ Temporary Slope Drain, 450 mm	L.F. m
261002	Temporary Slope Drain, 21″ Temporary Slope Drain, 525 mm	L.F. m
261003	Temporary Slope Drain, 24″ Temporary Slope Drain, 600 mm	L.F. m
261004	Temporary Slope Drain, 30″ Temporary Slope Drain, 750 mm	L.F. m
262000	Stilling Well Stilling Well	C.Y. m^3
263000	Sump Pit Sump Pit	EACH EA
264000	Dewatering Basin Dewatering Basin	EACH EA
265000	Geotextile Lined Channel Diversion Geotextile Lined Channel Diversion	C.Y. m^3
266000	Sandbag Dikes Sandbag Dikes	C.Y. m^3
266001	Sandbag Diversions Sandbag Diversions	C.Y. m^3

Item No.	*Item Description*	*Pay Unit*
268000	Stabilized Construction Entrance Stabilized Construction Entrance	TON t
269000	Turbidity Curtain, Floating Turbidity Curtain, Floating	L.F. m
269001	Turbidity Curtain, Staked Turbidity Curtain, Staked	L.F. m
270000	Portable Sediment Tank Portable Sediment Tank	EACH EA
271000	Stormwater Management Pond Stormwater Management Pond	C.Y. m^3
272000	Pond Outlet Structure, Concrete Pond Outlet Structure, Concrete	EACH EA
273000	Temporart Sediment Basin Outlet Structure, Corrugated Metal Temporary Sediment Basin Outlet Structure, Corrugated Metal	EACH EA
274000	Clay Borrow, Stormwater Management Pond, Type I Clay Borrow, Stormwater Management Pond, Type I	C.Y. m^3
274001	Clay Borrow, Stormwater Management Pond, Type II Clay Borrow, Stormwater Management Pond, Type II	C.Y. m^3
	DIVISION 300 – BASES	
301000	Select Borrow Base Course Select Borrow Base Course	C.Y. m^3
302002	Graded Aggregate Base Course, Type B Graded Aggregate Base Course, Type B	C.Y. m^3
302003	Graded Aggregate Base Course, Type B, Patching Graded Aggregate Base Course, Type B, Patching	C.Y. m^3
302005	Graded Aggregate Base Course, Type B Graded Aggregate Base Course, Type B	TON t
302006	Graded Aggregate Base Course, Type B, Patching Graded Aggregate Base Course, Type B, Patching	TON t
304000	Asphalt Stabilized Base Course Asphalt Stabilized Base Course	MILE km
304001	HFMS-2S HFMS-2S	GAL L
305001	Graded Aggregate for Temporary Roadway Material Graded Aggregate for Temporary Roadway Material	TON t
	DIVISION 400 – BITUMINOUS PAVEMENTS	
401001	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type A Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type A	TON t
401002	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type B Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type B	TON t
401003	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type C Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type C	TON t

Item No.	*Item Description*	*Pay Unit*
401004	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type D	TON
	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type D	t
401005	Hot-mix, Hot-Laid Bituminous Concrete Pavement, Type E	TON
	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type E	t
401006	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type C, Patching	TON
	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type C, Patching	t
401007	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type B, Patching	TON
	Hot-Mix, Hot-Laid Bituminous Concrete Pavement, Type B, Patching	t
401008	Entrance and Driveway Paving	S.Y.
	Entrance and Driveway Paving	m^2
401009	Bituminous Concrete Base Course	TON
	Bituminous Concrete Base Course	t
401010	Bituminous Concrete Base Course, Patching	TON
	Bituminous Concrete Base Course, Patching	t
402000	Hot-Mix Bituminous Concrete and/or Cold-Laid Bituminous Concrete (TRM)	TON
	Hot-Mix Bituminous Concrete and/or Cold-Laid Bituminous Concrete (TRM)	t
403000	Plant Mix Open-Graded Wearing Surface	TON
	Plant Mix Open-Graded Wearing Surface	t
404001	Bituminous surface Treatment, RS-1	GAL
	Bituminous Surface Treatment, RS-1	L
404002	Bituminous Surface Treatment, RS-2	GAL
	Bituminous Surface Treatment, RS-2	L
404003	Bituminous Surface Treatment, CRS-1	GAL
	Bituminous Surface Treatment, CRS-1	L
404004	Bituminous Surface Treatment, CRS-2	GAL
	Bituminous Surface Treatment, CRS-2	L
404005	Coarse Aggregate	TON
	Coarse Aggregate	t
405000	Retreatment and Seal Coats	GAL
	Retreatment and Seal Coats	L
406000	Hot-Mix Patching	SY-IN
	Hot-Mix Patching	m^2-25mm
	DIVISION 500 – RIGID PAVEMENT	
501001	Portland Cement Concrete Pavement, 8″	S.Y.
	Portland Cement Concrete Pavement, 200 mm	m^2
501002	Portland Cement Concrete Pavement, 9″	S.Y.
	Portland Cement Concrete Pavement, 225 mm	m^2
501003	Transverse Sawed Joints	L.F.
	Transverse Sawed Joints	m
501004	Portland Cement Concrete Pavement, 10″	S.Y.
	Portland Cement Concrete Pavement, 250 mm	m^2
501005	Portland Cement Concrete Pavement, 11″	S.Y.
	Portland Cement Concrete Pavement, 275 mm	m^2

Item No.	*Item Description*	*Pay Unit*
501006	Portland Cement Concrete Pavement, 12″ Portland Cement Concrete Pavement, 300 mm	S.Y. m^2
501007	Portland Cement Concrete Shoulder, 8″ Portland Cement Concrete Shoulder, 200 mm Avg.	S.Y. m^2
501008	Portland Cement Concrete Shoulder, 8½″ Portland Cement Concrete Shoulder, 213 mm Avg.	S.Y. m^2
501009	Portland Cement Concrete Shoulder, 10″ Portland Cement Concrete Shoulder, 250 mm Avg.	S.Y. m^2
501010	Portland Cement Concrete Shoulder, 9″ Portland Cement Concrete Shoulder, 225 mm Avg.	S.Y. m^2
501011	Portland Cement Concrete Shoulder, 8″ Portland Cement Concrete Shoulder, 200 mm Avg.	S.Y. m^2
501012	Portland Cement Concrete Pavement, 14″ Portland Cement Concrete Pavement, 350 mm Avg.	S.Y. m^2
503003	Patching Portland Cement Concrete Pavement, Type I, Class A Patching Portland Cement Concrete Pavement, Type I, Class A	S.Y. m^2
503004	Patching Portland Cement Concrete Pavement, Type II, Class A Patching Portland Cement Concrete Pavement, Type II, Class A	S.Y. m^2
503005	Deformed Bars Deformed Bars	EACH EA
503006	Dowel Bars Dowel Bars	EACH EA
503007	Deformed Bars, 36″ Deformed Bars, 900 mm	EACH EA
503009	Patching Portland Cement Concrete Pavement, Type I, Class B Patching Portland Cement Concrete Pavement, Type I, Class B	S.Y. m^2

DIVISION 600 – STRUCTURES

601001	Timber Structures Timber Structures	MFBM m^3
601002	Timber Structures (Treated) Timber Structures (Treated)	MFBM m^3
601003	Timber Structures (Glue-Laminated) Timber Structures (Glue-Laminated)	MFBM m^3
601004	Timber Structures (Glue-Laminated Timber Deck) Timber Structures (Glue-Laminated Timber Deck)	S.F. m^2
602001	Portland Cement Concrete Masonry, Class A Portland Cement Concrete Masonry, Class A	C.Y. m^3
602002	Portland Cement Concrete Masonry, Class B Portland Cement Concrete Masonry, Class B	C.Y. m^3
602003	Portland Cement Concrete Masonry, Abutment, Footing, Class A Portland Cement Concrete Masonry, Abutment, Footing, Class A	C.Y. m^3

Item No.	*Item Description*	*Pay Unit*
602004	Portland Cement Concrete Masonry, Abutment, Footing, Class B	C.Y.
	Portland Cement Concrete Masonry, Abutment, Footing, Class B	m^3
602005	Portland Cement Concrete Masonry, Abutment, Above Footing, Class B	C.Y.
	Portland Cement Concrete Masonry, Abutment, Above Footing, Class B	m^3
602006	Portland Cement Concrete Masonry, Pier Footing, Class B	C.Y.
	Portland Cement Concrete Masonry, Pier Footing, Class B	m^3
602007	Portland Cement Concrete Masonry, Pier Above Footing, Class A	C.Y.
	Portland Cement Concrete Masonry, Pier Above Footing, Class A	m^3
602008	Portland Cement Concrete Masonry, Pier Above Footing, Class B	C.Y.
	Portland Cement Concrete Masonry, Pier Above Footing, Class B	m^3
602009	Portland Cement Concrete Masonry, Approach Slab, Class A	C.Y.
	Portland Cement Concrete Masonry, Approach Slab, Class A	m^3
602010	Portland Cement Concrete Masonry, Approach Slab, Class B	C.Y.
	Portland Cement Concrete Masonry, Approach Slab, Class B	m^3
602011	Portland Cement Concrete Masonry, Substructure, Type A	C.Y.
	Portland Cement Concrete Masonry, Substructure, Type A	m^3
602012	Portland Cement Concrete Masonry, Substructure, Type B	C.Y.
	Portland Cement Concrete Masonry, Substructure, Type B	m^3
602013	Portland Cement Concrete Masonry, Superstructure, Type D	C.Y.
	Portland Cement Concrete Masonry, Superstructure, Type D	m^3
602014	Portland Cement Concrete Masonry, Approach Slab, Class D	C.Y.
	Portland Cement Concrete Masonry, Approach Slab, Class D	m^3
602015	Portland Cement Concrete Masonry, Abutment, Above Footing, Class A	C.Y.
	Portland Cement Concrete Masonry, Abutment, Above Footing, Class A	m^3
602016	Portland Cement Concrete Masonry, Class C	C.Y.
	Portland Cement Concrete Masonry, Class C	m^3
602017	Portland Cement Concrete Masonry, Parapet, Class A	C.Y.
	Portland Cement Concrete Masonry, Parapet, Class A	m^3
602018	Portland Cement Concrete Masonry, Class D	C.Y.
	Portland Cement Concrete Masonry, Class D	m^3
603000	Bar Reinforcement	LB
	Bar Reinforcement	kg
604000	Bar Reinforcement, Epoxy Coated	LB
	Bar Reinforcement, Epoxy Coated	kg
605001	Steel Structures	LB
	Steel Structures	kg
605002	Steel Structures	L.S.
	Steel Structures	L.S.
605003	Steel Structures (Unpainted)	L.S.
	Steel Structures (Unpainted)	L.S.
605005	Painting, Moisture-Cured Urethane System	L.S.
	Painting, Moisture-Cured Urethane System	L.S.

Item No.	*Item Description*	*Pay Unit*
605006	Painting, Moisture-Cured Urethane System Painting, Moisture-Cured Urethane System	S.F. m^2
606001	Metal Bridge Railing, Steel Metal Bridge Railing, Steel	L.F. m
606002	Metal Bridge Railing, Aluminum Metal Bridge Railing, Aluminum	L.F. m
607000	Removal of Existing Masonry Removal of Existing Masonry	C.Y. m^3
608000	Coarse Aggregate for Foundation Stabilization and Subfoundation Backfill Coarse Aggregate for Foundation Stabilization and Subfoundation Backfill	TON t
609000	Subfoundation Concrete Subfoundation Concrete	C.Y. m^3
610001	Stone Masonry Stone Masonry	S.F. m^2
611000	Brick Masonry Brick Masonry	S.F. m^2
612001	Reinforced Concrete Pipe, 12″, Class III Reinforced Concrete Pipe, 300 mm, Class III	L.F. m
612002	Reinforced Concrete Pipe, 15″, Class III Reinforced Concrete Pipe, 375 mm, Class III	L.F. m
612003	Reinforced Concrete Pipe, 18″, Class III Reinforced Concrete Pipe, 450 mm, Class III	L.F. m
612004	Reinforced Concrete Pipe, 21″, Class III Reinforced Concrete Pipe, 525 mm, Class III	L.F. m
612005	Reinforced Concrete Pipe, 24″, Class III Reinforced Concrete Pipe, 600 mm, Class III	L.F. m
612006	Reinforced Concrete Pipe, 27″, Class III Reinforced Concrete Pipe, 675 mm, Class III	L.F. m
612007	Reinforced Concrete Pipe, 30″, Class III Reinforced Concrete Pipe, 750 mm, Class III	L.F. m
612008	Reinforced Concrete Pipe, 33″, Class III Reinforced Concrete Pipe, 825 mm, Class III	L.F. m
612009	Reinforced Concrete Pipe, 36″, Class III Reinforced Concrete Pipe, 900 mm, Class III	L.F. m
612010	Reinforced Concrete Pipe, 42″, Class III Reinforced Concrete Pipe, 1050 mm, Class III	L.F. m
612011	Reinforced Concrete Pipe, 48″, Class III Reinforced Concrete Pipe, 1200 mm, Class III	L.F. m
612012	Reinforced Concrete Pipe, 54″, Class III Reinforced Concrete Pipe, 1350 mm, Class III	L.F. m
612013	Reinforced Concrete Pipe, 60″, Class III Reinforced Concrete Pipe, 1500 mm, Class III	L.F. m

Item No.	*Item Description*	*Pay Unit*
612014	Reinforced Concrete Pipe, 66″, Class III Reinforced Concrete Pipe, 1650 mm, Class III	L.F. m
612015	Reinforced Concrete Pipe, 72″, Class III Reinforced Concrete Pipe, 1800 mm, Class III	L.F. m
612016	Reinforced Concrete Pipe, 78″, Class III Reinforced Concrete Pipe, 1950 mm, Class III	L.F. m
612017	Reinforced Concrete Pipe, 84″, Class III Reinforced Concrete Pipe, 2100 mm, Class III	L.F. m
612018	Reinforced Concrete Pipe, 90″, Class III Reinforced Concrete Pipe, 2250 mm, Class III	L.F. m
612019	Reinforced Concrete Pipe, 96″, Class III Reinforced Concrete Pipe, 2400 mm, Class III	L.F. m
612020	Reinforced Concrete Pipe, 12″, Class IV Reinforced Concrete Pipe, 300 mm, Class IV	L.F. m
612021	Reinforced Concrete Pipe, 15″, Class IV Reinforced Concrete Pipe, 375 mm, Class IV	L.F. m
612022	Reinforced Concrete Pipe, 18″, Class IV Reinforced Concrete Pipe, 450 mm, Class IV	L.F. m
612023	Reinforced Concrete Pipe, 24″, Class IV Reinforced Concrete Pipe, 600 mm, Class IV	L.F. m
612024	Reinforced Concrete Pipe, 27″, Class IV Reinforced Concrete Pipe, 675 mm, Class IV	L.F. m
612025	Reinforced Concrete Pipe, 30″, Class IV Reinforced Concrete Pipe, 750 mm, Class IV	L.F. m
612026	Reinforced Concrete Pipe, 30″, Class V Reinforced Concrete Pipe, 750 mm, Class V	L.F. m
612027	Reinforced Concrete Pipe, 42″, Class IV Reinforced Concrete Pipe, 1050 mm, Class IV	L.F. m
612028	Reinforced Concrete Pipe, 48″, Class IV Reinforced Concrete Pipe, 1200 mm, Class IV	L.F. m
612029	Reinforced Concrete Pipe, 54″, Class IV Reinforced Concrete Pipe, 1350 mm, Class IV	L.F. m
612030	Reinforced Concrete Pipe, 18″, Class V Reinforced Concrete Pipe, 450 mm, Class V	L.F. m
612031	Reinforced Concrete Pipe, 24″, Class V Reinforced Concrete Pipe, 600 mm, Class V	L.F. m
612032	Reinforced Concrete Pipe, 15″, Class V Reinforced Concrete Pipe, 375 mm, Class V	L.F. m
612033	Reinforced Concrete Pipe, 21″, Class IV Reinforced Concrete Pipe, 525 mm, Class IV	L.F. m
612034	Reinforced Concrete Pipe, 36″, Class IV Reinforced Concrete Pipe, 900 mm, Class IV	L.F. m

Item No.	*Item Description*	*Pay Unit*
612035	Reinforced Concrete Pipe, 66″, Class V Reinforced Concrete Pipe, 1650 mm, Class V	L.F. m
612036	Reinforced Concrete Pipe, 48″, Class V Reinforced Concrete Pipe, 1200 mm, Class V	L.F. m
612038	Reinforced Concrete Pipe, 60″, Class IV Reinforced Concrete Pipe, 1500 mm, Class IV	L.F. m
612039	Reinforced Concrete Pipe, 36″, Class V Reinforced Concrete Pipe, 900 mm, Class V	L.F. m
612040	Reinforced Concrete Pipe, 30″, Class V Reinforced Concrete Pipe, 750 mm, Class V	L.F. m
612041	Reinforced Concrete Pipe, 54″, Class V Reinforced Concrete Pipe, 1350 mm, Class V	L.F. m
612042	Reinforced Concrete Pipe, 102″, Class III Reinforced Concrete Pipe, 2550 mm, Class III	L.F. m
612043	Reinforced Concrete Pipe, 42″, Class V Reinforced Concrete Pipe, 1050 mm, Class V	L.F. m
612044	Reinforced Concrete Pipe, 66″, Class IV Reinforced Concrete Pipe, 1650 mm, Class IV	L.F. m
612045	Reinforced Concrete Pipe, 39″, Class IV Reinforced Concrete Pipe, 975 mm, Class IV	L.F. m
612046	Reinforced Concrete Pipe, 21″, Class V Reinforced Concrete Pipe, 525 mm, Class V	L.F. m
612047	Reinforced Concrete Pipe, 27″, Class V Reinforced Concrete Pipe, 675 mm, Class V	L.F. m
612048	Reinforced Concrete Pipe, 33″, Class IV Reinforced Concrete Pipe, 825 mm, Class IV	L.F. m
612200	Reinforced Concrete Elliptical Pipe, 14 x 23″, Class III Reinforced Concrete Elliptical Pipe, 350 x 575 mm, Class III	L.F. m
612201	Reinforced Concrete Elliptical Pipe, 19 x 30″, Class III Reinforced Concrete Elliptical Pipe, 475 x 750 mm, Class III	L.F. m
612202	Reinforced Concrete Elliptical Pipe, 24 x 38″, Class III Reinforced Concrete Elliptical Pipe, 600 x 950 mm, Class III	L.F. m
612203	Reinforced Concrete Elliptical Pipe, 34 x 53″, Class III Reinforced Concrete Elliptical Pipe, 850 x 1325 mm, Class III	L.F. m
612204	Reinforced Concrete Elliptical Pipe, 32 x 49″, Class III Reinforced Concrete Elliptical Pipe, 800 x 1225 mm, Class III	L.F. m
612205	Reinforced Concrete Elliptical Pipe, 19 x 30″, Class IV Reinforced Concrete Elliptical Pipe, 475 x 750 mm, Class IV	L.F. m
612206	Reinforced Concrete Elliptical Pipe, 22 x 34″, Class III Reinforced Concrete Elliptical Pipe, 550 x 850 mm, Class III	L.F. m
612207	Reinforced Concrete Elliptical Pipe, 29 x 45″, Class III Reinforced Concrete Elliptical Pipe, 725 x 1125 mm, Class III	L.F. m

Item No.	*Item Description*	*Pay Unit*
612208	Reinforced Concrete Elliptical Pipe, 43 x 68″, Class IV Reinforced Concrete Elliptical Pipe, 1075 x 1700 mm, Class IV	L.F. m
612209	Reinforced Concrete Elliptical Pipe, 27 x 42″, Class III Reinforced Concrete Elliptical Pipe, 675 x 1050 mm, Class III	L.F. m
612210	Reinforced Concrete Elliptical Pipe, 22 x 34″, Class IV Reinforced Concrete Elliptical Pipe, 550 x 850 mm, Class IV	L.F. m
612211	Reinforced Concrete Elliptical Pipe, 38 x 60″, Class III Reinforced Concrete Elliptical Pipe, 950 x 1500 mm, Class III	L.F. m
612212	Reinforced Concrete Arch Pipe, 11 x 18″, Class III Reinforced Concrete Arch Pipe, 275 x 450 mm, Class III	L.F. m
612213	Reinforced Concrete Elliptical Pipe, 27 x 42″, Class IV Reinforced Concrete Elliptical Pipe, 675 x 1050 mm, Class IV	L.F. m
612214	Reinforced Concrete Elliptical Pipe, 32 x 49″, Class IV Reinforced Concrete Elliptical Pipe, 800 x 1225 mm, Class IV	L.F. m
612215	Reinforced Concrete Elliptical Pipe, 38 x 60″, Class IV Reinforced Concrete Elliptical Pipe, 950 x 1500 mm, Class IV	L.F. m
612216	Reinforced Concrete Elliptical Pipe, 14 x 23″, Class IV Reinforced Concrete Elliptical Pipe, 350 x 575 mm, Class IV	L.F. m
612217	Reinforced Concrete Elliptical Pipe, 48 x 76″, Class III Reinforced Concrete Elliptical Pipe, 1200 x 1900 mm, Class III	L.F. m
612218	Reinforced Concrete Elliptical Pipe, 34 x 53″, Class IV Reinforced Concrete Elliptical Pipe, 850 x 1325 mm, Class IV	L.F. m
612219	Reinforced Concrete Elliptical Pipe, 24 x 38″, Class IV Reinforced Concrete Elliptical Pipe, 600 x 950 mm, Class IV	L.F. m
612220	Reinforced Concrete Elliptical Pipe, 29 x 45″, Class IV Reinforced Concrete Elliptical Pipe, 725 x 1125 mm, Class IV	L.F. m
612221	Reinforced Concrete Elliptical Pipe, 48 x 76″, Class IV Reinforced Concrete Elliptical Pipe, 1200 x 1900 mm, Class IV	L.F. m
614001	Galvanized Corrugated Steel Pipe, 12″, 16 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 300 mm, 1.6 mm, 68 x 13 mm Corrugation	L.F. m
614002	Galvanized Corrugated Steel Pipe, 15″, 16 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 375 mm, 1.6 mm, 68 x 13 mm Corrugation	L.F. m
614003	Galvanized Corrugated Steel Pipe, 18″, 16 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 450 mm, 1.6 mm, 68 x 13 mm Corrugation	L.F. m
614004	Galvanized Corrugated Steel Pipe, 21″, 16 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 525 mm, 1.6 mm, 68 x 13 mm Corrugation	L.F. m
614005	Galvanized Corrugated Steel Pipe, 24″, 16 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 600 mm, 1.6 mm, 68 x 13 mm Corrugation	L.F. m
614006	Galvanized Corrugated Steel Pipe, 30″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 750 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614007	Galvanized Corrugated Steel Pipe, 36″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 900 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
614008	Galvanized Corrugated Steel Pipe, 42″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1050 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614009	Glavanized Corrugated Steel Pipe, 48″, 12 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1200 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614010	Galvanzied Corrugated Steel Pipe, 54″, 12 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1350 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614011	Galvanized Corrugated Steel Pipe, 60″, 10 Gage, 2 2/3 x 1/2 ″ Corrugation Galvanized Corrugated Steel Pipe, 1500 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614012	Galvanized Corrugated Steel Pipe, 66″, 10 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1650 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614013	Galvanized Corrugated Steel Pipe, 72″, 8 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1800 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614014	Galvanized Corrugated Steel Pipe, 78″, 8 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1950 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614015	Galvanized Corrugated Steel Pipe, 84″, 8 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 2100 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614016	Galvanized Corrugated Steel Pipe, 90″, 8 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 2250 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614017	Galvanized Corrugated Steel Pipe, 96″, 8 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 2400 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614018	Galvanized Corrugated Steel Pipe, 36″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 900 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614019	Galvanized Corrugated Steel Pipe, 42″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1050 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614020	Galvanized Corrugated Steel Pipe, 48″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1200 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614021	Galvanized Corrugated Steel Pipe, 54″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1350 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614022	Galvanized Corrugated Stell Pipe, 60″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1500 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614023	Galvanized Corrugated Steel Pipe, 66″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1650 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614024	Galvanized Corrugated Steel Pipe, 72″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1800 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614025	Galvanized Corrugated Steel Pipe, 78″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1950 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614026	Galvanized Corrugated Steel Pipe, 84″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2100 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614027	Galvanized Corrugated Steel Pipe, 90″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2250 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614028	Galvanized Corrugated Steel Pipe, 96″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2400 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
614029	Galvanized Corrugated Steel Pipe, 36″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 900 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614030	Galvanized Corrugated Steel Pipe, 42″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1050 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614031	Galvanized Corrugated Steel Pipe, 48″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1200 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614032	Galvanized Corrugated Steel Pipe, 54″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1350 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614033	Galvanized Corrugated Steel Pipe, 60″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1500 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614034	Galvanized Corrugated Steel Pipe, 66″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1650 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614035	Galvanized Corrugated Steel Pipe, 72″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1800 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614036	Galvanized Corrugated Steel Pipe, 78″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1950 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614037	Galvanized Corrugated Steel Pipe, 84″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2100 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614038	Galvanized Corrugated Steel Pipe, 90″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2250 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614039	Galvanized Corrugated Steel Pipe, 96″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2400 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614040	Galvanized Corrugated Steel Pipe, 17 x 13″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 430 x 330 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614041	Galvanized Corrugated Steel Pipe, 21 x 15″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 530 x 380 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614042	Galvanized Corrugated Steel Pipe, 24 x 18″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 610 x 460 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614043	Galvanized Corrugated Steel Pipe, 28 x 20″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 710 x 510 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614044	Galvanized Corrugated Steel Pipe, 35 x 24″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 885 x 610 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614045	Galvanized Corrugated Steel Pipe, 42 x 29″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1060 x 740 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614046	Galvanized Corrugated Steel Pipe, 49 x 33″, 12 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1240 x 840 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614047	Galvanized Corrugated Steel Pipe, 57 x 38″, 10 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1440 x 970 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614048	Galvanized Corrugated Steel Pipe, 64 x 43″, 10 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1620 x 1100 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614049	Galvanized Corrugated Steel Pipe, 71 x 47″, 8 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1800 x 1200 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
614050	Galvanized Corrugated Steel Pipe, 77 x 52″, 8 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1950 x 1320 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614051	Galvanized Corrugated Steel Pipe, 83 x 57″, 8 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 2100 x 1450 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614052	Galvanized Corrugated Steel Pipe, 40 x 31″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1010 x 790 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614053	Galvanized Corrugated Steel Pipe, 46 x 36″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1160 x 920 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614054	Galvanized Corrugated Steel Pipe, 53 x 41″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1340 x 1050 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614055	Galvanized Corrugated Steel Pipe, 60 x 46″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1520 x 1170 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614056	Galvanized Corrugated Steel Pipe, 66 x 51″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1670 x 1300 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614057	Galvanized Corrugated Steel Pipe, 73 x 55″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1850 x 1400 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614058	Galvanized Corrugated Steel Pipe, 81 x 59″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2050 x 1500 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614059	Galvanized Corrugated Steel Pipe, 87 x 63″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2200 x 1620 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614060	Galvanized Corrugated Steel Pipe, 95 x 67″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2400 x 1720 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614061	Galvanized Corrugated Steel Pipe, 103 x 71″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2600 x 1820 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614062	Galvanized Corrugated Steel Pipe, 81 x 59″, 10 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2050 x 1500 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614063	Galvanized Corrugated Steel Pipe, 87 x 63″, 10 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2200 x 1620 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614064	Galvanized Corrugated Steel Pipe, 95 x 67″, 10 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2400 x 1720 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614065	Galvanized Corrugated Steel Pipe, 103 x 71″, 10 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2600 x 1820 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614066	Galvanized Corrugated Steel Pipe, 40 x 31″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1010 x 790 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614067	Galvanized Corrugated Steel Pipe, 46 x 36″, 14 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1160 x 920 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614068	Galvanized Corrugated Steel Pipe, 53 x 41″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1340 x 1050 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614069	Galvanized Corrugated Steel Pipe, 60 x 46″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1520 x 1170 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614070	Galvanized Corrugated Steel Pipe, 66 x 51″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1670 x 1300 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
614071	Galvanized Corrugated Steel Pipe, 73 x 55″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1850 x 1400 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614072	Galvanized Corrugated Steel Pipe, 81 x 59″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2050 x 1500 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614073	Galvanized Corrugated Steel Pipe, 87 x 63″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2200 x 1620 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614074	Galvanized Corrugated Steel Pipe, 95 x 67″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2400 x 1720 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614075	Galvanized Corrugated Steel Pipe, 103 x 71″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2600 x 1820 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614076	Galvanized Corrugated Steel Pipe, 81 x 59″, 10 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2050 x 1500 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614077	Galvanized Corrugated Steel Pipe, 87 x 63″, 10 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2200 x 1620 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614078	Galvanized Corrugated Steel Pipe, 95 x 67″, 10 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2400 x 1720 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614079	Galvanized Corrugated Steel Pipe, 103 x 71″, 10 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2600 x 1820 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614080	Galvanized Corrugated Steel Pipe, 72″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1800 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614081	Galvanized Corrugated Steel Pipe, 8″, 16 Gage, 1½ x ¼″ Corrugation Galvanized Corrugated Steel Pipe, 200 mm, 1.6 mm, 38 x 6.5 mm Corrugation	L.F. m
614082	Galvanized Corrugated Steel Pipe, 18″, 16 Gage, Fully Coated And Paved Galvanized Corrugated Steel Pipe, 450 mm, 1.6 mm, Fully Coated and Paved	L.F. m
614083	Galvanized Corrugated Steel Pipe, 128 x 83″, 10 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 3240 x 2120 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614084	Galvanized Corrugated Steel Pipe, 10″, 16 Gage, 1½ x ¼″ Corrugation Galvanized Corrugated Steel Pipe, 250 mm, 1.6 mm, 38 x 6.5 mm Corrugation	L.F. m
614085	Galvanized Corrugated Steel Pipe, 60 x 46″, 10 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1520 x 1170 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614086	Galvanized Corrugated Steel Pipe, 27″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 675 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614087	Galvanized Corrugated Steel Pipe, 12″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 300 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614088	Galvanized Corrugated Steel Pipe, 8″, 16 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 200 mm, 1.6 mm, 68 x 13 mm Corrugation	L.F. m
614089	Galvanized Corrugated Steel Pipe, 6″, 18 Gage, 1½ x ¼″ Corrugation Galvanized Corrugated Steel Pipe, 150 mm, 1.3 mm, 38 x 6.5 mm Corrugation	L.F. m
614090	Galvanized Corrugated Steel Pipe, 117 x 79, 10 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 2970 x 2020 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614091	Galvanized Corrugated Steel Pipe, 60″, 12 Gage, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1500 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
614092	Galvanized Corrugated Steel Pipe, 57 x 38″, 12 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1440 x 970 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614093	Galvanized Corrugated Steel Pipe, 71 x 47″, 10 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1800 x 1200 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614094	Galvanized Corrugated Steel Pipe, Full Coated, 18″, 16 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, Full Coated, 450 mm, 1.6 mm, 68 x 13 mm Corrugation	L.F. m
614096	Galvanized Corrugated Steel Pipe. Full Coated, 15″, 16 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, Full Coated, 375 mm, 1.6 mm, 68 x 13 mm Corrugation	L.F. m
614097	Galvanized Corrugated Steel Pipe, 46 x 36″, 12 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 1160 x 920 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614098	Galvanized Corrugated Steel Pipe, 142 x 91″, 10 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 3600 x 2320 mm, 3.5 mm Corrugation	L.F. m
614099	Galvanized Corrugated Steel Pipe, 30″, 14 Gage, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe, 750 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614101	Galvanized Corrugated Steel Pipe, 57 x 38″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 1440 x 970 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614103	Galvanized Corrugated Steel Pipe, 15″, 14 Gage, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe, 375 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614200	Corrugated Aluminum Pipe, 12″, 14 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 300 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614201	Corrugated Aluminum Pipe, 15″, 14 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 375 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614202	Corrugated Aluminum Pipe, 18″, 14 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 450 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614203	Corrugated Aluminum Pipe, 21″, 14 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 525 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614204	Corrugated Aluminum Pipe, 24″, 14 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 600 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614205	Corrugated Aluminum Pipe, 30″, 12 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 750 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614206	Corrugated Aluminum Pipe, 36″, 12 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 900 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614207	Corrugated Aluminum Pipe, 42″, 10 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1050 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614208	Corrugated Aluminum Pipe, 48″, 10 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1200 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614209	Corrugated Aluminum Pipe, 54″, 10 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1350 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614210	Corrugated Aluminum Pipe, 60″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1500 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614211	Corrugated Aluminum Pipe, 66″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1650 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
614212	Corrugated Aluminum Pipe, 72″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1800 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614213	Corrugated Aluminum Pipe, 78″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1950 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614214	Corrugated Aluminum Pipe, 84″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 2100 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614215	Corrugated Aluminum Pipe, 90″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 2250 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614216	Corrugated Aluminum Pipe, 96″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 2400 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614217	Corrugated Aluminum Pipe, 36″, 14 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 900 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614218	Corrugated Aluminum Pipe, 42″, 14 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1050 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614219	Corrugated Aluminum Pipe, 48″, 14 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1200 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614220	Corrugated Aluminum Pipe, 54″, 12 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1350 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614221	Corrugated Aluminum Pipe, 60″, 12 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1500 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614222	Corrugated Aluminum Pipe, 66″, 12 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1650 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614223	Corrugated Aluminum Pipe, 72″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1800 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614224	Corrugated Aluminum Pipe, 78″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1950 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614225	Corrugated Aluminum Pipe, 84″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 2100 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614226	Corrugated Aluminum Pipe, 90″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 2250 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614227	Corrugated Aluminum Pipe, 96″, 8 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 2400 mm, 4.3 mm, 75 x 25 mm Corrugation	L.F. m
614228	Corrugated Aluminum Pipe, 36″, 14 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 900 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614229	Corrugated Aluminum Pipe, 42″, 14 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1050 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614230	Corrugated Aluminum Pipe, 48″, 14 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1200 mm, 2 mm, 125 x 25 mm Corrugation	L.F. m
614231	Corrugated Aluminum Pipe, 54″, 12 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1350 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614232	Corrugated Aluminum Pipe, 60″, 12 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1500 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
614233	Corrugated Aluminum Pipe, 66″, 12 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1650 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614234	Corrugated Aluminum Pipe, 72″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1800 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614235	Corrugated Aluminum Pipe, 78″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1950 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614236	Corrugated Aluminum Pipe, 84″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 2100 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614237	Corrugated Aluminum Pipe, 90″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 2250 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614238	Corrugated Aluminum Pipe, 96″, 8 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 2400 mm, 4.3 mm, 125 x 25 mm Corrugation	L.F. m
614239	Corrugated Aluminum Pipe, 17 x 13″, 14 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 425 x 325 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614240	Corrugated Aluminum Pipe, 21 x 15″, 12 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 525 x 375 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614241	Corrugated Aluminum Pipe, 24 x 18″, 12 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 600 x 450 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614242	Corrugated Aluminum Pipe, 28 x 20″, 10 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 700 x 500 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614243	Corrugated Aluminum Pipe, 35 x 24″, 10 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 875 x 600 mm, 3.5 mm, 68 x 13 mm Corrugation	L.F. m
614244	Corrugated Aluminum Pipe, 42 x 29″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1050 x 725 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614245	Corrugated Aluminum Pipe, 49 x 33″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1225 x 825 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614246	Corrugated Aluminum Pipe, 57 x 38″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1425 x 950 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614247	Corrugated Aluminum Pipe, 64 x 43″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1600 x 1075 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614248	Corrugated Aluminum Pipe, 71 x 47″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1775 x 1175 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614249	Corrugated Aluminum Pipe, 77 x 52″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 1925 x 1300 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614250	Corrugated Aluminum Pipe, 83 x 57″, 8 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 2100 x 1450 mm, 4.3 mm, 68 x 13 mm Corrugation	L.F. m
614251	Corrugated Aluminum Pipe, 40 x 31″, 12 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1000 x 775 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614252	Corrugated Aluminum Pipe, 46 x 31″, 12 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1150 x 775 mm, 2.8 mm, 75 x 25 mm Corrugation	L.F. m
614253	Corrugated Aluminum Pipe, 53 x 41″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1325 x 1025 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
614254	Corrugated Aluminum Pipe, 60 x 46″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1500 x 1150 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614255	Corrugated Aluminum Pipe, 66 x 51″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1650 x 1275 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614256	Corrugated Aluminum Pipe, 73 x 55″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 1825 x 1375 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614257	Corrugated Aluminum Pipe, 81 x 59″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 2025 x 1475 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614258	Corrugated Aluminum Pipe, 87 x 63″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 2175 x 1575 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614259	Corrugated Aluminum Pipe, 95 x 67″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 2375 x 1675 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614260	Corrugated Aluminum Pipe, 103 x 71″, 10 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 2575 x 1775 mm, 3.5 mm, 75 x 25 mm Corrugation	L.F. m
614261	Corrugated Aluminum Pipe, 40 x 31″, 12 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1000 x 775 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614262	Corrugated Aluminum Pipe, 46 x 31″, 12 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1150 x 775 mm, 2.8 mm, 125 x 25 mm Corrugation	L.F. m
614263	Corrugated Aluminum Pipe, 53 x 41″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1325 x 1025 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614264	Corrugated Aluminum Pipe, 60 x 46″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1500 x 1150 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614265	Corrugated Aluminum Pipe, 66 x 51″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1650 x 1275 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614266	Corrugated Aluminum Pipe, 73 x 55″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 1825 x 1375 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614267	Corrugated Aluminum Pipe, 81 x 59″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 2025 x 1475 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614268	Corrugated Aluminum Pipe, 87 x 63″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 2175 x 1575 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614269	Corrugated Aluminum Pipe, 95 x 67″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 2375 x 1675 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614270	Corrugated Aluminum Pipe, 103 x 71″, 10 Gage, 5 x 1″ Corrugation Corrugated Aluminum Pipe, 2575 x 1775 mm, 3.5 mm, 125 x 25 mm Corrugation	L.F. m
614271	Corrugated Aluminum Pipe, 6″, 14 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 150 mm, 2 mm, 68 x 13 mm Corrugation	L.F. m
614272	Corrugated Aluminum Pipe, 22 x 13″, 12 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 550 x 325 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m
614273	Corrugated Aluminum Pipe, 30″, 14 Gage, 3 x 1″ Corrugation Corrugated Aluminum Pipe, 750 mm, 2 mm, 75 x 25 mm Corrugation	L.F. m
614274	Corrugated Aluminum Pipe, 24″, 12 Gage, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe, 600 mm, 2.8 mm, 68 x 13 mm Corrugation	L.F. m

Item No.	*Item Description*	*Pay Unit*
617001	Reinforced Concrete Flared End Section, 12″	EACH
	Reinforced Concrete Flared End Section, 300 mm	EA
617002	Reinforced Concrete Flared End Section, 15″	EACH
	Reinforced Concrete Flared End Section, 375 mm	EA
617003	Reinforced Concrete Flared End Section, 18″	EACH
	Reinforced Concrete Flared End Section, 450 mm	EA
617004	Reinforced Concrete Flared End Section, 21″	EACH
	Reinforced Concrete Flared End Section, 525 mm	EA
617005	Reinforced Concrete Flared End Section, 24″	EACH
	Reinforced Concrete Flared End Section, 600 mm	EA
617006	Reinforced Concrete Flared End Section, 27″	EACH
	Reinforced Concrete Flared End Section, 675 mm	EA
617007	Reinforced Concrete Flared End Section, 30″	EACH
	Reinforced Concrete Flared End Section, 750 mm	EA
617008	Reinforced Concrete Flared End Section, 33″	EACH
	Reinforced Concrete Flared End Section, 825 mm	EA
617009	Reinforced Concrete Flared End Section, 36″	EACH
	Reinforced Concrete Flared End Section, 900 mm	EA
617010	Reinforced Concrete Flared End Section, 42″	EACH
	Reinforced Concrete Flared End Section, 1050 mm	EA
617011	Reinforced Concrete Flared End Section, 48″	EACH
	Reinforced Concrete Flared End Section, 1200 mm	EA
617012	Reinforced Concrete Flared End Section, 54″	EACH
	Reinforced Concrete Flared End Section, 1350 mm	EA
617013	Reinforced Concrete Flared End Section, 60″	EACH
	Reinforced Concrete Flared End Section, 1500 mm	EA
617014	Reinforced Concrete Flared End Section, 66″	EACH
	Reinforced Concrete Flared End Section, 1650 mm	EA
617015	Reinforced Concrete Flared End Section, 72″	EACH
	Reinforced Concrete Flared End Section, 1800 mm	EA
617016	Reinforced Concrete Flared End Section, 78″	EACH
	Reinforced Concrete Flared End Section, 1950 mm	EA
617017	Reinforced Concrete Flared End Section, 84″	EACH
	Reinforced Concrete Flared End Section, 2100 mm	EA
617018	Reinforced Concrete Flared End Section, 90″	EACH
	Reinforced Concrete Flared End Section, 2250 mm	EA
617019	Reinforced Concrete Flared End Section, 96″	EACH
	Reinforced Concrete Flared End Section, 2400 mm	EA
617020	Galvanized Corrugated Steel Pipe Flared End Section, 12″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 300 mm, 68 x 13 mm Corrugation	EA
617021	Galvanized Corrugated Steel Pipe Flared End Section, 15″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 375 mm, 68 x 13 mm Corrugation	EA

Item No.	*Item Description*	*Pay Unit*
617022	Galvanized Corrugated Steel Pipe Flared End Section, 18″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 450 mm, 68 x 13 mm Corrugation	EA
617023	Galvanized Corrugated Steel Pipe Flared End Section, 21″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 525 mm, 68 x 13 mm Corrugation	EA
617024	Galvanized Corrugated Steel Pipe Flared End Section, 24″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 600 mm, 68 x 13 mm Corrugation	EA
617025	Galvanized Corrugated Steel Pipe Flared End Section, 27″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 675 mm, 68 x 13 mm Corrugation	EA
617026	Galvanized Corrugated Steel Pipe Flared End Section, 30″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 750 mm, 68 x 13 mm Corrugation	EA
617027	Galvanized Corrugated Steel Pipe Flared End Section, 33″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 825 mm, 68 x 13 mm Corrugation	EA
617028	Galvanized Corrugated Steel Pipe Flared End Section, 36″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 900 mm, 68 x 13 mm Corrugation	EA
617029	Galvanized Corrugated Steel Pipe Flared End Section, 42″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1050 mm, 68 x 13 mm Corrugation	EA
617030	Galvanized Corrugated Steel Pipe Flared End Section, 48″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1200 mm, 68 x 13 mm Corrugation	EA
617031	Galvanized Corrugated Steel Pipe Flared End Section, 54″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1350 mm, 68 x 13 mm Corrugation	EA
617032	Galvanized Corrugated Steel Pipe Flared End Section, 60″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1500 mm, 68 x 13 mm Corrugation	EA
617033	Galvanized Corrugated Steel Pipe Flared End Section, 66″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1650 mm, 68 x 13 mm Corrugation	EA
617034	Galvanized Corrugated Steel Pipe Flared End Section, 72″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1800 mm, 68 x 13 mm Corrugation	EA
617035	Galvanized Corrugated Steel Pipe Flared End Section, 78″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1950 mm, 68 x 13 mm Corrugation	EA
617036	Galvanized Corrugated Steel Pipe Flared End Section, 84″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 2100 mm, 68 x 13 mm Corrugation	EA
617037	Galvanized Corrugated Steel Pipe Flared End Section, 90″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 2250 mm, 68 x 13 mm Corrugation	EA
617038	Galvanized Corrugated Steel Pipe Flared End Section, 96″, 2 2/3 x 1/2″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 2400 mm, 68 x 13 mm Corrugation	EA
617039	Galvanized Corrguated Steel Pipe Flared End Section, 36″, 3 x 1″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 900 mm, 75 x 25 mm Corrugation	EA
617040	Galvanized Corrugated Steel Pipe Flared End Section, 42″, 3 x 1″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1050 mm, 75 x 25 mm Corrugation	EA
617041	Galvanized Corrugated Steel Pipe Flared End Section, 48″, 3 x 1″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1200 mm, 75 x 25 mm Corrugation	EA
617042	Galvanized Corrugated Steel Pipe Flared End Section, 54″, 3 x 1″ Corrugation	EACH
	Galvanized Corrugated Steel Pipe Flared End Section, 1350 mm, 75 x 25 mm Corrugation	EA

Item No.	*Item Description*	*Pay Unit*
617043	Galvanized Corrugated Steel Pipe Flared End Section, 60″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1500 mm, 75 x 25 mm Corrugation	EACH EA
617044	Galvanized Corrugated Steel Pipe Flared End Section, 66″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1650 mm, 75 x 25 mm Corrugation	EACH EA
617045	Galvanized Corrugated Steel Pipe Flared End Section, 72″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1800 mm, 75 x 25 mm Corrugation	EACH EA
617046	Galvanized Corrugated Steel Pipe Flared End Section, 78″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1950 mm, 75 x 25 mm Corrugation	EACH EA
617047	Galvanized Corrugated Steel Pipe Flared End Section, 84″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2100 mm, 75 x 25 mm Corrugation	EACH EA
617048	Galvanized Corrugated Steel Pipe Flared End Section, 90″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2250 mm, 75 x 25 mm Corrugation	EACH EA
617049	Galvanized Corrugated Steel Pipe Flared End Section, 96″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2400 mm, 75 x 25 mm Corrugation	EACH EA
617050	Galvanized Corrugated Steel Pipe Flared End Section, 36″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 900 mm, 125 x 25 mm Corrugation	EACH EA
617051	Galvanized Corrugated Steel Pipe Flared End Section, 42″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1050 mm, 125 x 25 mm Corrugation	EACH EA
617052	Galvanized Corrugated Steel Pipe Flared End Section, 48″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1200 mm, 125 x 25 mm Corrugation	EACH EA
617053	Galvanized Corrugated Steel Pipe Flared End Section, 54″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1350 mm, 125 x 25 mm Corrugation	EACH EA
617054	Galvanized Corrugated Steel Pipe Flared End Section, 60″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1500 mm, 125 x 25 mm Corrugation	EACH EA
617055	Galvanized Corrugated Steel Pipe Flared End Section, 66″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1650 mm, 125 x 25 mm Corrugation	EACH EA
617056	Galvanized Corrugated Steel Pipe Flared End Section, 72″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1800 mm, 125 x 25 mm Corrugation	EACH EA
617057	Galvanized Corrugated Steel Pipe Flared End Section, 78″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1950 mm, 125 x 25 mm Corrugation	EACH EA
617058	Galvanized Corrugated Steel Pipe Flared End Section, 84″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2100 mm, 125 x 25 mm Corrugation	EACH EA
617059	Galvanized Corrugated Steel Pipe Flared End Section, 90″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2250 mm, 125 x 25 mm Corrugation	EACH EA
617060	Galvanized Corrugated Steel Pipe Flared End Section, 96″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2400 mm, 125 x 25 mm Corrugation	EACH EA
617061	Galvanized Corrugated Steel Pipe Flared End Section, 17 x 13″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 430 x 330 mm, 68 x 13 mm Corrugation	EACH EA
617062	Galvanized Corrugated Steel Pipe Flared End Section, 21 x 15″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 530 x 380 mm, 68 x 13 mm Corrugation	EACH EA

Item No.	*Item Description*	*Pay Unit*
617063	Galvanized Corrugated Steel Pipe Flared End Section, 24 x 18″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 610 x 460 mm, 68 x 13 mm Corrugation	EACH EA
617064	Galvanized Corrugated Steel Pipe Flared End Section, 28 x 20″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 710 x 510 mm, 68 x 13 mm Corrugation	EACH EA
617065	Galvanized Corrugated Steel Pipe Flared End Section, 35 x 24″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 885 x 610 mm, 68 x 13 mm Corrugation	EACH EA
617066	Galvanized Corrugated Steel Pipe Flared End Section, 42 x 29″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1060 x 740 mm, 68 x 13 mm Corrugation	EACH EA
617067	Galvanized Corrugated Steel Pipe Flared End Section, 49 x 33″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1240 x 840 mm, 68 x 13 mm Corrugation	EACH EA
617068	Galvanized Corrugated Steel Pipe Flared End Section, 57 x 38″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1440 x 970 mm, 68 x 13 mm Corrugation	EACH EA
617069	Galvanized Corrugated Steel Pipe Flared End Section, 64 x 43″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1620 x 1100 mm, 68 x 13 mm Corrugation	EACH EA
617070	Galvanized Corrugated Steel Pipe Flared End Section, 71 x 47″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1800 x 1200 mm, 68 x 13 mm Corrugation	EACH EA
617071	Galvanized Corrugated Steel Pipe Flared End Section, 77 x 52″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1950 x 1320 mm, 68 x 13 mm Corrugation	EACH EA
617072	Galvanized Corrugated Steel Pipe Flared End Section, 83 x 57″, 2 2/3 x 1/2″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2100 x 1450 mm, 68 x 13 mm Corrugation	EACH EA
617073	Galvanized Corrugated Steel Pipe Flared End Section, 40 x 31″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1010 x 790 mm, 75 x 25 mm Corrugation	EACH EA
617074	Galvanized Corrugated Steel Pipe Flared End Section, 46 x 36″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1160 x 920 mm, 75 x 25 mm Corrugation	EACH EA
617075	Galvanized Corrugated Steel Pipe Flared End Section, 53 x 41″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1340 x 1050 mm, 75 x 25 mm Corrugation	EACH EA
617076	Galvanized Corrugated Steel Pipe Flared End Section, 60 x 46″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1520 x 1170 mm, 75 x 25 mm Corrugation	EACH EA
617077	Galvanized Corrugated Steel Pipe Flared End Section, 66 x 51″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1670 x 1300 mm, 75 x 25 mm Corrugation	EACH EA

Item No.	*Item Description*	*Pay Unit*
617078	Galvanized Corrugated Steel Pipe Flared End Section, 73 x 55″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1850 x 1400 mm, 75 x 25 mm Corrugation	EACH EA
617079	Galvanized Corrugated Steel Pipe Flared End Section, 81 x 59″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2050 x 1500 mm, 75 x 25 mm Corrugation	EACH EA
617080	Galvanized Corrugated Steel Pipe Flared End Section, 87 x 63″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2200 x 1620 mm, 75 x 25 mm Corrugation	EACH EA
617081	Galvanized Corrugated Steel Pipe Flared End Section, 95 x 67″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2400 x 1720 mm, 75 x 25 mm Corrugation	EACH EA
617082	Galvanized Corrguated Steel Pipe Flared End Section, 103 x 71″, 3 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2600 x 1820 mm, 75 x 25 mm Corrugation	EACH EA
617083	Galvanized Corrugated Steel Pipe Flared End Section, 40 x 31″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1000 x 790 mm, 125 x 25 mm Corrugation	EACH EA
617084	Galvanized Corrugated Steel Pipe Flared End Section, 46 x 36″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1150 x 790 mm, 125 x 25 mm Corrugation	EACH EA
617085	Galvanized Corrugated Steel Pipe Flared End Section, 53 x 41″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1340 x 1050 mm, 125 x 25 mm Corrugation	EACH EA
617086	Galvanized Corrugated Steel Pipe Flared End Section, 60 x 46″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1520 x 1170 mm, 125 x 25 mm Corrugation	EACH EA
617087	Galvanized Corrugated Steel Pipe Flared End Section, 66 x 51″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1670 x 1300 mm, 125 x 25 mm Corrugation	EACH EA
617088	Galvanized Corrugated Steel Pipe Flared End Section, 73 x 55″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 1850 x 1400 mm, 125 x 25 mm Corrugation	EACH EA
617089	Galvanized Corrugated Steel Pipe Flared End Section, 81 x 59″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2050 x 1500 mm, 125 x 25 mm Corrugation	EACH EA
617090	Galvanized Corrugated Steel Pipe Flared End Section, 87 x 63″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2200 x 1620 mm, 125 x 25 mm Corrugation	EACH EA
617091	Galvanized Corrugated Steel Pipe Flared End Section, 95 x 47″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2400 x 1720 mm, 125 x 25 mm Corrugation	EACH EA
617092	Galvanized Corrugated Steel Pipe Flared End Section, 103 x 71″, 5 x 1″ Corrugation Galvanized Corrugated Steel Pipe Flared End Section, 2600 x 1820 mm, 125 x 13 mm Corrugation	EACH EA

Item No.	*Item Description*	*Pay Unit*
617093	Corrugated Aluminum Pipe Flared End Section, 12″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 300 mm, 68 x 13 mm Corrugation	EA
617094	Corrugated Aluminum Pipe Flared End Section, 15″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 375 mm, 68 x 13 mm Corrugation	EA
617095	Corrugated Aluminum Pipe Flared End Section, 18″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 450 mm, 68 x 13 mm Corrugation	EA
617096	Corrugated Aluminum Pipe Flared End Section, 21″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 525 mm, 68 x 13 mm Corrugation	EA
617097	Corrugated Aluminum Pipe Flared End Section. 24″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 600 mm, 68 x 13 mm Corrugation	EA
617098	Corrugated Aluminum Pipe Flared End Section, 30″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 750 mm, 68 x 13 mm Corrugation	EA
617099	Corrugated Aluminum Pipe Flared End Section. 36″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 900 mm, 68 x 13 mm Corrugation	EA
617100	Corrugated Aluminum Pipe Flared End Section, 42″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1050 mm, 68 x 13 mm Corrugation	EA
617101	Corrugated Aluminum Pipe Flared End Section, 48″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1200 mm, 68 x 13 mm Corrugation	EA
617102	Corrugated Aluminum Pipe Flared End Section, 54″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1350 mm, 68 x 13 mm Corrugation	EA
617103	Corrugated Aluminum Pipe Flared End Section. 60″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1500 mm, 68 x 13 mm Corrugation	EA
617104	Corrugated Aluminum Pipe Flared End Section, 66″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1650 mm, 68 x 13 mm Corrugation	EA
617105	Corrugated Aluminum Pipe Flared End Section, 72″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1800 mm, 68 x 13 mm Corrugation	EA
617106	Corrugated Aluminum Pipe Flared End Section, 78″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1950 mm, 68 x 13 mm Corrugation	EA
617107	Corrugated Aluminum Pipe Flared End Section. 84″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2100 mm, 68 x 13 mm Corrugation	EA
617108	Corrugated Aluminum Pipe Flared End Section, 90″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2250 mm, 68 x 13 mm Corrugation	EA
617109	Corrugated Aluminum Pipe Flared End Section, 96″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2400 mm, 68 x 13 mm Corrugation	EA
617110	Corrugated Aluminum Pipe Flared End Section, 36″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 900 mm, 75 x 25 mm Corrugation	EA
617111	Corrugated Aluminum Pipe Flared End Section, 42″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1050 mm, 75 x 25 mm Corrugation	EA
617112	Corrugated Aluminum Pipe Flared End Section. 48″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1200 mm, 75 x 25 mm Corrugation	EA
617113	Corrugated Aluminum Pipe Flared End Section, 54″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1350 mm, 75 x 25 mm Corrugation	EA

Item No.	*Item Description*	*Pay Unit*
617114	Corrugated Aluminum Pipe Flared End Section, 60″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1500 mm, 75 x 25 mm Corrugation	EA
617115	Corrugated Aluminum Pipe Flared End Section, 66″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1650 mm, 75 x 25 mm Corrugation	EA
617116	Corrugated Aluminum Pipe Flared End Section, 72″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1800 mm, 75 x 25 mm Corrugation	EA
617117	Corrugated Aluminum Pipe Flared End Section, 78″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1950 mm, 75 x 25 mm Corrugation	EA
617118	Corrugated Aluminum Pipe Flared End Section, 84″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2100 mm, 75 x 25 mm Corrugation	EA
617119	Corrugated Aluminum Pipe Flared End Section, 90″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2250 mm, 75 x 25 mm Corrugation	EA
617120	Corrugated Aluminum Pipe Flared End Section, 96″, 3 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2400 mm, 75 x 25 mm Corrugation	EA
617121	Corrugated Aluminum Pipe Flared End Section, 36″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 900 mm, 125 x 25 mm Corrugation	EA
617122	Corrugated Aluminum Pipe Flared End Section, 42″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1050 mm, 125 x 25 mm Corrugation	EA
617123	Corrugated Aluminum Pipe Flared End Section, 48″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1200 mm, 125 x 25 mm Corrugation	EA
617124	Corrugated Aluminum Pipe Flared End Section, 54″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1350 mm, 125 x 25 mm Corrugation	EA
617125	Corrugated Aluminum Pipe Flared End Section, 60″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1500 mm, 125 x 25 mm Corrugation	EA
617126	Corrugated Aluminum Pipe Flared End Section, 66″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1650 mm, 125 x 25 mm Corrugation	EA
617127	Corrugated Aluminum Pipe Flared End Section, 72″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1800 mm, 125 x 25 mm Corrugation	EA
617128	Corrugated Aluminum Pipe Flared End Section, 78″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 1950 mm, 125 x 25 mm Corrugation	EA
617129	Corrugated Aluminum Pipe Flared End Section, 84″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2100 mm, 125 x 25 mm Corrugation	EA
617130	Corrugated Aluminum Pipe Flared End Section, 90″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2250 mm, 125 x 25 mm Corrugation	EA
617131	Corrugated Aluminum Pipe Flared End Section, 96″, 5 x 1″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 2400 mm, 125 x 25 mm Corrugation	EA
617132	Corrugated Aluminum Pipe Flared End Section, 17 x 13″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 425 x 325 mm, 68 x 13 mm Corrugation	EA
617133	Corrugated Aluminum Pipe Flared End Section, 21 x 15″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 525 x 375 mm, 68 x 13 mm Corrugation	EA
617134	Corrugated Aluminum Pipe Flared End Section, 24 x 18″, 2 2/3 x 1/2″ Corrugation	EACH
	Corrugated Aluminum Pipe Flared End Section, 600 x 450 mm, 68 x 13 mm Corrugation	EA

Item No.	*Item Description*	*Pay Unit*
617135	Corrugated Aluminum Pipe Flared End Section, 28 x 20″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 700 x 500 mm, 68 x 13 mm Corrugation	EACH EA
617136	Corrugated Aluminum Pipe Flared End Section, 35 x 24″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 875 x 600 mm, 68 x 13 mm Corrugation	EACH EA
617137	Corrugated Aluminum Pipe Flared End Section, 42 x 29″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1050 x 725 mm, 68 x 13 mm Corrugation	EACH EA
617138	Corrugated Aluminum Pipe Flared End Section, 49 x 33″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1225 x 825 mm, 68 x 13 mm Corrugation	EACH EA
617139	Corrugated Aluminum Pipe Flared End Section, 57 x 38″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1425 x 950 mm, 68 x 13 mm Corrugation	EACH EA
617140	Corrugated Aluminum Pipe Flared End Section, 64 x 43″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1600 x 1075 mm, 68 x 13 mm Corrugation	EACH EA
617141	Corrugated Aluminum Pipe Flared End Section, 71 x 47″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1775 x 1175 mm, 68 x 13 mm Corrugation	EACH EA
617142	Corrugated Aluminum Pipe Flared End Section, 77 x 52″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1925 x 1300 mm, 68 x 13 mm Corrugation	EACH EA
617143	Corrugated Aluminum Pipe Flared End Section, 83 x 57″, 2 2/3 x 1/2″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2075 x 1425 mm, 68 x 13 mm Corrugation	EACH EA
617144	Corrugated Aluminum Pipe Flared End Section. 40 x 31″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1000 x 775 mm, 75 x 25 mm Corrugation	EACH EA
617145	Corrugated Aluminum Pipe Flared End Section, 46 x 31″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1150 x 775 mm, 75 x 25 mm Corrugation	EACH EA
617146	Corrugated Aluminum Pipe Flared End Section, 53 x 41″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1325 x 1025 mm, 75 x 25 mm Corrugation	EACH EA
617147	Corrugated Aluminum Pipe Flared End Section, 60 x 46″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1500 x 1150 mm, 75 x 25 mm Corrugation	EACH EA
617148	Corrugated Aluminum Pipe Flared End Section, 66 x 51″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1650 x 1275 mm, 75 x 25 mm Corrugation	EACH EA
617149	Corrugated Aluminum Pipe Flared End Section, 73 x 55″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1825 x 1375 mm, 75 x 25 mm Corrugation	EACH EA
617150	Corrugated Aluminum Pipe Flared End Section, 81 x 59″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2025 x 1475 mm, 75 x 25 mm Corrugation	EACH EA
617151	Corrugated Aluminum Pipe Flared End Section, 87 x 63″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2175 x 1575 mm, 75 x 25 mm Corrugation	EACH EA

Item No.	*Item Description*	*Pay Unit*
617152	Corrugated Aluminum Pipe Flared End Section, 95 x 67″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2375 x 1675 mm, 75 x 25 mm Corrugation	EACH EA
617153	Corrugated Aluminum Pipe Flared End Section, 103 x 71″, 3 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2575 x 1775 mm, 75 x 25 mm Corrugation	EACH EA
617154	Corrugated Aluminum Pipe Flared End Section, 40 x 31″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1000 x 775 mm, 125 x 25 mm Corrugation	EACH EA
617155	Corrugated Aluminum Pipe Flared End Section, 46 x 31″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1150 x 775 mm, 125 x 25 mm Corrugation	EACH EA
617156	Corrugated Aluminum Pipe Flared End Section, 53 x 41″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1325 x 1025 mm, 125 x 25 mm Corrugation	EACH EA
617157	Corrugated Aluminum Pipe Flared End Section, 60 x 46″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1500 x 1150 mm, 125 x 25 mm Corrugation	EACH EA
617158	Corrugated Aluminum Pipe Flared End Section, 66 x 51″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1650 x 1275 mm, 125 x 25 mm Corrugation	EACH EA
617159	Corrugated Aluminum Pipe Flared End Section, 73 x 55″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 1825 x 1375 mm, 125 x 25 mm Corrugation	EACH EA
617160	Corrugated Aluminum Pipe Flared End Section, 81 x 59″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2025 x 1475 mm, 125 x 25 mm Corrugation	EACH EA
617161	Corrugated Aluminum Pipe Flared End Section, 87 x 63″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2175 x 1575 mm, 125 x 25 mm Corrugation	EACH EA
617162	Corrugated Aluminum Pipe Flared End Section, 95 x 67″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2375 x 1675 mm, 125 x 25 mm Corrugation	EACH EA
617163	Corrugated Aluminum Pipe Flared End Section, 103 x 71″, 5 x 1″ Corrugation Corrugated Aluminum Pipe Flared End Section, 2575 x 1775 mm, 125 x 25 mm Corrugation	EACH EA
617164	Reinforced Concrete Flared End Section, 19 x 30″ Reinforced Concrete Flared End Section, 475 x 750 mm	EACH EA
617165	Reinforced Concrete Flared End Section, 14 x 23″ Reinforced Concrete Flared End Section, 350 x 575 mm	EACH EA
617166	Reinforced Concrete Flared End Section, 32 x 49″ Reinforced Concrete Flared End Section, 800 x 1225 mm	EACH EA
617167	Reinforced Concrete Flared End Section, 34 x 53″ Reinforced Concrete Flared End Section, 850 x 1325 mm	EACH EA

Item No.	*Item Description*	*Pay Unit*
617168	Reinforced Concrete Flared End Section, 27 x 42″ Reinforced Concrete Flared End Section, 675 x 1050 mm	EACH EA
617169	Reinforced Concrete Flared End Section, 38 x 60″ Reinforced Concrete Flared End Section, 950 x 1500 mm	EACH EA
617170	Reinforced Concrete Flared End Section, 43 x 68″ Reinforced Concrete Flared End Section, 1075 x 1700 mm	EACH EA
617171	Reinforced Concrete Flared End Section, 29 x 45″ Reinforced Concrete Flared End Section, 725 x 1125 mm	EACH EA
617172	Reinforced Concrete Flared End Section, 43 x 68″ Reinforced Concrete Flared End Section, 1075 x 1700 mm	EACH EA
617173	Reinforced Concrete Flared End Section, 13 x 22″ Reinforced Concrete Flared End Section, 325 x 550 mm	EACH EA
617174	Reinforced Concrete Flared End Section, 24 x 38″ Reinforced Concrete Flared End Section, 600 x 950 mm	EACH EA
617175	Reinforced Concrete Arch Flared End Section, 11 x 18″ Reinforced Concrete Arch Flared End Section, 275 x 450 mm	EACH EA
617176	Reinforced Concrete Flared End Section, 22 x 34″ Reinforced Concrete Flared End Section, 550 x 850 mm	EACH EA
617177	Corrugated Galvanized Steel Pipe Flared End Section, 8″ Corrugated Galvanized Steel Pipe Flared End Section, 200 mm	EACH EA
618020	Furnish Timber Piles - Treated, 12″ Furnish Timber Piles - Treated, 300 mm	L.F. m
618021	Furnish Timber Piles - Treated, 14″ Furnish Timber Piles - Treated, 350 mm	L.F. m
618022	Furnish Timber Piles - Treated, 16″ Furnish Timber Piles - Treated, 400 mm	L.F. m
618023	Furnish Timber Piles - Untreated, 12″ Furnish Timber Piles - Untreated, 300 mm	L.F. m
618024	Furnish Timber Piles - Untreated, 14″ Furnish Timber Piles - Untreated, 350 mm	L.F. m
618025	Furnish Timber Piles - Untreated, 16″ Furnish Timber Piles - Untreated, 400 mm	L.F. m
618026	Furnish Timber Test Piles, 12″ Furnish Timber Test Piles, 300 mm	L.F. m
618027	Furnish Timber Test Piles, 14″ Furnish Timber Test Piles, 350 mm	L.F. m
618028	Furnish Timber Test Piles, 16″ Furnish Timber Test Piles, 400 mm	L.F. m
618029	Furnish Timber Test Piles - Treated, 12″ Furnish Timber Test Piles - Treated, 300 mm	L.F. m
618030	Furnish Timber Test Piles - Treated, 14″ Furnish Timber Test Piles - Treated, 350 mm	L.F. m

Item No.	*Item Description*	*Pay Unit*
618031	Furnish Timber Test Piles - Treated, 16″ Furnish Timber Test Piles - Treated, 400 mm	L.F. m
618040	Furnish Cast-In-Place Concrete Piles, 12″ Furnish Cast-In-Place Concrete Piles, 300 mm	L.F. m
618041	Furnish Cast-In-Place Concrete Piles, 14″ Furnish Cast-In-Place Concrete Piles, 350 mm	L.F. m
618042	Furnish Cast-In-Place Concrete Piles, 16″ Furnish Cast-In-Place Concrete Piles, 400 mm	L.F. m
618043	Furnish Cast-In-Place Concrete Piles, 16″ Furnish Cast-In-Place Concrete Piles, 450 mm	L.F. m
618044	Furnish Cast-In-Place Concrete Piles, 16″ Bituminous Coated Furnish Cast-In-Place Concrete Piles, 400 mm, Bituminous Coated	L.F. m
618045	Furnish Steel Shell Test Piles, 12″ Furnish Steel Shell Test Piles, 300 mm	L.F. m
618046	Furnish Steel Shell Test Piles, 14″ Furnish Steel Shell Test Piles, 350 mm	L.F. m
618047	Furnish Steel Shell Test Piles, 16″ Furnish Steel Shell Test Piles, 400 mm	L.F. m
618048	Furnish Steel Shell Test Piles, 18″ Furnish Steel Shell Test Piles, 450 mm	L.F. m
618049	Furnish Steel Shell Test Piles, 16″, Bituminous Coated Furnish Steel Shell Test Piles, 400 mm, Bituminous Coated	L.F. m
618060	Steel H Piles, HP 12 x 53 Steel H Piles, HP 310 x 79	L.F. m
618061	Steel H Piles, HP 12 x 63 Steel H Piles, HP 310 x 94	L.F. m
618062	Steel H Piles, HP 14 x 73 Steel H Piles, HP 360 x 108	L.F. m
618063	Steel H Test Piles, HP 12 x 53 Steel H Test Piles, HP 310 x 79	L.F m
618064	Steel H Test Piles, HP 12 x 74 Steel H Test Piles, HP 310 x 110	L.F. m
618065	Steel H Test Piles, HP 14 x 73 Steel H Test Piles, HP 360 x 108	L.F. m
618066	Steel H Piles, HP 10 x 42 Steel H Piles, HP 250 x 62	L.F. m
618067	Steel H Test Piles, HP 10 x 42 Steel H Test Piles, HP 250 x 62	L.F. m
618068	Steel H Test Piles, HP 12 x 63 Steel H Test Piles, HP 310 x 94	L.F. m
618069	Steel H Piles, HP 12 x 84 Steel H Piles, HP 310 x 125	L.F. m

Item No.	*Item Description*	*Pay Unit*
618070	Steel H Test Piles, HP 12 x 84 Steel H Test Piles, HP 310 x 125	L.F. m
618080	Furnish Precast Prestressed Concrete Pile, 12 x 12″ Furnish Precast Prestressed Concrete Pile, 300 x 300 mm	L.F. m
618081	Furnish Precast Prestressed Concrete Pile, 14 x 14″ Furnish Precast Prestressed Concrete Pile, 350 x 350 mm	L.F. m
618082	Furnish Precast Prestressed Concrete Pile, 16 x 16″ Furnish Precast Prestressed Concrete Pile, 400 x 400 mm	L.F. m
618083	Furnish Precast Prestressed Concrete Pile, 18 x 18″ Furnish Precast Prestressed Concrete Pile, 450 x 450 mm	L.F. m
618084	Furnish Precast Prestressed Concrete Pile, 20 x 20″ Furnish Precast Prestressed Concrete Pile, 500 x 500 mm	L.F. m
618085	Furnish Precast Prestressed Concrete Pile, 24 x 24″ Furnish Precast Prestressed Concrete Pile, 600 x 600 mm	L.F. m
618090	Furnish Precast Prestressed Concrete Test Pile, 12 x 12″ Furnish Precast Prestressed Concrete Test Pile, 300 x 300 mm	L.F. m
618091	Furnish Precast Prestressed Concrete Test Pile, 14 x 14″ Furnish Precast Prestressed Concrete Test Pile, 350 x 350 mm	L.F. m
618092	Furnish Precast Prestressed Concrete Test Pile, 16 x 16″ Furnish Precast Prestressed Concrete Test Pile, 400 x 400 mm	L.F. m
618093	Furnish Precast Prestressed Concrete Test Pile, 18 x 18″ Furnish Precast Prestressed Concrete Test Pile, 450 x 450 mm	L.F. m
618094	Furnish Precast Prestressed Concrete Test Pile, 20 x 20″ Furnish Precast Prestressed Concrete Test Pile, 500 x 500 mm	L.F. m
618095	Furnish Precast Prestressed Concrete Test Pile, 24 x 24″ Furnish Precast Prestressed Concrete Test Pile, 600 x 600 mm	L.F. m
619005	Install Timber Piles - Treated 12″ Install Timber Piles - Treated, 300 mm	L.F. m
619006	Install Timber Piles - Treated, 14″ Install Timber Piles - Treated, 350 mm	L.F. m
619007	Install Timber Piles - Treated, 16″ Install Timber Piles - Treated, 400 mm	L.F. m
619008	Install Timber Piles - Untreated, 12″ Install Timber Piles - Untreated, 300 mm	L.F. m
619009	Install Timber Piles - Untreated, 14″ Install Timber Piles - Untreated, 350 mm	L.F. m
619010	Install Timber Piles - Untreated, 16″ Install Timber Piles - Untreated, 400 mm	L.F. m
619011	Install Timber Test Piles - Treated, 12″ Install Timber Test Piles - Treated, 300 mm	L.F. m
619012	Install Timber Test Piles - Treated, 14″ Install Timber Test Piles - Treated, 350 mm	L.F. m

Item No.	*Item Description*	*Pay Unit*
619013	Install Timber Test Piles - Treated, 16″ Install Timber Test Piles - Treated, 400 mm	L.F. m
619014	Install Timber Test Piles - Untreated, 12″ Install Timber Test Piles - Untreated, 300 mm	L.F. m
619015	Install Timber Test Piles - Untreated, 14″ Install Timber Test Piles - Untreated, 350 mm	L.F. m
619016	Install Timber Test Piles - Untreated, 16″ Install Timber Test Piles - Untreated, 400 mm	L.F. m
619020	Install Cast-In-Place Concrete Piles, 12″ Install Cast-In-Place Concrete Piles, 300 mm	L.F. m
619021	Install Cast-In-Place Concrete Piles, 14″ Install Cast-In-Place Concrete Piles, 350 mm	L.F. m
619022	Install Cast-In-Place Concrete Piles, 16″ Install Cast-In-Place Concrete Piles, 400 mm	L.F. m
619023	Install Cast-In-Place Concrete Piles, 18″ Install Cast-In-Place Concrete Piles, 450 mm	L.F. m
619024	Install Steel Shell Test Piles, 12″ Install Steel Shell Test Piles, 300 mm	L.F. m
619025	Install Steel Shell Test Piles, 14″ Install Steel Shell Test Piles, 350 mm	L.F. m
619026	Install Steel Shell Test Piles, 16″ Install Steel Shell Test Piles, 400 mm	L.F. m
619027	Install Steel Shell Test Piles, 18″ Install Steel Shell Test Piles, 450 mm	L.F. m
619040	Install Steel H Piles, HP 12 x 53 Install Steel H Piles, HP 310 x 79	L.F. m
619041	Install Steel H Piles, HP 12 x 63 Install Steel H Piles, HP 310 x 94	L.F. m
619042	Install Steel H Piles, HP 14 x 73 Install Steel H Piles, HP 360 x 108	L.F. m
619043	Install Steel H Test Piles, HP 12 x 53 Install Steel H Test Piles, HP 310 x 79	L.F. m
619044	Install Steel H Test Piles, HP 12 x 74 Install Steel H Test Piles, HP 310 x 110	L.F. m
619045	Install Steel H Test Piles, HP 14 x 73 Install Steel H Test Piles, HP 360 x 108	L.F. m
619046	Install Steel H Piles, HP 10 x 42 Install Steel H Piles, HP 250 x 62	L.F. m
619047	Install Steel H Test Piles, HP 10 x 42 Install Steel H Test Piles, HP 250 x 62	L.F. m
619048	Install Steel H Test Piles, HP 12 x 63 Install Steel H Test Piles, HP 310 x 94	L.F. m

Item No.	*Item Description*	*Pay Unit*
619049	Install Steel H Piles, HP 12 x 84 Install Steel H Piles, HP 310 x 125	L.F. m
619050	Install Steel H Test Piles, HP 12 x 84 Install Steel H Test Piles, HP 310 x 125	L.F. m
619060	Install Precast Prestressed Concrete Pile, 12 x 12″ Install Precast Prestressed Concrete Pile, 300 x 300 mm	L.F. m
619061	Install Precast Prestressed Concrete Pile, 14 x 14″ Install Precast Prestressed Concrete Pile, 350 x 350 mm	L.F. m
619062	Install Precast Prestressed Concrete Pile, 16 x 16″ Install Precast Prestressed Concrete Pile, 400 x 400 mm	L.F. m
619063	Install Precast Prestressed Concrete Pile, 18 x 18″ Install Precast Prestressed Concrete Pile, 450 x 450 mm	L.F. m
619064	Install Precast Prestressed Concrete Pile. 20 x 20″ Install Precast Prestressed Concrete Pile, 500 x 500 mm	L.F. m
619065	Install Precast Prestressed Concrete Pile, 24 x 24″ Install Precast Prestressed Concrete Pile, 600 x 600 mm	L.F. m
619066	Install Precast Prestressed Concrete Test Pile, 12 x 12″ Install Precast Prestressed Concrete Test Pile, 300 x 300 mm	L.F. m
619067	Install Precast Prestressed Concrete Test Pile, 14 x 14″ Install Precast Prestressed Concrete Test Pile, 350 x 350 mm	L.F. m
619068	Install Precast Prestressed Concreet Test Pile, 16 x 16″ Install Precast Prestressed Concrete Test Pile, 400 x 400 mm	L.F. m
619069	Install Precast Prestressed Concrete Test Pile, 18 x 18″ Install Precast Prestressed Concrete Test Pile, 450 x 450 mm	L.F. m
619070	Install Precast Prestressed Concrete Test Pile, 20 x 20″ Install Precast Prestressed Concrete Test Pile, 500 x 500 mm	L.F. m
619071	Install Precast Prestressed Concrete Test Pile, 24 x 24″ Install Precast Prestressed Concrete Test Pile, 600 x 600 mm	L.F. m
621020	Timber Sheet Piles - Treated Timber Sheet Piles - Treated	MFBM m^3
621021	Timber Sheet Piles - Untreated Timber Sheet Piles - Untreated	MFBM m^3
622001	Steel Sheet Piles, PZ 22 (Unprotected) Steel Sheet Piles, PZ 22 (Unprotected)	S.F. m^2
622002	Steel Sheet Piles, PZ 27 (Unprotected) Steel Sheet Piles, PZ 27 (Unprotected)	S.F. m^2
622003	Steel Sheet Piles, PZ 27 (Unprotected) Steel Sheet Piles, PZ 35 (Unprotected)	S.F. m^2
622004	Steel Sheet Piles, PZ 40 (Unprotected) Steel Sheet Piles, PZ 40 (Unprotected)	S.F. m^2
622005	Steel Sheet Piles, PS 31 (Unprotected) Steel Sheet Piles, PS 31 (Unprotected)	S.F. m^2

Item No.	*Item Description*	*Pay Unit*
622006	Steel Sheet Piles, PS 27.5	S.F.
	Steel Sheet Piles, PS 27.5	m^2
622007	Steel Sheet Piles, PZ 22	S.F.
	Steel Sheet Piles, PZ 22	m^2
622008	Steel Sheet Piles, PZ 27	S.F.
	Steel Sheet Piles, PZ 27	m^2
622009	Steel Sheet Piles, PZ 35	S.F.
	Steel Sheet Piles, PZ 35	m^2
622010	Steel Sheet Piles, PZ 40	S.F.
	Steel Sheet Piles, PZ 40	m^2
622011	Steel Sheet Piles, PS 31	S.F.
	Steel Sheet Piles, PS 31	m^2
622012	Steel Sheet Piles, PSA-23	S.F.
	Steel Sheet Piles, PSA-23	m^2
623000	Prestressed Reinforced Concrete Members	L.S.
	Prestressed Reinforced Concrete Members	L.S.
623001	Prestressed Reinforced Concrete Members, I-Beams	L.S.
	Prestressed Reinforced Concrete Members, I-Beams	L.S.
623002	Prestressed Reinforced Concrete Members, Box-Beams	L.S.
	Prestressed Reinforced Concrete Members, Box-Beams	L.S.
	DIVISION 700 – MISCELLANEOUS CONSTRUCTION	
701001	Portland Cement Concrete Gutter, 4″	S.Y.
	Portland Cement Concrete Gutter, 100 mm	m^2
701002	Portland Cement Concrete Gutter, 6″	S.Y.
	Portland Cement Concrete Gutter, 150 mm	m^2
701003	Portland Cement Concrete Gutter, 8″	S.Y.
	Portland Cement Concrete Gutter, 200 mm	m^2
701004	Portland Cement Concrete Valley Gutter, 8″	S.Y.
	Portland Cement Concrete Valley Gutter, 200 mm	m^2
701010	Portland Cement Concrete Curb, Type 1	L.F.
	Portland Cement Concrete Curb, Type 1	m
701011	Portland Cement Concrete Curb, Type 2	L.F.
	Portland Cement Concrete Curb, Type 2	m
701012	Portland Cement Concrete Curb, Type 3	L.F.
	Portland Cement Concrete Curb, Type 3	m
701020	Integral Portland Cement Concrete Curb and Gutter, Type 1	L.F.
	Integral Portland Cement Concrete Curb and Gutter, Type 1	m
701021	Integral Portland Cement Concrete Curb and Gutter, Type 2	L.F.
	Integral Portland Cement Concrete Curb and Gutter, Type 2	m
701022	Integral Portland Cement Concrete Curb and Gutter, Type 3	L.F.
	Integral Portland Cement Concrete Curb and Gutter, Type 3	m
701023	Integral Portland Cement Concrete Curb and Gutter, Type 4	L.F.
	Integral Portland Cement Concrete Curb and Gutter, Type 4	m

Item No.	*Item Description*	*Pay Unit*
703001	Portland Cement Concrete Parkway Curb, Type 1 Portland Cement Concrete Parkway Curb, Type 1	L.F. m
703008	Portland Cement Concrete Parkway Curb, Type 1, Modified Portland Cement Concrete Parkway Curb, Type 1, Modified	L.F. m
705001	Portland Cement Concrete Sidewalk, 4″ Portland Cement Concrete Sidewalk, 100 mm	S.F. m^2
705002	Portland Cement Concrete Sidewalk, 6″ Portland Cement Concrete Sidewalk, 150 mm	S.F. m^2
705003	Portland Cement Concrete Sidewalk, 4″, Modified Portland Cement Concrete Sidewalk, 100 mm, Modified	S.F. m^2
705004	Portland Cement Concrete Sidewalk, 6″, Modified Portland Cement Concrete Sidewalk, 150 mm, Modified	S.F. m^2
705005	Portland Cement Concrete Sidewalk, 7½″ Portland Cement Concrete Sidewalk, 188 mm	S.F. m^2
705006	Portland Cement Concrete Sidewalk, Variable Depth Portland Cement Concrete Sidewalk, Variable Depth	S.F. m^2
707001	Corrugated Metal Downspouts, 8″ Corrugated Metal Downspouts, 200 mm	L.F. m
707002	Corrugated Metal Downspouts, 10″ Corrugated Metal Downspouts, 250 mm	L.F. m
707003	Corrugated Metal Downspouts, 12″ Corrugated Metal Downspouts, 300 mm	L.F. m
707004	Corrugated Metal Downspouts, 15″ Corrugated Metal Downspouts, 375 mm	L.F. m
707005	Downspout Splash Aprons Downspout Splash Aprons	EACH EA
707006	Intake Aprons Intake Aprons	EACH EA
707007	Intake Basin Intake Basin	EACH EA
707008	Corrugated Metal Downspouts, 18″ Corrugated Metal Downspouts, 450 mm	L.F. m
708040	Drainage Inlet, Type 1 Drainage Inlet, Type 1	EACH EA
708041	Drainage Inlet, Type 2 Drainage Inlet, Type 2	EACH EA
708042	Drainage Inlet, Type 3 Drainage Inlet, Type 3	EACH EA
708043	Drainage Inlet, Type 4 Drainage Inlet, Type 4	EACH EA
708044	Drainage Inlet, Type 5 Drainage Inlet, Type 5	EACH EA

Item No.	*Item Description*	*Pay Unit*
708100	Manhole, Type 1 Manhole, Type 1	EACH EA
708101	Manhole, Type 2 Manhole, Type 2	EACH EA
708102	Manhole, Type 3 Manhole, Type 3	EACH EA
708103	Manhole, Type 4 Manhole, Type 4	EACH EA
708104	Manhole, Type 5 Manhole, Type 5	EACH EA
710001	Adjusting and Repairing Existing Drainage Inlet and Manhole (Drainage Inlet) Adjusting and Repairing Existing Drainage Inlet and Manhole (Drainage Inlet)	EACH EA
710002	Adjusting and Repairing Existing Drainage Inlet and Manhole (Manhole) Adjusting and Repairing Existing Drainage Inlet and Manhole (Manhole)	EACH EA
710003	Adjusting and Repairing Existing Drainage Inlet and Manhole (Manhole), Special Adjusting and Repairing Existing Drainage Inlet and Manhole (Manhole), Special	EACH EA
712005	Riprap, R-4 Riprap, R-4	S.Y. m^2
712006	Riprap, R-5 Riprap, R-5	S.Y. m^2
712007	Riprap, R-6 Riprap, R-6	S.Y. m^2
712008	Riprap, R-7 Riprap, R-7	S.Y. m^2
712020	Riprap, R-4 Riprap, R-4	TON t
712021	Riprap, R-5 Riprap, R-5	TON t
712022	Riprap, R-6 Riprap, R-6	TON t
712023	Riprap, R-7 Riprap, R-7	TON t
712030	Presacked Concrete Riprap Presacked Concrete Riprap	C.Y. m^3
714003	Ditching Ditching	L.F. m
715000	Perforated Pipe Underdrains, 4″ Perforated Pipe Underdrains, 100 mm	L.F. m
715001	Perforated Pipe Underdrains, 6″ Perforated Pipe Underdrains, 150 mm	L.F. m
715002	Perforated Pipe Underdrains, 8″ Perforated Pipe Underdrains, 200 mm	L.F. m

Item No.	*Item Description*	*Pay Unit*
715003	Perforated Pipe Underdrains, 10″ Perforated Pipe Underdrains, 250 mm	L.F. m
715004	Perforated Pipe Underdrains, 12″ Perforated Pipe Underdrains, 300 mm	L.F. m
715005	Perforated Pipe Underdrains, 15″ Perforated Pipe Underdrains, 375 mm	L.F. m
715006	Perforated Pipe Underdrains, 4″ Perforated Pipe Underdrains, 100 mm	L.F. m
715007	Perforated Pipe Underdrains, 24″ Perforated Pipe Underdrains, 600 mm	L.F. m
715008	Perforated Pipe Underdrains, 18″ Perforated Pipe Underdrains, 450 mm	L.F. m
716000	Converting Existing Drainage Inlet to Junction Box Converting Existing Drainage Inlet to Junction Box	EACH EA
717000	Permanent Roadway Drains Permanent Roadway Drains	L.F. m
718000	Roof Drains Roof Drains	L.F. m
720004	Bridge Guardrail Bridge Guardrail	L.F. m
720005	Steel Rail Element, Straight Steel Rail Element, Straight	L.F. m
720006	Steel Rail Element, Curved Steel Rail Element, Curved	L.F. m
720007	Galvanized Steel Posts Galvanized Steel Posts	EACH EA
720008	Galvanized Steel Brackets Galvanized Steel Brackets	EACH EA
720009	Short Wood Breakaway Post, Treated Short Wood Breakaway Post, Treated	EACH EA
720010	Treated Wood Block Treated Wood Block	EACH EA
720012	Block B for Post B and Block C for Post C Block B for Post B and Block C for Post C	EACH EA
720013	End Section (Rounded) End Section (Rounded)	EACH EA
720014	Terminal Connector, Bridge and Barrier Terminal Connector, Bridge and Barrier	EACH EA
720016	Salvaged Rail Element Salvaged Rail Element	L.F. m
720017	Salvaged Galvanized Steel Posts Salvaged Galvanized Steel Posts	EACH EA

Item No.	*Item Description*	*Pay Unit*
720018	Salvaged Galvanized Steel Brackets Salvaged Galvanized Steel Brackets	EACH EA
720021	Galvanzied Thrie Beam Terminal Connector, Bridge and Barrier Galvanized Thrie Beam Terminal Connector, Bridge and Barrier	EACH EA
720022	Galvanized Rail Element, Thrie Beam Galvanized Rail Element, Thrie Beam	EACH EA
720023	Galvanized Transition Section, Thrie Beam Galvanized Transition Section, Thrie Beam	EACH EA
720024	Galvanized Steel Post, Thrie Beam Galvanized Steel Post, Thrie Beam	EACH EA
720025	Galvanized Steel Bracket, Thrie Beam Galvanized Steel Bracket, Thrie Beam	EACH EA
720026	Bridge Rail Retrofit, Type 1 Bridge Rail Retrofit, Type 1	L.F. m
720027	Bridge Rail Retrofit, Type 2 Bridge Rail Retrofit, Type 2	L.F. m
720028	Bridge Rail Retrofit, Type 3 Bridge Rail Retrofit, Type 3	L.F. m
720029	Galvanized Rail Element Galvanized Rail Element	EACH EA
720030	Galvanized Steel Psot, 7′ Galvanized Steel Post, 2.1 m	EACH EA
720031	Galvanized Steel Beam Guardrail (Close Post Spacing) Galvanized Steel Beam Guardrail (Close Post Spacing)	L.F. m
720032	Galvanized Steel Post, 8′ Galvanized Steel Post, 2.4 m	EACH EA
720033	Galvanized W-Beam Offset Block Galvanized W-Beam Offset Block	EACH EA
720034	Galvanized W-Beam Back-Up Plate Galvanized W-Beam Back-Up Plate	EACH EA
720035	Galvanized Thrie Beam Back-Up Plate Galvanized Thrie Beam Back-Up Plate	EACH EA
720036	Galvanized Thrie Beam Offset Block Galvanized Thrie Beam Offset Block	EACH EA
720037	Long Wood Breakaway Post, Treated Long Wood Breakaway Post, Treated	EACH EA
720038	Galvanized Steel Tube Galvanized Steel Tube	EACH EA
720039	Galvanized Soil Plate Galvanized Soil Plate	EACH EA
720040	Swaged Cable Assemblage and Related Hardware Swaged Cable Assemblage and Related Hardware	EACH EA

Item No.	*Item Description*	*Pay Unit*
720041	Reflectorized Washers Reflectorized Washers	EACH EA
720042	Galvanized Bearing Plate Galvanized Bearing Plate	EACH EA
720050	Galvanized Steel Beam Guardrail, Type 1 Galvanized Steel Beam Guardrail, Type 1	L.F. m
720051	Galvanized Steel Beam Guardrail, Type 2 Galvanized Steel Beam Guardrail, Type 2	L.F. m
720052	Galvanized Steel Beam Guardrail, Type 3 Galvanized Steel Beam Guardrail, Type 3	L.F. m
720053	Guardrail Over Culverts, Type 1 Guardrail Over Culverts, Type 1	EACH EA
720054	Guardrail Over Culverts, Type 2 Guardrail Over Culverts, Type 2	EACH EA
720055	Curved Guardrail Section Curved Guardrail Section	L.F. m
725001	Guardrail-to-Barrier Connection (Exit Type) Guardrail-to-Barrier Connection (Exit Type)	EACH EA
725002	Guardrail-to-Barrier Connection, Approach Type 1 Guardrail-to-Barrier Connection, Approach Type 1	EACH EA
725003	Guardrail-to-Barrier Connection, Approach Type 2 Guardrail-to-Barrier Connection, Approach Type 2	EACH EA
726001	End Anchorage End Anchorage	EACH EA
726002	Buried End Section Buried End Section	EACH EA
727000	Right-Of-Way Fence Right-Of-Way Fence	L.F. m
727001	Right-Of-Way Fence Gate Right-Of-Way Fence Gate	EACH EA
727002	Barbed Wire Fence Barbed Wire Fence	L.F. m
727003	Chain-Link Fence, 4′ High Chain-Link Fence, 1.2 m High	L.F. m
727004	Chain-Link Fence, 6′ High Chain-Link Fence, 1.8 m High	L.F. m
727005	Terminal Posts for 4′ Chain-Link Fence Terminal Posts for 1.2 m Chain-Link Fence	EACH EA
727006	Terminal Posts for 6′ Chain-Link Fence Terminal Posts for 1.8 m Chain-Link Fence	EACH EA
727007	Chain-Link Fence, 8′ High Chain-Link Fence, 2.4 m High	L.F. m

Item No.	*Item Description*	*Pay Unit*
727008	Terminal Posts for 8′ Chain-Link Fence Terminal Posts for 2.4 m Chain-Link Fence	EACH EA
727009	Chain-Link Fence, 5′ High Chain-Link Fence, 1.5 m High	L.F. m
727010	Terminal Post for 5′ Chain-Link Fence Terminal Post for 1.5 m Chain-Link Fence	EACH EA
727011	Reset Chain-Link Fence Reset Chain-Link Fence	L.F. m
727012	Vehicular Gates Vehicular Gates	EACH EA
727013	Walk Gates Walk Gates	EACH EA
732002	Topsoil, 6″ Depth Topsoil, 150 mm Depth	S.Y. m^2
732003	Topsoil, 12″ Depth Topsoil, 300 mm Depth	S.Y. m^2
733002	Topsoiling, 6″ Depth Topsoiling, 150 mm Depth	S.Y. m^2
733003	Topsoiling, 8″ Depth Topsoiling, 200 mm Depth	S.Y. m^2
733006	Topsoiling, 12″ Depth Topsoiling, 300 mm Depth	S.Y. m^2
734007	Wetland Seeding, Type HM Wetland Seeding, Type HM	S.Y. m^2
734011	Facultative Wet Blend Facultative Wet Blend	S.Y. m^2
734012	Refertilization and Liming, Grass Seeding - Dry Ground Refertilization and Liming, Grass Seeding - Dry Ground	S.Y. m^2
734013	Permanent Grass Seeding - Dry Ground Permanent Grass Seeding - Dry Ground	S.Y. m^2
734014	Permanent Crown Vetch Seeding Permanent Crown Vetch Seeding	S.Y. m^2
734015	Permanent Grass Seeding - Wet Ground Permanent Grass Seeding - Wet Ground	S.Y. m^2
734016	Permanent Grass Seeding - Subdivision Permanent Grass Seeding - Subdivision	S.Y. m^2
734017	Temporary Grass Seeding - Dry Ground Temporary Grass Seeding - Dry Ground	S.Y. m^2
734018	Temporary Grass Seeding - Wet Ground Temporary Grass Seeding - Wet Ground	S.Y. m^2
734019	Permanent Grass Seeding - Wet Ground Permanent Grass Seeding - Wet Ground	LB kg

Item No.	*Item Description*	*Pay Unit*
734020	Temporary Grass Seeding - Wet Ground	LB
	Temporary Grass Seeding - Wet Ground	kg
735003	Mulching, Soil Reinforcement Mat	S.Y.
	Mulching, Soil Reinforcement Mat	m^2
735006	Mulching, Straw	S.Y.
	Mulching, Straw	m^2
735008	Mulching, Bonded Fiber Matrix Blanket	S.Y.
	Mulching, Bonded Fiber Matrix Blanket	m^2
735009	Mulching, Straw-Coconut Fiber Blanket	S.Y.
	Mulching, Straw-Coconut Fiber Blanket	m^2
736004	Sodding, Tall Fescue-Blue Grass	S.Y.
	Sodding, Tall Fescue-Blue Grass	m^2
737000 - 737499	Plantings	EACH
	Plantings	EA
738000	Transplanting	EACH
	Transplanting	EA
738001	Transplanting - Herbaceous Perennials and Annuals	EACH
	Transplanting - Herbaceous Perennials and Annuals	EA
738002	Transplanting - Evergreen & Deciduous Groundcover	EACH
	Transplanting - Evergreen & Deciduous Groundcover	EA
738003	Transplanting - Evergreen & Deciduous Shrubs Less Than 4′	EACH
	Transplanting - Evergreen & Deciduous Shrubs Less Than 1.2 m	EA
738004	Transplanting - Evergreen & Deciduous Shrubs More Than 4′	EACH
	Transplanting - Evergreen & Deciduous Shrubs More Than 1.2 m	EA
738005	Transplanting - Small Deciduous Shade Trees Less Than 8′	EACH
	Transplanting - Small Deciduous Shade Trees Less Than 2.4 m	EA
738006	Transplanting - Large Deciduous Shade Trees More Than 8′	EACH
	Transplanting - Large Deciduous Shade Trees More Than 2.4 m	EA
738007	Transplanitng - Small Deciduous Ornamental/Flowering Trees Less Than 6′	EACH
	Transplanting - Small Deciduous Ornamental/Flowering Trees Less Than 1.8 m	EA
738008	Transplanting - Large Deciduous Ornamental/Flowering Trees More Than 6′	EACH
	Transplanting - Large Deciduous Ornamental/Flowering Trees More Than 1.8 m	EA
738009	Transplanting - Small Evergreen Trees Less Than 8′	EACH
	Transplanting - Small Evergreen Trees Less Than 2.4 m	EA
738010	Transplanting - Large Evergreen Trees More Than 8′	EACH
	Transplanting - Large Evergreen Trees More Than 2.4 m	EA
741001	Tree Removal 6″ to 10.9″	EACH
	Tree Removal 151 mm to 279 mm	EA
741002	Tree Removal 11″ to 14.9″	EACH
	Tree Removal 280 mm to 379 mm	EA
741003	Tree Removal 15″ to 18.9″	EACH
	Tree Removal 380 mm to 479 mm	EA

Item No.	*Item Description*	*Pay Unit*
741004	Tree Removal 19″ to 24.9″	EACH
	Tree Removal 480 mm to 639 mm	EA
741005	Tree Removal 25″ to 30.9″	EACH
	Tree Removal 640 mm to 789 mm	EA
741006	Tree Removal 31″ to 36.9″	EACH
	Tree Removal 790 mm to 939 mm	EA
741007	Tree Removal 37″ to 42.9″	EACH
	Tree Removal 940 mm to 1099 mm	EA
741008	Tree Removal 43″ to 48.9″	EACH
	Tree Removal 1100 mm to 1249 mm	EA
741009	Tree Removal 49″	EACH
	Tree Removal 1250 mm and above	EA
743001	Arrowpanels, Type A	EA-DY
	Arrowpanels, Type A	EA-DY
743002	Arrowpanels, Type B	EA-DY
	Arrowpanels, Type B	EA-DY
743003	Arrowpanels, Type C	EA-DY
	Arrowpanels, Type C	EA-DY
744001	Conduit Junction Well, Type 1	EACH
	Conduit Junction Well, Type 1	EA
744002	Conduit Junction Well, Type 2	EACH
	Conduit Junction Well, Type 2	EA
744003	Conduit Junction Well, Type 3	EACH
	Conduit Junction Well, Type 3	EA
744004	Conduit Junction Well, Type 4	EACH
	Conduit Junction Well, Type 4	EA
744005	Conduit Junction Well, Type 5	EACH
	Conduit Junction Well, Type 5	EA
745001	Conduit Under Existing Pavement, 1½″	L.F.
	Conduit Under Existing Pavement, 38 mm	m
745002	Conduit Under Existing Pavement, 2″	L.F.
	Conduit Under Existing Pavement, 50 mm	m
745003	Conduit Under Existing Pavement, 2½″	L.F.
	Conduit Under Existing Pavement, 63 mm	m
745004	Galvanized Conduit Under New Pavement or in Sodded Trench, 1½″	L.F.
	Galvanized Conduit Under New Pavement or in Sodded Trench, 38 mm	m
745005	Galvanized Conduit Under New Pavement or in Sodded Trench, 2″	L.F.
	Galvanized Conduit Under New Pavement or in Sodded Trench, 50 mm	m
745006	Galvanized Conduit Under New Pavement or in Sodded Trench, 2½″	L.F.
	Galvanized Conduit Under New Pavement or in Sodded Trench, 63 mm	m
745009	Galvanized Conduit Under New Pavement or in Sodded Trench, 3/4″	L.F.
	Galvanized Conduit Under New Pavement or in Sodded Trench, 19 mm	m

Item No.	*Item Description*	*Pay Unit*
745010	Galvanized Conduit Under New Pavement or in Sodded Trench, 3″ Galvanized Conduit Under New Pavement or in Sodded Trench, 75 mm	L.F. m
745012	PVC Conduit Under Existing Pavement, 1″ PVC Conduit Under Existing Pavement, 25 mm	L.F. m
745014	PVC Conduit Under Existing Pavement, 2″ PVC Conduit Under Existing Pavement, 50 mm	L.F. m
745016	PVC Conduit Under Existing Pavement, 3″ PVC Conduit Under Existing Pavement, 75 mm	L.F. m
745017	PVC Conduit Under New Pavement or in Sodded Trench, 1″ PVC Conduit Under New Pavement or in Sodded Trench, 25 mm	L.F. m
745018	PVC Conduit Under New Pavement or in Sodded Trench, 2″ PVC Conduit Under New Pavement or in Sodded Trench, 50 mm	L.F. m
745019	PVC Conduit Under New Pavement or in Sodded Trench, 3″ PVC Conduit Under New Pavement or in Sodded Trench, 75 mm	L.F. m
745020	Galvanized Conduit Under New Pavement or in Sodded Trench, 4″ Galvanized Conduit Under New Pavement or in Sodded Trench, 100 mm	L.F. m
745021	Galvanized Conduit Under Existing Pavement 4″ Galvanized Conduit Under Existing Pavement 100 mm	L.F. m
745022	Galvanized Conduit Under New Pavement or in Sodded Trench, 1″ Galvanized Conduit Under New Pavement or in Sodded Trench, 25 mm	L.F. m
745023	Galvanized Conduit Under New Pavement or in Sodded Trench, 3/4″ Galvanized Conduit Under New Pavement or in Sodded Trench, 19 mm	L.F. m
745024	PVC Conduit Under New Pavement or Sodded Trench, 1½″ PVC Conduit Under New Pavement or Sodded Trench, 38 mm	L.F. m
745025	PVC Conduit Under New Pavement or Sodded Trench, 6″ PVC Conduit Under New Pavement or Sodded Trench, 150 mm	L.F. m
745026	PVC Conduit Under New Pavement or in Sodded Trench, 2½″ PVC Conduit Under New Pavement or in Sodded Trench, 63 mm	L.F. m
746001	Pole Base, Type 1 Pole Base, Type 1	EACH EA
746002	Pole Base, Type 2 Pole Base, Type 2	EACH EA
746003	Pole Base, Type 2A Pole Base, Type 2A	EACH EA
746004	Pole Base, Type 2B Pole Base, Type 2B	EACH EA
746005	Pole Base, Type 3 Pole Base, Type 3	EACH EA
746006	Pole Base, Type 3A Pole Base, Type 3A	EACH EA
746007	Pole Base, Type 3B Pole Base, Type 3B	EACH EA

Item No.	*Item Description*	*Pay Unit*
746008	Pole Base, Type 4 Pole Base, Type 4	EACH EA
746009	Pole Base, Type 5 Pole Base, Type 5	EACH EA
746010	Pole Base, Type 6 Pole Base, Type 6	EACH EA
747001	Cabinet Base Cabinet Base	EACH EA
748001	Painting of White or Yellow, 4″ Line Painting of White or Yellow, 100 mm Line	L.F. m
748002	Painting of White or Yellow, 6″ Line Painting of White or Yellow, 150 mm Line	L.F. m
748003	Painting of White or Yellow, Symbol/Legend Painting of White or Yellow, Symbol/Legend	S.F. m^2
748008	Painting of White or Yellow, 12″ Line Painting of White or Yellow, 300 mm Line	L.F. m
748014	Permanent Pavement Striping, Alkyd-Thermoplastic, 4″ Permanent Pavement Striping, Alkyd-Thermoplastic, 100 mm	L.F. m
748015	Permanent Pavement Striping, Symbol/Legend Alkyd-Thermoplastic Permanent Pavement Striping, Symbol/Legend Alkyd-Thermoplastic	S.F. m^2
748016	Permanent Pavement Striping, Alkyd-Thermoplastic, 8″ Permanent Pavement Striping, Alkyd-Thermoplastic, 200 mm	L.F. m
748017	Permanent Pavement Striping, Alkyd-Thermoplastic, 6″ Permanent Pavement Striping, Alkyd-Thermoplastic, 150 mm	L.F. m
748018	Painting of White or Yellow, 8″ Line Painting of White or Yellow, 200 mm Line	L.F. m
748019	Temporary Markings, Paint, 4″ Temporary Markings, Paint, 100 mm	L.F. m
748020	Temporary Markings, Paint, 6″ Temporary Markings, Paint, 150 mm	L.F. m
748026	Temporary Markings, Paint, Symbol/Legend Temporary Markings, Paint, Symbol/Legend	S.F. m^2
748027	Permanent Pavement Striping, Alkyd-Thermoplastic, 12″ Permanent Pavement Striping, Alkyd-Thermoplastic, 300 mm	L.F. m
748028	Permanent Pavement Striping, Alkyd-Thermoplastic, 4″ on Hot-Mix Type C Permanent Pavement Striping, Alkyd-Thermoplastic, 100 mm on Hot-Mix Type C	L.F. m
748029	Permanent Pavement Striping, Symbol/Legend, Alkyd-Thermoplastic on Hot-Mix Type C Permanent Pavement Striping, Symbol/Legend, Alkyd-Thermoplastic on Hot-Mix Type C	S.F. m^2
748030	Permanent Pavement Striping, Alkyd-Thermoplastic, 4″ on Open-Graded Permanent Pavement Striping, Alkyd-Thermoplastic, 100 mm on Open-Graded	L.F. m
748031	Permanent Pavement Striping, Symbol/Legend, Alkyd-Thermoplastic on Open-Graded Permanent Pavement Striping, Symbol/Legend, Alkyd-Thermoplastic on Open-Graded	S.F m^2

Item No.	*Item Description*	*Pay Unit*
749000	Reinforced Concrete Masonry Sign Foundation Reinforced Concrete Masonry Sign Foundation	EACH EA
750000	Adjust Water Valve Boxes Adjust Water Valve Boxes	EACH EA
751000	Adjust Fire Hydrants Adjust Fire Hydrants	EACH EA
752000	Relocate Fire Hydrants Relocate Fire Hydrants	EACH EA
753000	Adjust Sanitary Sewer Laterals Adjust Sanitary Sewer Laterals	EACH EA
754000	Adjust Water Services Adjust Water Services	EACH EA
755000	Hot-Mix, Hot-Laid Bituminous Concrete Curb Hot-Mix, Hot-Laid Bituminous Concrete Curb	L.F. m
756000	Sand Sand	TON t
758000	Removal Existing Portland Cement Concrete Pavement Curb, Sidewalk, Etc. Removal Existing Portland Cement Concrete Pavement Curb, Sidewalk, Etc.	S.F. m^2
759004	Field Office, Type I Field Office, Type I	EA-MO EA-MO
759005	Field Office, Type II Field Office, Type II	EA-MO EA-MO
759006	Field Office, Type III Field Office, Type III	EA-MO EA-MO
760000	Pavement - Milling, Hot-Mix Pavement - Milling, Hot-Mix	SY-IN m^2-25 mm
760001	Pavement - Milling, Concrete Pavement - Milling, Concrete	SY-IN m^2-25 mm
760002	Pavement - Milling, Hot-Mix, Strip Cut Pavement - Milling, Hot-Mix, Strip Cut	SY-IN m^2-25 mm
760003	Pavement - Milling, Hot-Mix, Variable Depth Pavement - Milling, Hot-Mix, Variable Depth	S.F. m^2
760004	Pavement - Milling, Hot-Mix, 1″ Depth Pavement - Milling, Hot-Mix, 25 mm Depth	S.F. m^2
760005	Pavement - Milling, Hot-Mix, 1½″ Depth Pavement - Milling, Hot-Mix, 38 mm Depth	S.F. m^2
760006	Pavement - Milling, Hot-Mix, 2″ Depth Pavement - Milling, Hot-Mix, 50 mm Depth	S.F. m^2
760007	Pavement - Milling, Hot-Mix, 2½″ Depth Pavement - Milling, Hot-Mix, 63 mm Depth	S.F. m^2

Item No.	*Item Description*	*Pay Unit*
760008	Pavement - Milling, Hot-Mix, 3″ Depth	S.F.
	Pavement - Milling, Hot-Mix, 75 mm Depth	m^2
760009	Pavement - Milling, Hot-Mix, 3½″ Depth	S.F.
	Pavement - Milling, Hot-Mix, 89 mm Depth	m^2
760010	Pavement - Milling, Hot-Mix, 4″ Depth	S.F.
	Pavement - Milling, Hot-Mix, 100 mm Depth	m^2
761001	Butt Joints, Hot-Mix	S.F.
	Butt Joints, Hot-Mix	m^2
761002	Butt Joints, Concrete	S.F.
	Butt Joints, Concrete	m^2
762001	Saw Cutting, Hot-Mix	L.F.
	Saw Cutting, Hot-Mix	m
762002	Saw Cutting, Concrete, Full Depth	L.F.
	Saw Cutting, Concrete, Full Depth	m
762003	Saw Cutting, Concrete, Variable Depth	L.F.
	Saw Cutting, Concrete, Variable Depth	m
762004	Saw Cutting, Concrete, 2″	L.F.
	Saw Cutting, Concrete, 50 mm	m
762005	Saw Cutting, Concrete, 3″	L.F.
	Saw Cutting, Concrete, 75 mm	m
762006	Saw Cutting, Concrete, 4″	L.F.
	Saw Cutting, Concrete, 100 mm	m
763000	Initial Expense	L.S.
	Initial Expense	L.S.

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